THE ROLE OF COGNITIVE DIVERSITY AND BRAINWRITING ON CREATIVITY

A Thesis

by

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Submitted to the College of Graduate Studies of
Tarleton State University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

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December 2021

Major Subject: Applied Psychology

ACKNOWLEDGEMENTS

I would like to acknowledge my committee chair and mentor, Dr. Baruah. She has spent a significant amount of time guiding me through the entire process of this thesis. Also, for looking over my paper numerous times. Thanks to her, I have a better understanding about what goes into a research study. I would like to also thank my thesis committee members, Dr. Borchardt and Dr. Paulus, for taking the time to guide me and providing me with the necessary feedback to strengthen my study. Also, to the faculty members that shared this study with their students so that I may receive participants. I would like to thank my thesis group colleagues for their assistance in my study. Finally, to all my family and friends that have supported me during this time. Thank you all.

October 13, 2021

Abstract

Jimenez, Edgar, The Role of Cognitive Diversity and Brainwriting on Creativity, MASTER OF SCIENCE (Applied Psychology), December 2021, 69 pp., 2 tables, 2 figures, 97 references.

The current study examines the effects that cognitive diversity and two virtual idea generation methods (e.g., verbal brainstorming and brainwriting) have on creativity during the generation and selection phases of creativity. A sample of 133 students collaborated in groups of two to three to complete a creativity task using either verbal brainstorming or brainwriting modality. To manipulate cognitive diversity, the groups were primed with two conditions, namely, diverse or homogenous job-related diversity. The study is a 2 (brainwriting/verbal brainstorming) x 2 (functionally diverse/homogenous groups) x 2 (generation/selection) mixed factorial design. Results revealed that virtual brainwriting groups generated more ideas, more original ideas, and ideas of good quality than verbal brainstorming groups. Diverse groups were found to have selected ideas of higher originality than homogenous groups. The results of the study suggest ways to optimize creativity in virtual groups which may contribute to future approaches to brainstorming in workplace settings.

Keywords: Creativity, Brainwriting, Brainstorming, Cognitive Diversity, Stages of Innovation

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The role of cognitive diversity and brainwriting on creativity

Introduction

Creativity is a critical factor when producing new ideas, products, or services in organizations. Due to trends in globalization, and increasing diversity in workgroups, it is becoming important that the organizations learn how to manage diversity in team creativity (Williams & O'Reilly, 1998). Diversity refers to differences among individuals in a variety of ways such as culture, gender, race, education, knowledgebase, and cognitive styles (Jamieson & O'Mara, 1991; Miller et al., 1998; Westwood & Low, 2003). Diversity can promote creative outcomes in groups (Torchia et al., 2015), however, diversity is a "double-edged sword" (Milliken & Martins, 1996, p. 403) enhancing creativity as well as causing dissatisfaction among the group members (Milliken et al., 2003). Past studies have revealed that surface-level diversity such as demographic diversity (e.g., gender and ethnicity) led to mixed results in terms of team creativity (Terjesen et al., 2009; Torchia et al., 2010; Wiersema & Bird, 1993), whereas deeper level diversity, such as team cognitive style diversity, is positively linked to creativity (e.g., Aggarwal & Woolley, 2018; Torchia et al., 2015). Cognitive style refers to how individuals process information and may influence how people scan and interpret their environment for this information (Aggarwal & Woolley, 2018). However, the link between deeper level diversity (such as knowledge sharing) and creativity has been relatively overlooked (Bodla et al., 2018). The role of diversity in team interaction also depends on the mode of knowledge sharing (communication) among the team members.

Past studies had reported that the modality of brainwriting (group of people silently writing and sharing their written ideas in sequential order) could minimize the digression of the group from the focal topic (VanGundy, 1983) and enhance careful processing of shared ideas in

groups (Paulus & Yang, 2000). Although verbal interaction is seen as a natural modality for group interaction, using brainwriting can enhance the exchange of ideas (Brown & Paulus, 2002). Brainwriting, in contrast to verbal brainstorming, is a modality that involves silently writing down and sharing ideas on sticky notes in a collaborative setting (Heslin, 2009). In verbal interactions, clues to the latent individual differences (personalities, values, attitudes) are taken from members' interactions and these clues are expressed in the exchanges of information (Harrison et al., 2002). With the advances in information and communication technologies, organizations are increasingly using virtual teams to connect employees regardless of their geographic location, so that they can combine their knowledgebases to produce creative solutions to various business problems (Martins & Shelley, 2011). There is a growing body of literature on the effects of cognitive diversity (diversity in knowledgebase) on creativity in traditional face-to-face teams (e.g., Aggarwal and Woolley, 2018; Shin et al., 2012). However, the effects have not been examined much in virtual teams. To the best of my knowledge, the role of team cognitive diversity in verbal brainstorming and brainwriting techniques has not been directly compared across the stages of creativity (idea-generation and selection) in the virtual team context. In this study, I focus on team cognitive diversity and how the modality of communication (verbal brainstorming and brainwriting) impacts creativity in virtual teams.

Cognitive Diversity

McGrath et al. (1995) defined diversity in terms of five clusters of attributes, namely, 1) demographic attributes (e.g., age, race, ethnicity, sexual orientation); 2) task-related knowledge, skills, and abilities; 3) values, beliefs, and attitudes; 4) personality, cognitive and behavioral styles; 5) status in a workgroup (organizational rank, affiliation, etc.). Although the above clusters are multifaceted, they are not independent. For example, values, beliefs, and attitudes

overlap with cognitive styles. Drawing on the above definition, the present paper is concerned with diversity in terms of task-related attributes, such as abilities, knowledge, and expertise at the workplace (cognitive diversity). Cognitive diversity is defined as the extent to which a group exhibits differences in knowledge, preferences, experience, thinking styles, and beliefs (Dahlin et al., 2005; Mitchell & Nicholas, 2006).

Evidence from past research suggests that cognitive diversity is linked to team creativity. Torchia et al. (2015) explored deep-level (cognitive) diversity in a board of directors. The study focused on deep-level diversity as opposed to surface-level or cultural diversity and examined whether the backgrounds and personalities of the board members impacted the levels of cognitive conflict and creativity during the decision-making process. The results revealed a positive relationship between deep-level diversity and creativity. Specifically, deep-level diversity was found to enhance the quality of ideas and created more unique perspectives. Mitchell and Nicholas (2006) found that cognitive diversity played a significant role in the production of new knowledge. Participants were able to offer their unique perspectives, because they came from different educational backgrounds, to create original knowledge. Thus, factors that would typically restrain innovation (e.g., a lack of unique perspectives) were overcome and new ideas were created (Mitchell & Nicholas, 2006). Similarly, Paulus and Kenworthy (2019) reported that cognitive diversity can increase the range of ideas generated due to the diversity in knowledge and experience.

Aggarwal and Woolley (2018) studied the relationship between cognitive style diversity, cognition, and team creativity. Transactive memory system (TMS) was identified as a factor for the productivity of a group. TMS is defined as an understanding of how skills are distributed within the team, so members can identify who to communicate to for completing certain tasks.

To start, team members completed the Object-Spatial Imagery and Verbal Questionnaire (OSIVQ), which measured the individuals' verbalization and object and spatial visualization. Cognitive style diversity was measured as the sum of the within-group standard deviation for each cognitive style. Cognitive style diversity was found to indirectly influence team creativity through TMS when controlling for team strategic consensus. The results suggest that cognitive style diversity may have hurt team strategic consensus, but facilitates TMS, which was found to be a mechanism in explaining the positive effect of cognitive style diversity on team creativity (Aggarwal & Woolley, 2018).

Similarly, Shin et al. (2012) found that cognitive team diversity was positively related to individual team member creativity and the relationship was moderated by team members' creative self-efficacy. It was theorized that cognitive diversity was likely to promote creativity processes by sharing different knowledge, experiences, and perspectives. During the idea generation stage, group members combine or build on others' ideas, process information, and listen to others' unique perspectives to produce the most creative ideas. Groups that were more cognitively diverse were also found to boost task conflicts, while demographically diverse groups were believed to result in interpersonal conflicts. This may be because cognitively diverse groups were able to recognize their conflicts as part of the creativity process, while those that were demographically diverse believed their conflicts were due to social categorization disagreements. For this reason, task conflict may have actually promoted creativity while interpersonal conflicts restrained it. This supports why a positive relationship was found between team cognitive diversity and individual creativity when they rated their creativity positively. Moreover, no relationship was found between demographically diverse groups and individual creativity. (Shin et al., 2012).

Several components make up cognitive diversity. For example, people can have various levels of expertise working in different job disciplines, also termed functional diversity by some researchers. Many empirical studies have shown that functionally diverse teams can be more innovative than functionally homogeneous teams (Bantel & Jackson, 1989). Hollingshead (2000) reported that people were more likely to recall information in their area of expertise when working with a partner from a different work-related background. The author reasoned that this may be because participants were made to focus on their own area of expertise and each member was inclined to focus on areas in which their skills, experiences, and perspectives would thrive under these conditions.

Another study (Coursey et al., 2019) examined levels of expertise in sports and their impact on creativity. They were asked to rate their own level of expertise based on their knowledge and ability to explain sports to others. Their "expertise scores" were then used to label them as either high or low in expertise based on how their scores compared to the overall mean scores. The results reported that homogenously low expertise groups were found to present more ideas than homogenously high expertise and heterogeneous groups during the asynchronous interaction phase. This may be because those with high levels of expertise were more limited in their production of truly novel ideas due to their extensive experiences. Similarly, Kurtzberg (2005) found that cognitively diverse groups produced a greater number of ideas than homogenous groups. Moreover, Wang et al. (2016) suggested that cognitive diversity presented groups with a broad range of knowledge, skills, and ways of thinking that would eliminate redundant responses when producing new ideas, plans, or products. In a meta-analysis, Van Dijk et al. (2012) reported that job-related diversity was positively related to innovative performance.

Coursey et al. (2018) performed a study concerning many different personal factors, such as gender, age, ethnicity, and political affiliation, among others. Participants were asked to collaborate with others online regarding ways to improve the healthcare system. Results showed that individuals with differing political and value-based identities were more likely to produce higher levels of replies to partners as well as producing new ideas. This suggests groups where members are diverse in deeper level diversity such as expertise and knowledgebase, tend to perform better in producing innovative ideas, provided that they were not made aware of these personal differences.

Although many studies found a positive effect of cognitive diversity and more specifically, in terms of work-related diversity, some studies also reported negative effects. Murray (1989) reported that occupational diversity had a negative effect on short-term performance (company earnings/net worth) for board members in the oil industry. Their results suggest that occupational expertise diversity may have created interaction difficulties amongst board leaders. Milliken et al. (2003) noted that diversity plays a significant role in creativity and innovation. However, some groups experience interpersonal issues with people that have different backgrounds and perspectives. They may experience higher levels of conflict and difficulty identifying with other members of the group. Tiwana and McLean (2005) also reported that diversity in expertise levels did not solely account for creativity during group projects. Rather, they promote individual knowledge when working together as a group. Diversity in expertise has also been reported to be helpful at the generation phase of creativity, as the team benefits from combining a variety of perspectives, but not at the implementation stage of creativity, as it limited team's flexibility (Lovelace et al., 2001; Nuscheler et al., 2019).

Nuscheler et al. (2019) reported that low diversity in expertise is associated with fast and efficient team coordination especially in a competitive market context.

The above review of literature reveals that while some studies have produced mixed results (e.g., Milliken & Martins, 1996; Milliken et al., 2003), other studies have suggested that functional diversity has a positive effect on producing creative ideas (e.g., Torchia et al., 2015; Kurtzberg, 2005; Shin et al., 2012). Although work-related cognitive diversity is suggested to have a positive influence in areas such as storage and integration of knowledge (e.g., Hollingshead, 2000; Aggarwal & Woolley, 2018), the findings are inconsistent in the literature. The contradictory findings reported in the literature call for investigation of the context in which such work-related expertise can be effective (Bowers et al., 2000; Nuscheler et al., 2019). Additionally, few studies have investigated the effects of cognitive diversity across the stages of generation and selection, and it is not clear what factors lead such cross-functional teams to generate and select innovative ideas in product development (Poljo, 2018). The type of modality used by groups to generate and select ideas also affects creativity. Most studies have explored idea generation, but it is yet to be explored, how virtual brainstorming and the brainwriting paradigm can play a role in idea selection. The first objective of the study is to examine the effectiveness of work-related diversity in structured team ideation and selection process.

Verbal Brainstorming Versus Brainwriting

One important contextual factor is the modality (e.g., verbal or written communication) used by the groups to collaborate and perform a creativity task. Creative ideas can be generated using different types of modalities (VanGundy, 1988). For example, verbal or face-to-face brainstorming is one of the most popularly used modalities or techniques for producing creative ideas. Verbal brainstorming involves groups generating new ideas or solutions on a specific topic

(Osborn, 1957). The goal of verbal brainstorming is for a group of individuals to share amongst each other a series of ideas and to work together to produce the most unique and constructive ideas. The groups are typically instructed to follow four rules given by Osborn (1957) – criticism is ruled out, generate as many ideas as possible, free-wheeling is welcome, combination and improvements are sought. People tend to enjoy verbal interactions and this excitement is believed to enhance creative productivity during the idea generation phase (Paulus, 2000). However, verbal brainstorming also has many limitations, such as "verbal traffic jams" (Brown & Paulus, 2002, p.211), in which group members may lose their train of thought. Thus, production blocking occurs in verbal brainstorming because individuals must wait to present their ideas one at a time (Diehl & Stroebe, 1987). They may decide that their ideas are not good enough while they are waiting for their turn to present them, forget their idea once it is their turn, or others' ideas may influence their own original thoughts. Such collaborative inhibition occurs in the verbal paradigm because one participant's strategy for retrieving ideas from a category is made obsolete by the premature retrieval of ideas by another participant (Basden et al., 1997).

Social loafing is also common during verbal brainstorming sessions because some individuals may defer their role in generating ideas to other group members (Heslin, 2009). Social loafing refers to a decrease in motivation and effort when working in groups as opposed to working individually (Karau & Williams, 1993). Moreover, some researchers believe that social loafing is due to a reduction in self-evaluation. When working in groups, individuals' efforts are combined, and they may avoid taking the blame for a bad group performance. They may also avoid taking credit for good group performances (Karau & Williams, 1993). Evaluation apprehension is another limitation in the brainstorming process in which team members choose not to share all ideas because of their fear of negative feedback from the other members of their

group (Diehl & Stroebe, 1987). During the idea generation process, it is suggested that participants feel the need to withhold their ideas when they are told that their ideas will be evaluated. The demerits of face-to-face groups as stated above are also expected to be present in synchronous face-to-face virtual groups as there is no difference in the team interactions. Warkentin et al. (1997) reported that virtual and face-to-face teams exhibit similar levels of communication effectiveness.

In contrast, brainwriting is a modality that involves silently sharing ideas within a collaborative context by taking turns writing down ideas in a face-to-face environment (Heslin, 2009). There are multiple techniques used in brainwriting, all of which replace the use of verbal communication with written communication (VanGundy, 1983). In one common technique, group members take turns writing down their ideas on a sheet of paper or post-it notes. They then place the ideas in the center of the table and group members have the choice to pull out one or more of these ideas to create new ideas (Michinov, 2012). Another technique is electronic gallery brainwriting where the group members can type and read the same set of comments in parallel on the same computer screen (Aiken et al., 2007).

According to Heslin (2009), brainwriting technique potentially reduces interpersonal conflicts, domination of one or two of the group members, along with other limitations that would possibly exist in methods such as verbal brainstorming. Several studies have found that groups using the brainwriting paradigm produce more ideas than verbal brainstorming groups (VanGundy, 1995). Litcanu et al. (2015), for example, compared group verbal brainstorming and brainwriting. This study used a 6-3-5 brainwriting paradigm in which six participants sat in a group while being supervised by a moderator. Each participant was asked to write down three ideas on a worksheet every five minutes. After each session, they would hand the list of ideas to

the next participant, for a total of six rounds. Participants were encouraged to read the ideas written down and either build on them or let them influence new ideas. Litcanu et al. (2015) concluded that the brainwriting method was preferred and suggested that the brainstorming method tended to impose dominant group members, an issue that could be eliminated using the brainwriting paradigm.

The brainwriting paradigm may decrease limitations seen in verbal brainstorming, such as social loafing (Karau & Williams, 1993), evaluation apprehension, and production blocking (Diehl & Stroebe, 1987). Coskun (2011) explored the effects that brainwriting had over these concerns and found that brainwriting greatly reduced or eliminated these limitations. During the idea generation phase, a group of three individuals was asked to write their ideas onto a sheet of paper then pass it to the next person. Each person was asked to contribute to an idea until they had seen all of the ideas. The papers were then placed in the middle of the table. This process was repeated until the end of the session. The results found that those who exercised with close word associations produced more unique ideas than those who exercised with distant ones. Those who received memory instructions also produced fewer ideas than those who did not receive memory instruction (Coskun, 2011). Additionally, VanGundy (1993) found that brainwriting groups who shared their ideas produced four times as many ideas as those that did not share amongst the group. That is, people were more productive working in groups than working individually.

Le Hénaff et al. (2018) tested the effects of anonymity and intergroup comparison. Using the brainwriting paradigm, participants took turns writing ideas down on sticky notes. The anonymous groups used the same colored sticky notes while the identified groups used different colored sticky notes. Anonymous groups were found to produce more ideas and ideas of greater

diversity than those who were easily identified. The results suggested that those in the anonymous groups focused more on the quality of the ideas rather than being pressured into producing a larger quantity, competing with the other members of the groups. The effect of evaluation apprehension was reduced due to anonymity in groups (Le Hénaff et al., 2018).

Paulus and Yang (2000) found that brainwriting groups were more productive in creating unique ideas than those that worked individually. The group writing procedure may have increased the participants' attention to the ideas of the other members of their group. In this study, participants were asked to memorize the ideas of other members of the group. This attention to others may have additionally enhanced the production of their own ideas. Individuals in the brainwriting group were also believed to be more productive than those working alone because of social competition that was exhibited amongst the group members. There appeared to be an upward rather than a downward comparison process observed because of this competition (Paulus & Yang, 2000).

In sum, several studies have reported brainwriting as a form of communication technique that resulted in higher creativity than verbal brainstorming (Le Hénaff et al., 2018; Heslin, 2009; VanGundy, 1995). Although some studies (e.g., VanGundy, 1995) had compared the performance of brainwriting with verbal brainstorming groups in a collocated context, no experimental studies have compared the modality of virtual brainwriting with verbal brainstorming in a virtual team context. Virtual teams are groups of geographically dispersed individuals who communicate through information and communication technologies (Bell & Kozlowski, 2002). Although the effectiveness of face-to-face teams in creativity has been investigated extensively, research in the face-to-face teams in virtual context as compared to virtual brainwriting has not received much attention in the literature (Chamakiotis et al., 2013;

O'Neill et al., 2016). The findings so far have revealed that some factors can enhance creativity (e.g., collaborative climate, a lesser degree of conflicts) whereas others can hinder creativity (e.g., dominance, technical issues, subgroup formation) in virtual team context (see Chamakiotis et al., 2013; Litcanu et al., 2015; Ocker, 2005) but research has not specifically focused on virtual brainwriting. Overall, the findings are mixed, and no experimental studies have compared the two paradigms. Due to COVID-19, there has been increasing importance on virtual groups at workplaces. Hence, examining the role of work-related diversity in verbal and brainwriting paradigms in a virtual context is currently necessary.

Theory and Hypothesis Development

The similarity-attraction paradigm (Byrne, 1971) suggests that people typically prefer to be with similar partners because they anticipate their own values, attitudes, and beliefs will be reinforced. This can promote conflicts in teams (Jehn et al., 1999; Mannix & Neale, 2005). Such a preference towards homogeneity can promote the creation of more similar ideas and perspectives than divergent ones. Based on Williams and O'Reilly's (1998) "value in diversity" theory, cognitively diverse groups may be more motivated to produce innovative ideas because the exposure to different or divergent perspectives promotes team creativity. When each team member has a unique domain of expertise, there is a greater possibility of the creation of unique and nonoverlapping knowledge (Zajac et al., 2014).

The Associative Memory Model (Brown & Paulus, 2002) posits that stimuli are linked in our memory in the form of a network of semantically related nodes (or images). When one stimulus is activated in memory, it activates additional nodes in the semantic network. When the stimuli are diverse (Mednick, 1962) such activation can be enhanced by newer associations and new knowledge applicable in new concepts. When the groups are cognitively diverse in terms of

their knowledge base, a diverse set of stimuli can spread activate a diverse semantic network of knowledgebase resulting in novel associations. The cognitive-social-motivational model of group ideation (Paulus & Brown, 2007) extended the above model and reported that group diversity can increase cognitive stimulation by leading to a more diverse set of ideas from which the group can draw. According to this model, group cognitive diversity triggers a more diverse pool of ideas resulting more conceptual combination of ideas. These various perspectives may, thus, lead to the production of new ideas and thought processes in a group brainstorming environment. The alternative thinking styles may provide possible alternative solutions to various problems.

In terms of idea selection, the decision-making theory suggests that cognitive diversity presents a wide variety of thinking, perspectives, and skills that may lead to a selection of more original ideas (De Dreu et al., 2008). Some studies have confirmed the notion that the expertise of the team members affects the evaluation of creative ideas (e.g., Dailey & Mumford, 2006). Onarheim and Christensen (2012) reported that more radical ideas are less preferred by experts than incremental ideas. Since radical innovation is associated with high risk-taking (Amabile et al., 1996), people avoid selecting radical ideas. By nature, people are risk-averse while selecting ideas and hence they opt for average or feasible ideas (feasibility bias) (Dailey & Mumford, 2006; Rietzschel et al., 2010). On the other hand, some studies report that since work-related diversity promotes a wide range of information sharing (Bunderson & Sutcliffe, 2002), teams with work-related diversity can be better at making well-informed decisions, with fewer biases (overconfidence), than teams composed of functionally narrow individuals (Burke & Steensma, 1998). Given that the literature reveals a certain controversy about the influence of work-related diversity on team idea selection (decision-making), it will be interesting to examine the role of cognitive diversity in terms of work-related expertise on idea selection. Past studies have

reported that the generation of good ideas doesn't automatically lead to the selection of good ideas because groups often tend to select feasible ideas more than the original ones (feasibility bias) (Rietzschel et al., 2010). However, if the groups are provided with specific evaluation criteria or standards, the selection can result in high creativity (Harvey, 2014) by correcting the deficiencies in ideas (Lonergan et al. 2004).

Based on the theory of "value in diversity" and the Associative Memory Model, it is predicted that groups that are functionally diverse in work-related backgrounds will generate a wide variety of ideas from different areas resulting in higher originality and number of good quality ideas (ideas high in novelty and feasibility) than homogenous groups due to activation of unrelated categories of ideas. Additionally, clear instructions to evaluate the ideas for originality and feasibility during the idea selection process will further help reduce the groups' default focus on feasible ideas (Baruah et al., 2021; Rietzschel et al., 2007). Hence, I predict as follows:

H1: Functionally diverse groups will generate and select more original ideas and good quality ideas than homogenous groups.

I predict that brainwriting groups will generate more ideas due to reduced production blocking because of turn-taking compared to verbal groups. This modality will promote enhanced sharing and building on each other's ideas as the participants have the equal opportunity to pay attention to others' ideas (Paulus & Yang, 2000). The generation of more and better ideas in the brainwriting session should lead to better ideas chosen during the selection phase of creativity.

Even in high cognitive diversity conditions, the verbal brainstorming groups may not be able to generate the most ideas and the most original ideas due to production blocking associated with the lack of turn-taking. However, these limitations will not be observed as often for those in

the brainwriting paradigm. Everyone will have an equal opportunity to contribute during the idea generation process. Therefore, groups in this condition will be able to read others' ideas and write their ideas as they come into their minds. The brainwriting condition will facilitate more cognitive stimulation (mutual idea sharing, which facilitates the generation of more ideas and more elaboration) due to enhanced attention to the others' ideas. These groups will also select high-quality ideas in the selection session as the performance in the initial session will be carried over to the subsequent session (entrainment effect). Entrainment effect posits that the performance at the initial stage is the important factor in determining the subsequent outcome (Kelly & Karau, 1999). As previously noted, cognitively diverse groups would benefit from different perspectives and experiences to create more unique ideas, and this performance will be enhanced under the brainwriting condition. Hence, I predict the following:

H2: Groups under the brainwriting condition will generate more ideas compared to the groups under the verbal brainstorming condition.

H3: Groups under the brainwriting condition will also generate and select more original ideas and good quality ideas than those under the verbal brainstorming condition.

H4: The functionally diverse groups under the brainwriting condition will generate and select ideas of the highest originality and good quality.

Method

Participants

One hundred thirty-three students participated in this study. Out of those, 108 met the group criteria and were used in the final analysis. They participated in groups of 2 or 3 with 24 groups in the brainwriting modality and 26 groups in the verbal brainstorming modality. The brainwriting groups were further divided into 13 diverse and 11 homogenous groups. The verbal

brainstorming groups were divided into 14 diverse and 123 homogenous groups. A total of 42 dyads and 8 triads participated in this study. Functional diversity was manipulated in terms of work-related diversity. Functionally diverse groups consisted of participants that were primed for differences in their work-related backgrounds and homogenous groups consisted of participants that were primed for similarities in work-related backgrounds. The participants' ages ranged from 18-56 years (M = 28.9). Of the eligible participants, 84.5% were female and 15.5% were male. Students were recruited using the Sona system.

Design

The study is a 2 (brainwriting/verbal brainstorming) x 2 (functionally diverse/homogenous groups) x 2 (generation/selection) mixed factorial design. The type of diversity and type of modality were between-subject variables, whereas the "stages of creativity" (generation and selection) were repeated measures variables.

Measures

The dependent measures for this study include the total number of ideas (quantity), originality, feasibility, good quality ideas, and elaboration. The quantity of ideas refers to the number of non-redundant ideas generated in the generation phase of the brainstorming session. For the selection phase, the number of ideas includes those (top five ideas) that were retained and selected by the groups (Rietzschel, et al., 2010). Elaboration refers to the total number of details added to an individual idea (Guilford, 1966). Originality and feasibility were rated on a five-point rating scale (1 = 'not at all original/feasible', 5 = 'extremely original/feasible'). Unoriginal ideas received a score of 1, as they are very common or refer to an idea that already exists. Very original ideas received a score of 5 as they are rarely mentioned and very innovative (Rietzschel, et al., 2010). Additionally, unfeasible ideas refer to those that are impossible to implement, while

highly feasible ideas are very easy to implement and do not require large investments (Rietzschel, et al., 2010). Good quality ideas are those that receive a score of 3 or higher in both originality and feasibility on a five-point Likert scale as determined by trained raters using the previously defined terms (Blair & Mumford, 2007).

A demographic questionnaire was used to determine differences in participants' backgrounds such as their majors, current jobs, etc. (see Appendix B). Additionally, there was a post-experimental questionnaire used to check the manipulation and measure the thoughts and feelings of the groups about their performances (Appendix K).

Procedure

Participants logged in to the Zoom conference portal. The experimenter asked each participant to fill in the informed consent (Appendix A) and then to fill out demographic forms (Appendix B) using Google Forms. Each member also received a unique identification name via Zoom chat (BWD1, BWD2, etc., for those in the brainwriting condition; VBD101, VBD102, etc., for those in the verbal brainstorming condition). Participants were then randomly placed into their functionally diverse or homogenous groups. The participants were told that they had been assigned in their respective groups because they had been determined to be the most similar (homogenous) or different (diverse) based on work-related backgrounds. Functionally diverse groups had a short 10-minute priming session in which they were asked to fill in the common form with information regarding 10 differences in job function (Appendix C). Similarly, the homogenous groups discussed similarities in their job functions (Appendix D).

Virtual Brainwriting Condition. For those in the brainwriting condition, the participants received brainwriting rules (Appendix E). Then, the participants were invited to join a virtual brainwriting session by using the Miro application. The link to the application was

provided by the experimenter. The experimenter asked each participant to create their own anonymous profile for the Miro application, using the identification name given to them by the experimenter. The experimenter allowed the participants a few minutes to familiarize themselves with the application prior to the brainwriting session. Participants then received 10 minutes to silently generate as many ideas as possible for a given problem (Appendix G).

Prior to the experiment, they were encouraged to look at others' ideas and take turns so that it may have influenced them to build on those ideas or create their own original ideas (Appendix E). Using their uniquely colored digital sticky notes, participants submitted each idea on the canvas which all group members could view.

The experimenter then instructed (Appendix I) the participants to evaluate the ideas that were high in both originality and feasibility and to select the top 5 ideas. For this 10-minute session, participants were able to verbally communicate with each other to decide which ideas to select. The participants then posted the top five selected ideas in an assigned area next to the generated ideas on the canvas. Then, the participants received a post-experimental questionnaire (Appendix K). This questionnaire included items for manipulation check on cognitive diversity and their thoughts and feelings about their performance in the brainstorming and the selection task.

Virtual Verbal Brainstorming Condition. The groups under the verbal brainstorming paradigm received Osborn's brainstorming rules (Appendix F). The experimenter then read the brainstorming problem (Appendix H) to the participants. Ideas were communicated face-to-face via the Zoom application. They were also asked to type their ideas on the Zoom chat, so they could have retrieved them during the selection stage. This session was recorded and the data was transcribed. The participants had 10 minutes to complete this brainstorming task.

The experimenter instructed (Appendix J) the participants to evaluate the ideas that are high in originality and feasibility and to select the top 5 ideas. They were asked to make a list on the Zoom chat. This session also lasted for 10 minutes. The participants received the same post-experimental questionnaire (Appendix K) as the brainwriting group to evaluate their self-performance. The experimenter recorded the complete verbal brainstorming and decision-making sessions. Once the study ended, the individuals were debriefed and thanked.

Results

Data Scoring

The data were cleaned by removing the irrelevant and repeated ideas within a group. Then, two trained raters rated 50% each of the total data for feasibility and originality. To test the interrater reliability, the raters rated the same 25% of ideas. An agreement was reached when the ratings were the same on the five-point Likert scale or when the difference of the ratings was no more than one point (Baruah & Paulus, 2011; Diehl & Stroebe, 1987). The interclass correlation was used to measure this agreement between the raters. The interrater agreements of the ratings as measured by interclass correlation were as follows: originality = .91, feasibility = .88, and elaboration = .94. Based on criteria by Cicchetti and Sparrow (1981), the reliability values were considered to be “excellent”.

Manipulation Check

A question was included in the post-experimental questionnaire that tested for manipulation. The questions asked, “How different would you consider your group's work-related backgrounds to be?” An independent T-test was performed to check if there was a significant difference between homogenous and diverse groups. The T-test revealed a marginally

significant effect [$t(51) = 1.98$, $p = .053$] with the mean rating of the diverse groups ($M = 6.03$, $SE = .31$) higher than the homogenous groups ($M = 5.14$, $SE = .31$) as rated on a 9-point scale.

Correlations

There was a negative correlation between originality and feasibility [$r(50) = -0.32$, $p < .05$] at the generation stage but not at the selection stage [$r(50) = -0.18$, $p > .05$]. Quantity was positively correlated with originality [$r(50) = .28$, $p < .05$] and negatively correlated with feasibility [$r(50) = -0.28$, $p < .05$] in the generation stage.

Interaction Between Type of Cognitive Diversity, Modality, and Stages

First, a 2x2x2 mixed factorial MANOVA was performed with functional diversity (2 levels, diverse and homogenous), modality used (2 levels, brainwriting and face-to-face brainstorming), and stages of creativity (2 levels, generation and selection) as independent variables for the combined dependent variables of originality, feasibility, and good quality ideas. The MANOVA revealed a significant interaction of diversity and stages of creativity [$F(1.48) = 4.99$, $p < .05$, ${}_p\eta^2 = .09$], and stages and type of modality used [$F(1, 48) = 4.91$, $p < .05$, ${}_p\eta^2 = .09$]. However, the MANOVA revealed no main effect of any of the independent variables. Table 1 presents the mean and standard deviations of all the dependent variables.

Univariate Analysis for the Type of Modality

A 2x2x2 mixed factorial ANOVA results for each of the dependent variables are presented in Table 2. The ANOVA for originality revealed that there was a significant main effect of the type of modality in terms of originality [$F(1, 48) = 44.06$, $p < .001$, ${}_p\eta^2 = .48$]. The means revealed that the brainwriting group condition led to more original ideas ($M = 2.63$, $SD = .26$) than the verbal brainstorming ($M = 2.23$, $SD = .23$). There was also a significant interaction

of modality and the stages of creativity in terms of original ideas [$F(1,48) = 4.91$, $p < .05$, $_p\eta^2 = .093$]. The brainwriting condition generated the most original ideas during the selection stage of creativity (see Figure 1).

The ANOVA for feasibility revealed a significant main effect of modality [$F(1, 48) = 11.18$, $p < .01$, $_p\eta^2 = .19$]. The means revealed that verbal brainstorming groups generated ideas of higher feasibility ($M = 3.00$, $SD = .46$) than brainwriting groups ($M = 2.67$, $SD = .24$). The ANOVA for good quality ideas revealed a significant main effect of the type of modality [$F(1, 48) = 15.18$, $p < .001$, $_p\eta^2 = .24$]. The means revealed that brainwriting groups generated higher proportion of good quality ideas ($M = .40$, $SD = .22$) than verbal brainstorming groups ($M = .20$, $SD = .18$). Because the number of ideas varied across generation (free ideation) and the selection (maximum 5 ideas) phase, the number of good quality ideas also varied. Hence, I calculated the proportion of good quality ideas to make the two conditions comparable. Additionally, the ANOVA for elaboration did not reveal a significant effect of modality [$F(1,48) = 2.95$, $p = .09$, $_p\eta^2 = .58$]. However, brainwriting groups conditions ($M = 25.11$, $SD = 32.32$) led to more elaboration than verbal brainstorming groups ($M = 12.74$, $SD = 26.38$).

Additionally, a separate ANOVA for each of generation and selection phase was performed. At the generation phase, there was a significant main effect of modality in terms of quantity [$F(1, 47) = 15.18$, $p < .01$, $_p\eta^2 = .21$], originality [$F(1, 47) = 29.31$, $p < .001$, $_p\eta^2 = .38$], feasibility [$F(1, 47) = 13.27$, $p < .01$, $_p\eta^2 = .22$], and good quality ideas [$F(1, 47) = 15.22$, $p < .001$, $_p\eta^2 = .25$]. The brainwriting groups generated significantly higher quantity of ideas ($M = 22.52$, $SD = 8.30$) than the verbal brainstorming groups ($M = 15.43$, $SD = 5.89$). The brainwriting groups generated significantly more original ideas ($M = 2.57$, $SD = .20$) than the verbal brainstorming groups ($M = 2.25$, $SD = .22$). The verbal brainstorming groups generated

significantly more feasible ideas (M = 2.98, SD = .40) than the brainwriting groups (M = 2.63, SD = .23). Lastly, the brainwriting groups generated a significantly higher proportion of ideas of good quality (M = .37, SD = .16) than the verbal brainstorming groups (M = .20, SD = .16).

For the selection phase, there was a significant main effect of modality in terms of originality [$F(1, 47) = 36.50$, $p < .001$, ${}_p\eta^2 = .44$], feasibility [$F(1, 47) = 6.72$, $p < .05$, ${}_p\eta^2 = .13$], and good quality ideas [$F(1, 47) = 10.15$, $p < .01$, ${}_p\eta^2 = .18$]. The brainwriting groups selected significantly more original ideas (M = 2.64, SD = .27) than the verbal brainstorming groups (M = 2.21, SD = .25). The verbal brainstorming groups selected significantly more feasible ideas (M = 3.02, SD = .52) than the brainwriting groups (M = 2.71, SD = .26). Lastly, the brainwriting groups selected a higher proportion of good quality ideas (M = .43, SD = .29) than the verbal brainstorming groups (M = .21, SD = .21). Thus, H2 and H3, which stated that brainwriting will lead to the generation and selection of more ideas and, generation and selection of more original and good quality ideas were supported.

Univariate Analysis for the Type of Cognitive Diversity

A 2x2x2 mixed factorial ANOVA for originality revealed no main effect of diversity for any of the dependent variables. H1, which stated that cognitively diverse groups will generate and select more original and good quality ideas was not supported. However, there was a significant interaction of diversity and stages of creativity, [$F(1, 48) = 4.99$, $p < .05$, ${}_p\eta^2 = .09$] for originality. The diverse groups produced ideas of the highest originality at the selection stage (see Figure 2). Finally, H4, which states that diverse brainwriting groups will generate and select ideas of the highest originality and quality was not supported. No other interaction effect was

evident from the analysis. Separate analyses of generation and selection phases revealed no significant difference in terms of cognitive diversity.

Post-Experimental Questionnaire

A post-experimental questionnaire was used to measure the thoughts and feelings of the groups in the generation and the selection phase. For the question, "Were you able to build new ideas from your group members' ideas?", the homogenous groups reported higher agreement ($M = 7.37$, $SD = .98$) as a response compared to the diverse groups ($M = 6.68$, $SD = 1.38$), $t(51) = -2.09$, $p < .05$.

Discussion

The study examines the effects of the type of brainstorming paradigm and functional diversity on the creative performance of collaborative groups across the idea generation and selection phases in virtual settings. Broadly, the present research seeks to provide some responses to the following questions: Do virtual brainwriting groups perform better than virtual verbal brainstorming groups? Does the functional diversity of group members further influence creative performance during a virtual brainwriting task?

To the best of my knowledge, this is one of the first studies that experimentally tests the effectiveness of virtual brainwriting followed by an idea selection session compared to virtual brainstorming groups. The first key finding of the study is that the virtual brainwriting groups generated more ideas, more original ideas, less feasible, and higher proportion of good quality ideas than verbal brainstorming groups. Consistent with VanGundy (1995), the brainwriting condition produced more ideas than verbal brainstorming. Confirming Heslin's (2009) suggestion regarding the need for experimental studies examining the potentials of brainwriting,

my study further reported that the virtual brainwriting paradigm can be another effective method of brainstorming paradigm compared to regular virtual verbal brainstorming groups. Michinov (2012) reported that in face-to-face brainwriting (using chits), additional effort is needed to pick up and read the ideas written by other participants; and they are, therefore, likely to focus on their own ideas, without paying much attention to those produced by others. My study shows an alternative method of brainwriting, wherein all the ideas were laid out using "electronic post-it notes" on the canvas which allowed everyone to view the ideas simultaneously on the screen. Such an electronic brainwriting paradigm can reduce the likelihood of attention loss thereby enhancing the focus on the task. Cognitive facilitation, whereby the ideas of other people trigger novel associations (Paulus et al., 2001) happens when individuals pay attention to other peoples' ideas (Dugosh et al., 2000). In the post-experimental questionnaire, a participant in the brainwriting condition commented - "Seeing other idea pools getting bigger, it gave me something to work off of and inspiration to work hard." This indicates enhanced attention and motivation among virtual brainstorming groups to generate more ideas by seeing the pool of ideas of others. This could have contributed to the generation of more ideas and more association between the ideas. Additionally, the finding in the current study has confirmed that the brainwriting groups generated more original ideas whereas the verbal brainstorming groups continued generating more feasible ideas than the novel ones.

Michinov (2012) reported that brainwriting groups had a disadvantage compared to the electronic brainstorming groups because the face-to-face brainwriting participants (using chits) could not view the complete pool of ideas. In my study, the groups in both modalities could view the complete pool of ideas. In verbal brainstorming sessions, one of the group members typed all the ideas being generated in the group. Still, the brainwriting groups were more creative than the

virtual brainstorming groups. The attention and cognitive stimulation were likely to be higher in this paradigm because of anonymity in the current study,

In the current study, the brainwriting groups were anonymous. They could only view the ideas generated in different colored "post-it notes". This condition of anonymity could have further enhanced the group's focus on the task due to the lack of distraction from the observable diversities. Anonymous participants have been found to generate more ideas, and ideas of greater diversity, than those who could be identified, but only when intergroup comparison was salient (Hénaff et al., 2018). Research shows that anonymity promotes effective evaluation of communication as the source is not attached to the ideas, especially in an anonymous electronic brainstorming paradigm (Dennis et al., 2019). Individuals are more open to producing unique ideas when they are anonymous (Cooper et al., 1998). In contrast, the virtual verbal brainstorming group members could see and hear each other much like a face-to-face condition. All the factors leading to production blocking among the face-to-face groups could still be present in the virtual verbal brainstorming groups except for the fact that the groups can view the complete pool of ideas.

In terms of real-world settings, some of the past studies have reported the effectiveness of brainwriting that includes drawing and annotation (Linsey et al., 2010). The virtual brainwriting paradigm used in the current study can be helpful for design engineers where they often need sketches to explain the unique design ideas (Van Der Lugt, 2002). Future research can conduct studies incorporating such sketching activities in the virtual brainwriting paradigm using anonymity. This technique allows for a visual means of expression, which could be suitable for design engineers.

The second key finding of the current study is that participants who initially brainstorm using the brainwriting paradigm make better decisions at the selection phase. The brainwriting groups in this study selected ideas of higher originality compared to the verbal groups. Previous studies have consistently found that participants tend to focus on feasibility more than the originality of ideas (Dailey & Mumford, 2006; Rietzschel et al., 2010).

In this study, the gain in performance at the selection stage can be attributed to two factors. Firstly, I provided specific instructions to evaluate the ideas while selecting the top five ideas. Past studies have reported that specific instruction regarding selection criteria can enhance the idea selection process (Rietzschel et al., 2010; Harvey, 2014). The specific instruction that the groups were to select and evaluate the ideas simultaneously could have been beneficial. The dialectical perspective of creativity suggests that the phases of creativity can be intertwined so that they can occur in various orders and through multiple cycles (Anderson, De Dreu, & Nijstad, 2004; Bledow, Frese, Anderson, Erez, & Farr, 2009; Harvey, 2014; Schroeder, Van de Ven, Scudder, & Polley, 1986; Van de Ven & Poole, 1995). In support of this perspective, Rietzschel et al. (2007) found no difference between separating and not separating the ideation and evaluation stages. The iterative focus on selection and evaluation could have benefitted the brainwriting groups more than the verbal brainstorming groups because of the less production blocking and undivided attention in the brainwriting group condition.

Secondly, the enhanced focus on original ideas at the selection stage in the current study can be attributed to the fact that the focus on originality at the generation phase was carried over to the selection phase (entrainment effect, Kelly & Karau, 1999). Future studies should further explore such effects more in-depth for various virtual brainstorming modalities across stages of creativity such as generation, selection, refinement, and implementation.

The third key finding of the study is that the diverse groups chose ideas of higher originality and good quality at the selection phase. The findings, in terms of the effectiveness of the homogenous groups in the generation phase, are consistent with Shin et al. (2012) and contrary to Milliken et al. (2003). Firstly, in the brainstorming stage, one is opened to generating any ideas without much deliberation. However, the selection stage needs careful evaluation. While evaluating the ideas, the diversity of perspectives should allow groups to reconsider the choices and challenge each other's ideas (Chatman et al., 1998) before finalizing the top choices. Ancona and Caldwell (1992) reported that nonoverlapping knowledge and unique information through non-redundant peer networks enhances team performance. Thus, diverse group conditions should be more helpful in the decision-making phase. Secondly, the evaluation instruction that was given prior to the selection stage might have helped the diverse groups to continue focusing on the original ideas, reducing the likelihood of feasibility bias. In contrast, the consensus-seeking nature of the homogeneous groups might have allowed for fewer challenges and contradictions (Williams & O'Reilly, 1998) resulting in the selection of less original ideas at the decision-making phase.

Surprisingly, the homogeneous groups produced more original ideas than the diverse groups at the generation stage, although the effect was not found at the selection stage. The deep exploration hypothesis by Rietzschel et al. (2007) suggests that although the homogenous condition leads to enhanced focus on fewer topics or categories, deeper exploration of limited categories can lead to the creation of more unlikely ideas once the common ideas are exhausted. In response to the question, "Were you able to build new ideas from your group members' ideas?", in the post-experimental questionnaire, the homogeneous groups reported higher mean agreement compared to the diverse groups. This finding further reveals that homogenous work-

related diversity may be helpful at the generation stage as the participants have an opportunity to focus on a narrow set of topics. The similarities in work experience can be associated with higher interpersonal attraction (Wiersema & Bantel, 1992) and better team compatibility (Mullen & Copper, 1994). Facilitating knowledge integration (Lin et al., 2012) may allow the homogenous teams to pay more attention and build on each other's ideas. In future research, it will be interesting to study the degree of within category fluency in each of the homogenous and diverse groups to study which groups explored ideas more in-depth to create novel ideas at the idea-generation stage.

Limitations

Due to the COVID-19 pandemic, certain aspects of this study were changed to accommodate restriction guidelines. The study used all virtual sessions. This required students to have access to their own Zoom accounts, Google accounts (to fill in Google Forms), and to have stable internet connections to participate in this study. Although it was instructed for them at the beginning of each study to avoid any distractions, some students participated with other people in their homes or they participated in a public location. Additionally, all forms had to be filled in online. This may have been easier to be done with physical copies. Some students in the brainwriting condition were also challenged in learning a new virtual application called Miro to generate their ideas. Additionally, the study lacked a control group. Hence, it is not clear whether the performances of the diverse and homogenous groups were above or below the baseline performance. It is possible that both diverse and homogenous groups would perform better than the control group.

Future Implications and Conclusion

Although there are some restrictions in having all virtual sessions, there are also many benefits from this. Virtual studies allow individuals to collaborate in a group setting wherever they may be. For the brainwriting sessions, no verbal communication is allowed. This is made simpler when participants are not in the same location and are muted through the Zoom application. Virtual post-it notes, as opposed to physical post-it notes, are also more useful in preventing unnecessary waste. Furthermore, anonymity reduces the potential impact of observable diversity on collaborative tasks.

The current research explores the effects of having groups from different work-related backgrounds. Diversity was manipulated in this study using priming sessions. Future studies could measure actual diversity by looking at participants' work-related backgrounds and examine the effects across stages of diversity. Additionally, other areas of diversity (e.g., race, gender, personality types) should be explored in the future. The study also further explores the effectiveness of the virtual brainwriting paradigm. It has been conducted during the COVID-19 pandemic when the importance of virtual groups has increased significantly. The findings of the current study make a critical contribution to the literature, given that online platforms are evolving as even more significant mediums for creativity and problem-solving tasks. The virtual brainwriting application, for example, could be used in different disciplines, such as education, as a means of generating ideas in interactive group settings. The act of writing down ideas encourages people to thoroughly process and express ideas clearly (Litcanu et al., 2015). Future research should examine how to develop deep and meaningful virtual group support for workplaces in real-world settings.

Table 1-*Descriptive Statistics*

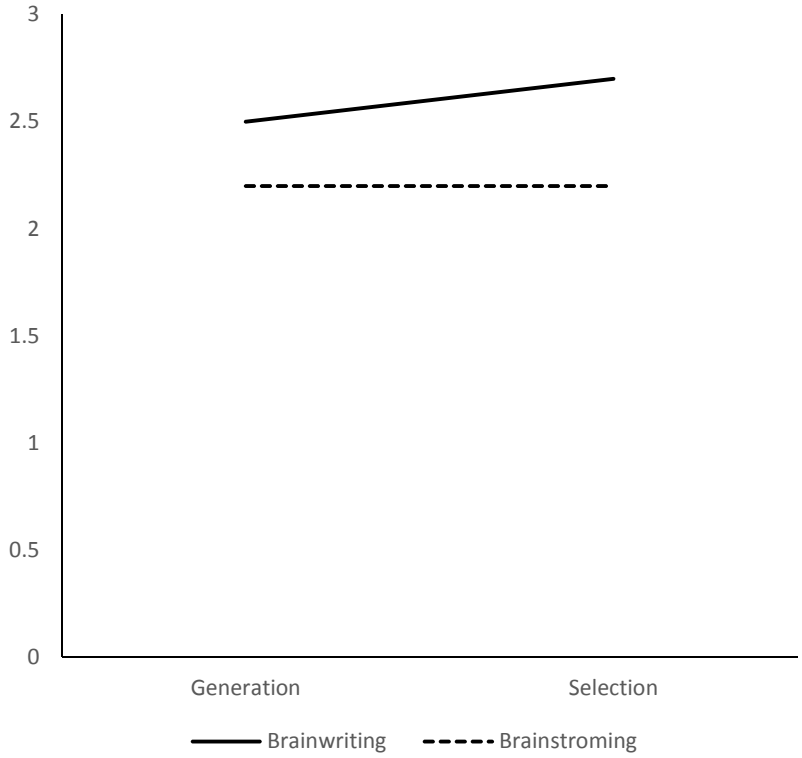
Type of Modality	Dependent Variables	Condition	Generation *M*(*SD*)	Selection *M*(*SD*)
Brainwriting	Quantity	Diverse	21.42(*5.50*)	N/A
		Homogenous	23.08(*10.48*)	N/A
	Originality	Diverse	2.54(*0.17*)	2.78(*0.21*)
		Homogenous	2.61(*0.22*)	2.58(*0.28*)
	Feasibility	Diverse	2.60(*0.26*)	2.68(*0.25*)
		Homogenous	2.69(*0.19*)	2.72(*0.26*)
	Elaboration	Diverse	22.66(*25.47*)	28.33(*44.69*)
		Homogenous	22.80(*24.68*)	26.67(*34.47*)
	Good Quality Ideas	Diverse	0.32(*0.13*)	0.40(*0.30*)
		Homogenous	0.44(*0.17*)	0.47(*0.27*)
Verbal Brainstorming	Quantity	Diverse	15.14(*6.46*)	N/A
		Homogenous	15.71(*5.50*)	N/A
	Originality	Diverse	2.21(*0.26*)	2.19(*0.21*)
		Homogenous	2.29(*0.18*)	2.23(*0.28*)
	Feasibility	Diverse	2.96(*0.45*)	2.94(*0.51*)
		Homogenous	3.00(*0.38*)	3.10(*0.54*)
	Elaboration	Diverse	11.74(*19.06*)	5.71(*21.38*)
		Homogenous	12.07(*19.05*)	21.43(*46.05*)
	Good Quality Ideas	Diverse	0.17(*0.16*)	0.17(*0.15*)
		Homogenous	0.23(*0.15*)	0.24(*0.26*)

Table 2-*ANOVA for All Dependent Variables*

Measures	Source	Df	F	$_p\eta^2$
Originality	Diversity	1,48	0.00	0.00
	Modality	1,48	44.06**	0.48
	Stages	1,48	1.03	0.02
	Diversity*Modality	1,48	1.08	0.02
	Diversity *stages	1,48	4.91*	0.09
	Modality*stages	1,48	4.99*	0.09
	Diversity*Modality*Stages	1,48	2.89	0.06
Feasibility	Diversity	1,48	0.65	0.01
	Modality	1,48	11.18**	0.19
	Stages	1,48	1.58	0.03
	Diversity*Modality	1,48	0.04	0.00
	Diversity *stages	1,48	0.16	0.00
	Modality*stages	1,48	0.06	0.00
	Diversity*Modality*Stages	1,48	1.16	0.02
Good Quality Ideas	Diversity	1,48	2.32	0.05
	Modality	1,48	15.18**	0.24
	Stages	1,48	1.57	0.03
	Diversity*Modality	1,48	0.08	0.00
	Diversity *stages	1,48	1.57	0.00
	Modality*stages	1,48	0.98	0.02
	Diversity*Modality*Stages	1,48	0.43	0.01
Quantity*	Diversity	1,48	0.31	0.01
	Modality	1,48	11.67**	0.20
	Diversity*Modality	1,48	0.08	0.00

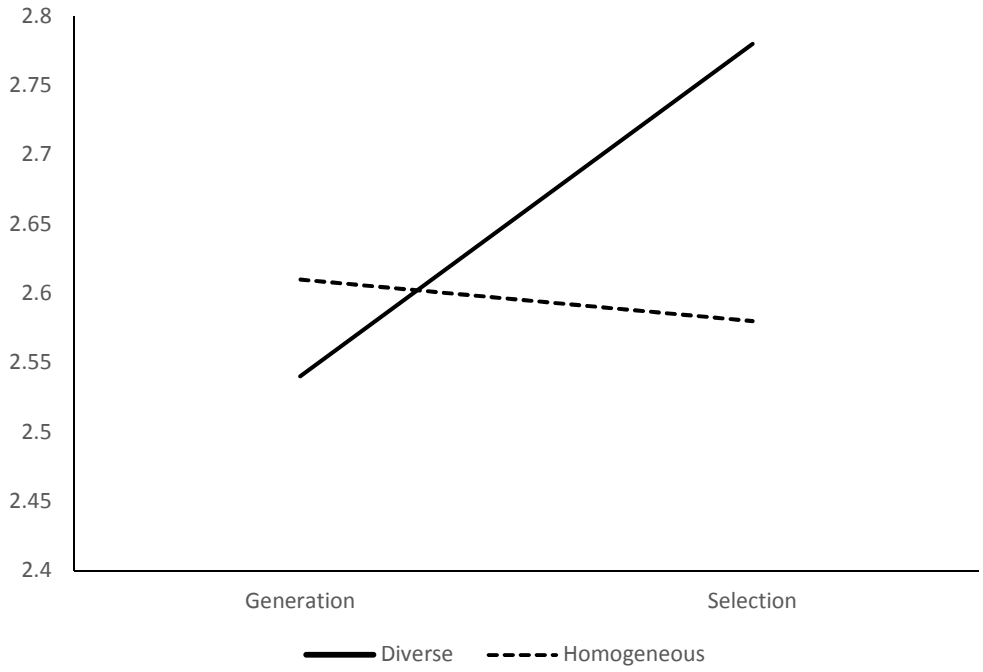
Note. ** $p < .001$, * $p < .05$. $_p\eta^2$ = Partial eta square

Figure 1-*Interaction between modality and stages of creativity for originality*



Note: Interaction between type of modality and stages of innovation in terms of originality.

Figure 2-*Type of diversity and stages of creativity for originality*



Note: Interaction between type of diversity and stages of innovation in terms of originality.

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APPENDIX A

INFORMED CONSENT

Participant ID:

Informed Consent

Purpose: Today's organizations seek opportunities to build a successful business. Organizations must evaluate many ideas before arriving at a good quality idea. The main objective of this research is to enhance the quality of ideas that is generated through brainstorming through different brainstorming paradigms.

Study Procedure: Interaction with others will be completed either through verbal communication or by posting virtual Post-it sticky notes. You will be given instructions on how to complete the task in each session.

Your Right to Withdraw: You have the right to discontinue the study at any time during your participation.

Benefits: This study does not guarantee benefits for the participants. Participants can become knowledgeable of how research is proceeded.

Risk: This study has minimal risk.

Estimated Time: It will take approximately one hour to complete the study.

Researcher Contact Information: This study will be conducted by Edgar Jimenez from the Graduate Department of Psychological Sciences. Any questions about the study should be sent to edgar.jimenez@go.tarleton.edu

By signing this form, you acknowledge that you understand the information in accordance to the study.

_____ _____

Participant's Signature Today's Date

_____ _____

Experimenter's Signature Today's Date

APPENDIX B

BACKGROUND QUESTIONNAIRE

Participant ID: _____

Please answer the following information about yourself:

1. Gender: _____
2. Age: _____
3. Major: _____
4. Ethnicity: _____
5. City of Birth: _____
6. Current Job: _____ Number of years: _____
7. Previous job (if any): _____ Number of years: _____
8. Future Career Goal: _____

APPENDIX C

FUNCTIONALLY DIVERSE GROUPS PRIMING DISCUSSION

Participant ID: _____ to _____

Please enter your job position under your Participant ID. One participant will be designated the leader and first fill out the information for themselves and then for the rest of the group below. The leader and the other group members will be asked to explain their job functions as the leader writes each one down. Then with your group members, discuss how **different** your job functions are from each other. Job functions include any duties, characteristics, or goals one has in their work environment (or in their school environment if no previous job). You have 10 minutes to complete this task.

	ID Participant 1 Job position:	ID Participant 2 Job position:	ID Participant 3 Job position:
Your current/most recent job functions	1. 2. 3. 4. 5. 6. 7. 8. 9. 10.	1. 2. 3. 4. 5. 6. 7. 8. 9. 10.	1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

APPENDIX D

HOMOGENOUS GROUPS PRIMING DISCUSSION

Participant ID: _____ to _____

Please enter your job position under your Participant ID. One participant will be designated the leader and first fill out the information for themselves and then for the rest of the group below. The leader and the other group members will be asked to explain their job functions as the leader writes each one down. Then with your group members, discuss how **similar** your job functions are from each other. Job functions include any duties, characteristics, or goals one has in their work environment (or in their school environment if no previous job). You have 10 minutes to complete this task.

	ID Participant 1 Job position:	ID Participant 2 Job position:	ID Participant 3 Job position:
Your job functions	1. 2. 3. 4. 5. 6. 7. 8. 9. 10.	1. 2. 3. 4. 5. 6. 7. 8. 9. 10.	1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

APPENDIX E

BRAINWRITING RULES AND ADDITIONAL RULES

With the advances in information and communication technologies, organizations are increasingly using virtual teams to connect employees regardless of their geographic location, so that they can combine their knowledgebases to produce creative solutions to various business problems (Martins & Shelley, 2011). Modern organizations today search for procedures that will enhance not just the quantity of ideas, but the quality of ideas generated by participants as well. Brainwriting is a modality that involves silently sharing ideas within a collaborative context by taking turns writing down ideas (Heslin, 2009). There are multiple techniques used in brainwriting, all of which replaces the use of verbal communication with written communication (VanGundy, 1983). During this experiment, you will participate in two sessions. During the sessions, you are required to apply these rules:

1. **Quantity is wanted.** Produce as many ideas as possible.
2. **Freewheeling is encouraged.** Each idea can lead to another idea that may be better. Generate as many ideas to produce better ideas.
3. **Criticism is not allowed.** Participants' critical opinions of ideas will not be allowed. Every idea is welcomed.
4. **Combine and improve ideas.** Combination of ideas can produce better ideas. Be willing to create unique ideas by further expanding on others' ideas.
5. **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 their experiences.
    ii) Do not explain ideas. Do not expand on why you think something is good or bad. Simply state your idea and continue with the next ideas.

APPENDIX F

OSBORN'S RULES AND ADDITIONAL RULES FOR VERBAL BRAINSTORMING

With the advances in information and communication technologies, organizations are increasingly using virtual teams to connect employees regardless of their geographic location, so that they can combine their knowledgebases to produce creative solutions to various business problems (Martins & Shelley, 2011). Many studies have built a foundation on Osborn's (1953) rules to produce a good quantity of ideas. Modern organizations today search for brainstorming procedures that will enhance not just the quantity of ideas, but the quality of ideas generated by participants as well. During this experiment, you will participate in two sessions. During the sessions, you are required to apply Osborn's rules (rules 1-4) as well as these additional rules:

1. **Quantity is wanted.** Produce as many ideas as possible.

2. **Freewheeling is encouraged.** Each idea can lead to another idea that may be better. Generate as many ideas to produce better ideas.

3. **Criticism is not allowed.** Participants' critical opinions of ideas will not be allowed. Every idea is welcomed.

4. **Combine and improve ideas.** Combination of ideas can produce better ideas. Be willing to create unique ideas by further expanding on others' ideas.

5. **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 their experiences.

   ii) Do not explain ideas. Do not expand on why you think something is good or bad. Simply state your idea and continue with the next ideas.

APPENDIX G

BRAINWRITING PROBLEM

During this session, you will generate ideas over the given topic. You will have 10 minutes to produce as many ideas as possible using your uniquely colored virtual Post-it notes. Remember the rules given to you. Combine ideas, freewheeling is welcome, typos are fine, quantity is wanted, and criticism is not allowed. Additionally, no verbal communication will be allowed for this session. When generating ideas, you may use your areas of expertise to provide a unique perspective. However, do not restrict yourself to only this as quantity is mostly desired for this study.

The topic that you will generate ideas from is: **What are some ways to improve Tarleton State University (TSU)? Any suggestions about improving TSU will be acceptable.**

APPENDIX H

VERBAL BRAINSTORMING PROBLEM

During this session, you will generate ideas over the given topic. You will discuss ideas as a group through the Zoom application. For each idea generated, one member (leader) will briefly type these ideas using the Zoom chat. You will have 10 minutes to generate your ideas. Remember the rules given to you. Combine ideas, freewheeling is welcome, typos are fine, quantity is wanted, and criticism is not allowed. When generating ideas, you may use your areas of expertise to provide a unique perspective. However, do not restrict yourself to only this as quantity is mostly desired for this study.

The topic that you will generate ideas from is: **What are some ways to improve Tarleton State University (TSU)? Any suggestions about improving TSU will be acceptable.**

APPENDIX I

BRAINWRITING SELECTION SESSION INSTRUCTIONS

During this session, you will collaborate with your group members to select the five best ideas that are high in feasibility as well as originality out of your group's overall generated ideas. The definitions of feasibility and originality are given below:

Feasibility: Feasibility is the extent to which an idea is relatively easy or feasible to adopt. It may or may not be a good idea. The point is to capture the degree to which the idea is one that could actually be done without a lot of effort or cost.

Originality: Originality refers to the degree to which an idea is unique or unlikely to be mentioned by others. It may or may not be a good idea. The point is to capture the degree to which the idea is one that no or few individuals would be likely to generate.

You will select the best five ideas (in any order). Do this by dragging those sticky notes into the designated box. You will have 10 minutes to complete this task.

APPENDIX J

VERBAL BRAINSTORMING SELECTION SESSION INSTRUCTIONS

During this session, you will discuss with your group members to select the five best ideas that are high in feasibility as well as originality out of your group's overall generated ideas. The definitions of feasibility and originality are given below:

Feasibility: Feasibility is the extent to which an idea is relatively easy or feasible to adopt. It may or may not be a good idea. The point is to capture the degree to which the idea is one that could actually be done without a lot of effort or cost.

Originality: Originality refers to the degree to which an idea is unique or unlikely to be mentioned by others. It may or may not be a good idea. The point is to capture the degree to which the idea is one that no or few individuals would be likely to generate.

Discuss, then type the best five ideas (in any order) and post to everyone on the Zoom chat. You will have 10 minutes to complete this task.

APPENDIX K

POST-EXPERIMENTAL QUESTIONNAIRE

Participants no: _____

Please complete this questionnaire of your participation in this study. This questionnaire will inform the experimenter of your overall satisfaction of your experience in the study. The more extreme you feel in one direction or another, the more you should mark a number in that direction. The following scales rate your satisfaction response towards the study. You should try to make your response selection as accurate as possible.

1. How different would you consider your group's work-related backgrounds to be?

   1 2 3 4 5 6 7 8 9

   Very Similar Very Different

2. How different were the ideas that you generated from the ideas that others in the group generated?

   1 2 3 4 5 6 7 8 9

   Very Similar Very Different

3. Were you able to build new ideas from your group members' ideas?

   1 2 3 4 5 6 7 8 9

   Not at all Very Much

4. How would you rate the quality of ideas that your group **generated**?

   1 2 3 4 5 6 7 8 9

   Very Few Very Many

5. How would you rate the quality of ideas that your group **selected**?

   1 2 3 4 5 6 7 8 9

   Very Low Very High

6. How much did you enjoy the idea generation session?

   1 2 3 4 5 6 7 8 9

   Not at all Very Much

7. How much did you enjoy the idea selection session?

   1 2 3 4 5 6 7 8 9

   Not at all Very Much

8. How focused were you on the brainstorming task?

   1 2 3 4 5 6 7 8 9

   Not at all Very Much

9. How focused were you on the idea selection task?

   1 2 3 4 5 6 7 8 9

   Not at all Very Much

10. How motivated were you to complete the task?

    1 2 3 4 5 6 7 8 9

    Not at all motivated Very Motivated

11. How much did you feel that your idea generation was inhibited while brainstorming in groups?

    1 2 3 4 5 6 7 8 9

    Not at all Very Much

12. Please indicate if there is anything specific or in general that prompted you to work harder or generate more ideas _____