

CREATIVITY IN THE 21st CENTURY

**EXPLORING DIFFERENCES IN CREATIVE VIRTUAL AND
FACE-TO-FACE MEETINGS**

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Creativity in the 21st Century - Exploring differences in creative virtual and face-to-face meetings

Abstract:

In a post-Covid-19 world, discussions regarding meeting virtually or face-to-face are more relevant than ever. Moreover, the ability to solve problems through creative thinking is crucial for students, not only for their personal performance but also for their contribution to the future development of organizations and societies. This study uses Media Richness Theory (MRT) and Guilford's measures of divergent thinking to investigate the impact virtual environments have on creative idea generation. The thesis aims to answer the following research question: *To what extent is group creativity in the form of idea generation affected by virtual versus face-to-face meeting environments?* The question is answered through a mixed methods abductive study. Data was collected through an experiment, whereby university students exercised Guilford's Alternative Uses Test including an evaluation on the following four criteria of creativity: Fluency, Flexibility, Originality, and Elaboration. In addition, qualitative data in the form of interviews and observations were used to capture and evaluate the subjective nature of creativity. The result of the study is that Fluency and Flexibility are negatively affected and Originality positively affected by a virtual environment. Findings regarding Elaboration are inconclusive. The results conclude that face-to-face is the overall optimal medium for creative meetings. Since MRT predicts only one of four criteria of creativity correctly, the results of this thesis restrict the use of MRT for the purpose of recommending which communication medium should be utilised for group meetings with the aim of generating ideas.

Keywords:

Creativity, Divergent Thinking, Face-to-Face Teams, Media Richness Theory, Virtual Teams

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Definitions and Abbreviations

Term	Abbreviation	Definition
Divergent Thinking	...	The phenomena of generating several different solutions to a given problem (Guilford 1967). Used interchangeably with the term idea generation.
Media Richness Theory	MRT	A theoretical structure for analyzing different communication mediums. Suggests that all communication mediums lie on a spectrum from less to more rich, where face-to-face is the richest medium (Daft, Lengel 1984).
Torrance Test of Creative Thinking	TTCT	90 minute test of creativity in the form of divergent thinking within the educational field (Kim 2006).
Consensual Assessment Technique	CAT	Test of creativity using expert judges. According to this theory there exists no objective criterion to measure creativity (Amabile 1982).
Alternative Uses Test	AUT	A widely used test of divergent thinking within creativity research (Guilford 1967).
Mediums / Media	...	The means through which information is communicated and conveyed, e.g. through face-to-face or virtual communication (Daft, Lengel 1984).
Ordinary Least Squares	OLS	“A generalized linear modeling technique that may be used to model a single response variable which has been recorded on at least an interval scale.” (Moutinho 2011).
Control Group	...	Groups conducting the experiment face-to-face.
Experimental Group	...	Groups conducting the experiment virtually.
Treatment	...	Exposing participants to a virtual environment.
Stockholm School of Economics	SSE	Private business school located in Stockholm, Sweden.

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1. Introduction

1.1. Background

“Without creativity, there would be no progress and we would be forever repeating the same patterns.” (De Bono 1999). Creativity is in many ways an asset. It can be considered the key to solving individual, social and organizational problems (Metwaly, Kyndt et al. 2017) and is thus an important aspect of the management field (Proctor 1991). Hence, creativity has for a long time been regarded as a hot topic of research and has recently sparked new interest due to the discourse on how it enables sustainable development initiatives (Awan, Sroufe et al. 2019). The importance of creativity is further pronounced in the world of academia where there exists a quest for creativity and innovation through the transfer and creation of knowledge (Braun, Peus et al. 2016).

During the Covid-19 pandemic, many students and faculties within higher education discovered the advantages of remote work, such as accessibility and comfort (Mukhtar, Javed et al. 2020). Lockdowns and closed universities forced the rapid adaptation of studying remotely and the replacement of face-to-face interaction with virtual meetings. However, nowadays in the post-pandemic world, students and universities are required to make a decision. They must choose either to continue to develop the practice of utilizing virtual meetings or to re-introduce the standard of meeting face-to-face. This decision is important, not only for students and their performance, but also for schools and potential employers. The ability to solve problems through creative thinking and innovative solutions is crucial for the development of organizations as well as societies (Metwaly, Kyndt et al. 2017). Thus, exploring which meeting format fosters this ability becomes highly relevant.

To make an informed decision of what medium to use, a significant need has arisen to explore the influence virtual environments have on creative group meetings. Management scholars and practitioners claim that the increase of remote work within groups calls for research on how virtual configurations reshape different management practices within academia and business (Chamakiotis, Dekoninck et al. 2013). The shift to studying and working from home in combination with a growing concern for the environmental impact, time, and cost of travel (Caulfield, Charly 2022) further supports this assessment.

One of the most common theories for analyzing different communication mediums is Media Richness Theory (MRT) (Daft, Lengel et al. 1984). Still, there are conflicting opinions in the academic field as to which sort of medium is most effective for creative tasks (Suh 1999; Reiter-Palmon, Kramer et al. 2021). This thesis thus aims to investigate the impact virtual

versus face-to-face environments have on creative idea generation in groups and tests MRT's validity in recommending a communication medium for this purpose.

1.2. Research Gap

There is a lack of research on the impact virtual meetings, in the form of video calls, have on collaborative communication regarding creativity (Reiter-Palmon, Kramer et al. 2021). Furthermore, there exist conflicting views in the literature regarding which level of richness is appropriate for facilitating creativity in the form of idea generation (Suh 1999; Reiter-Palmon, Kramer et al. 2021; Brucks, Levav 2022; Grözinger, Irlenbusch et al. 2020; Redlbacher, Hattke 2022). The ambiguity of previous research calls for further exploration in this area to clarify the currently conflicting recommendations of communication mediums for creative tasks. Additionally, most previous studies of creativity in virtual environments have been of quantitative nature. This thesis thus further intends to contribute to the literature by combining a quantitative and qualitative approach to comprehend the subjective nature of creativity.

1.3. Aim and research question

This study aims to investigate the impact virtual versus face-to-face environments have on creative idea generation in groups. The main purpose is to contribute to research regarding remote work within higher education and more specifically clarify the now conflicting literature regarding communication mediums' relation to creativity. In addition, the researchers hope to facilitate the choice of medium for the creative needs of students and teachers. The goal of this thesis is to investigate the impact virtual environments have on students' creativity in the form of divergent thinking.

The phenomenon of creativity in virtual versus face-to-face environments is studied, through creativity measures of divergent thinking, and hypothesized, based on theories of media richness. The results are further discussed and explained by concepts regarding environmental impact, psychological safety, and heightened creative performance from increased engagement within groups.

This research report, using a concurrent mixed methods approach, aims to answer the following research question:

To what extent is group creativity in the form of idea generation affected by virtual versus face-to-face meeting environments?

1.4. Delimitation

The sample of this study consists of students studying a Bachelor of Sciences program at the Stockholm School of Economics (SSE).

In this thesis, virtual meetings are defined as meetings that occur via virtual platforms, such as zoom, where participants are not collocated (Reiter-Palmon, Kramer et al. 2021). This study does not consider hybrid forms of virtual meetings, nor virtual meetings where the camera and/or microphone is turned off.

In addition, this thesis is delimited to observing creativity in the form of divergent thinking, which is measured through the four elements Fluency, Flexibility, Originality, and Elaboration (Guilford 1967).

The study focuses on meetings held in groups since there is a lack of research using standardized tests to explore co-creativity (Wu, Su et al. 2022).

2. Literature Review

2.1. Creativity

2.1.1. Defining Creativity

The definition of creativity, which has long been a topic of debate among researchers, is constantly changing. Considering that this thesis researches creativity in group constellations, a definition of group creativity is provided. Co-creativity is the phenomenon of how individuals produce innovative ideas together and includes shared knowledge, shared ideas and shared achievements (Wu, Su et al. 2022).

J.P. Guilford, is considered by scholars to be the founder of modern creativity research (Akbari Chermahini, Hickendorff et al. 2012). Guilford introduced the concepts of convergent and divergent thinking to define creativity (Guilford 1967). Divergent thinking is the ability to generate several ideas or solutions to a situation or problem, and convergent thinking refers to the process of choosing the most logical answer to the problem (Guilford 1967).

Considering that the objective of this thesis is to investigate the impact virtual versus face-to-face environments have on the generation of ideas in groups, Guilford's (1967) convergent thinking is outside the scope of the research topic and will therefore be disregarded. This study focuses on creativity through the activities which lead to idea generation, i. e. divergent thinking. An opportunity hence arises for future research to study convergent thinking in remote settings.

2.1.2. Measuring Creativity

Difficulties relating to measuring creativity include the lack of consensus regarding the definition of creativity, which leads to problems in the validity of creativity measures (Runco 2010). Sternberg's article "What's wrong with creativity testing" (2020) concludes that different ways of viewing creativity lead to different ways of measuring it. Sternberg (2020) does not suggest that creativity measures are invalid, but rather, that care should be taken to ensure that the test truly measures what is later claimed in the results. Thus, thorough consideration has been taken in the decision of how to measure creativity to ensure that the selection of the test fits the purpose of this study.

Creativity Tests used to measure divergent thinking in other studies include:

- Torrance Test of Creative Thinking (TTCT), the most widely used test of creativity in the educational field (Kim 2006).
- The Consensual Assessment Technique (CAT), which uses expert judges to assess creative performance (Amabile 1982).

- J.P. Guilford's (1967) Alternative Uses Test (AUT) used to measure creativity in the form of divergent thinking.

The time constraints of conducting the required amount of full TTCT trials (90 minutes) (Kim 2006) led to the TTCT being disregarded. The accessibility constraints of appointing appropriate observers for CAT (Amabile 1982) resulted in the exclusion of CAT.

In this thesis, J.P. Guilford's (1967) Alternative Uses Test (AUT) has been chosen to measure creativity. AUT has been shown to be a valid indicator of divergent thinking and is still widely employed (Runco, Acar 2012; Wu, Su et al. 2022). Since AUT has been vastly used, there exists norms and extensive research which can be consulted for interpretations of scores and results (Runco, Acar 2012). Further, AUT has been verified to successfully assess creative performance within groups (Wu, Su et al. 2022).

2.1.3. Psychological Safety and Creativity

Team psychological safety is the shared perception among team members that it is safe for members to voice their ideas within a team (Edmondson 1999). Psychological safety has been described as a key to innovation (Mukerjee, Metiu 2022) since an important aspect of co-creativity is the process of group interaction in sharing knowledge (Wu, Su et al. 2022). Hence, high levels of psychological safety within a group is a significant predictor of creative team performance, specifically idea generation (Kessel, Kratzer et al. 2012; Mukerjee, Metiu 2022).

Further, psychological safety among students of higher education has been shown to influence knowledge sharing behavior positively in face-to-face environments compared to in virtual environments (Catyanadika, Rajasekera 2022) as well as increase engagement and commitment to a given task (Tu 2021; Mukerjee, Metiu 2022).

2.1.4. Engagement and Creativity

Having fun has been found to correlate with engagement (Jamaludin, Ahmad et al. 2015), which enhances creativity (Bakker, Xanthopoulou 2013). Groups that feel increased engagement through strongly emphasizing shared goals, value participative problem-solving and spend more time socializing with each other, are proven to exercise increased creativity (Gilson, Shalley 2004).

2.1.5. Environmental Impact on Creativity

Amabile (2013) asserted that the generation of creative output requires not only internal but also external components, such as the surrounding environment. Recent studies have revealed that some environmental stimuli can enhance creativity and the generation of creative ideas (Daikoku, Fang et al. 2021). A study conducted by Schertz, Bowman et al. (2022) shows that

environmental influences have an effect on cognition in the form of thoughts and feelings. Thus, the surroundings and environment of an individual can affect which ideas they generate.

2.2. Remote Work

2.2.1. Media Richness Theory

MRT suggests that all communication mediums lie on a spectrum from less to more rich. Face-to-face is the richest type of communication, while documents are on the lower spectrum of media richness. Richer communication mediums are, according to the theory, able to communicate more information not just by spoken or written words, but also in the form of for example body language and tone of voice (Daft, Lengel et al. 1984). Using too rich a medium when communicating simpler communication, for example creative idea generation, leads to noise and ambiguity, decreasing meeting performance (Daft, Lengel et al. 1984; Daft, Lengel 1986).

According to MRT there are 4 characteristics used to measure communication type richness (Daft, Lengel et al. 1984):

Feedback: Some media allow receivers of information to give feedback in different amounts of time. In a face-to-face conversation, feedback can take the form of an instant facial expression or a look. This is not possible in for example a letter where the respondent must take time to write something down to give feedback.

Channels: Different media allows for different types of channels. In face-to-face communication, you receive information through both audio and visualization. In a phone call, you only communicate through audio.

Source: Different media is deemed more or less personal. Face-to-face is regarded as the most personal while communicating through written numbers is deemed the least personal.

Language: Different media is categorized by the type of language used. Face-to-face is the richest regarding the variation of language using both natural language (meaning spoken or written words) and body language.

2.2.2. Criticism of Media Richness Theory

MRT has received criticism from a plurality of papers (Ishii, Lyons et al. 2019). Researchers have argued that MRT does not acknowledge social influence and external factors (Fulk, Steinfield et al. 1987). Moreover, although there are some studies investigating MRT using virtual communication, empirical tests of MRT for newer forms of media have not been substantial and thus resulted in ambiguous findings (Dennis, Valacich et al. 2008). Scholars also highlight MRT's inability to take into account personal experience of, and attitude

towards the medium when evaluating richness (Ishii, Lyons et al. 2019). Furthermore, other researchers suggest the communicator's relationship is an important factor in determining the optimal medium used (Haythornthwaite 2002). This factor is not examined by MRT and its importance is supported by multiple studies (Ledbetter, Taylor et al. 2016; Pusateri, Roaché et al. 2015).

2.3. Research Intersection

There exist a few studies which have researched idea generation and creativity in virtual environments. One paper conducted by Brucks and Levav (2022) compares creativity in virtual and face-to-face meetings through a quantitative approach. The result found that “/.../ videoconferencing inhibits the production of creative ideas.”. On the other hand, another study found that virtual meetings were superior to face-to-face meetings, in conducting creative tasks (Redlbacher, Hattke 2022). A third study found that there was no significant difference in creative performance between the two mediums (Grözinger, Irlenbusch et al. 2020). These findings show ambiguous conclusions about which medium is most appropriate for creative idea generation.

3. Theoretical Frameworks

3.1. Use of Theoretical Frameworks

This thesis tests whether or not MRT (Daft, Lengel et al. 1984) correctly advocates the optimal medium for meetings with the purpose of generating creative ideas. Guilford's (1967) AUT is used to measure creativity in the form of divergent thinking in both environments.

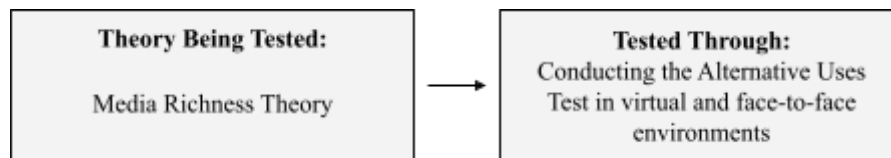


Figure 1: Use of Theoretical Frameworks

3.3.1. Media Richness Theory

By studying differences in creativity in face-to-face and virtual meetings, this paper studies the effect of different communication mediums. MRT (Daft, Lengel et al. 1984) has for many years been a prominent theory when evaluating different mediums of communication (Anders, Coleman et al. 2020; Ishii, Lyons et al. 2019)

MRT states that the appropriateness to use certain media depends on the characteristics of the task at hand (Daft, Lengel et al. 1984). Rich media (face-to-face) is appropriate when the group is required to interpret and analyze difficult and complex issues whereas less rich media (virtual) is suitable when the complexity of the organizational phenomena discussed in the meeting is low (Daft, Lengel et al. 1984). See *Figure 2*.

Discourse of MRT portrays contrasting recommendations of medium for creative idea generation. According to Reiter-Palmon, Kramer et al. (2021), using rich communication mediums is associated with higher levels of creativity in groups in general. On the other hand, it is argued by other researchers that tasks requiring participants to brainstorm or generate ideas are more appropriately conducted via less rich forms of media (Suh 1999) due to the low complexity of the task. Also, there exists a conflict in the literature outside of the scope of MRT about which communication medium is the most appropriate for creative tasks. Some suggest that face-to-face environments are optimal (Brucks, Levav 2022) and others advocate for virtual environments (Redlbacher, Hattke 2022).

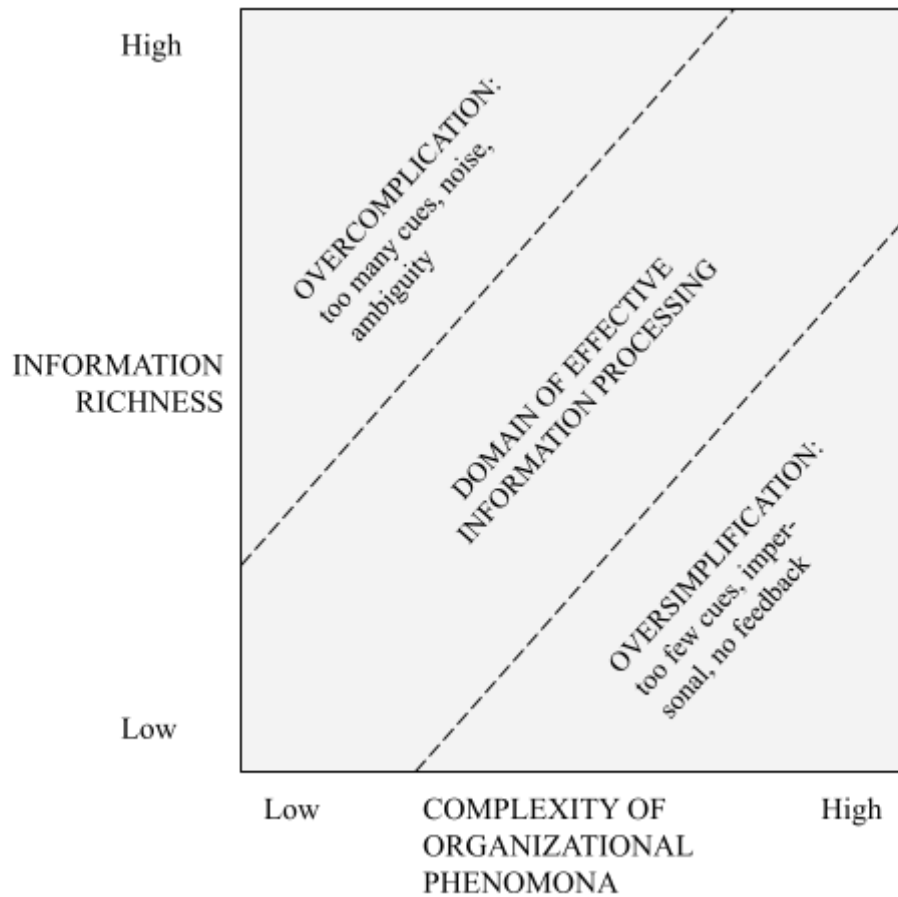


Figure 2: Model of Managerial Information Processing
 From “Information richness: A new approach to managerial behavior and organization design.” Daft Lengel et al. 1984, 6, 199

3.2.2. Alternative Uses Test

This thesis measures creativity in the form of divergent thinking through J.P. Guilford’s (1967) AUT.

The AUT involves participants generating as many novel alternative uses for an object (for example a paper clip) as possible during a two minute interval (Guilford 1967). Creativity in the form of divergent thinking is assessed through four elements; Fluency, Flexibility, Originality, and Elaboration (Guilford 1967). According to Palanica, Lyons et al.’s (2019) revised version of the AUT (Guilford 1967) in consultation with Guilford et. al’s (1978) Alternate Uses Manual and Sample, the four elements are used to assess the alternative uses as follows:

Fluency: The total number of responses generated

Flexibility: The number of different categories of responses

Originality: Each response is compared to all responses from all of the groups. Responses given by only 5% of the sample are deemed as original and awarded 1 point. Responses generated by more than 5% of the sample are not deemed as original and are thus awarded 0 points.

Elaboration: Assesses the level of detail of the response and is scored as the average number of words per response.

3.3.3. Hypotheses Formulation

Virtual meetings are judged to be less rich than face-to-face meetings due to increased equivocality (Kahai, Cooper 2003; Daft, Lengel 1986). Taking into account the low task complexity of idea generation (Daft, Lengel et al. 1984; Suh 1999), a higher score in all four of Guilford's (1967) categories of creativity is expected to be achieved using less rich communication mediums, i.e. the virtual medium. Therefore, the hypotheses proposed below predict all categories of creativity to receive higher scores in virtual meetings than face-to-face meetings.

Hypothesis 1: Groups via virtual medium will exhibit higher Fluency scores than groups via face-to-face medium

Hypothesis 2: Groups via virtual medium will exhibit higher Flexibility scores than groups via face-to-face medium

Hypothesis 3: Groups via virtual medium will exhibit higher Originality scores than groups via face-to-face medium

Hypothesis 4: Groups via virtual medium will exhibit higher Elaboration scores than groups via face-to-face medium

4. Method

4.1. Research Stance

This thesis was conducted within the pragmatic paradigm where reality is viewed as external and rich, thus it can be interpreted in many different ways (Saunders, Lewis et al. 2019). The research paper has used qualitative research methods to explore the perceptions of creativity through a subjective ontology. Additionally, quantitative measures, through an objective ontology, have been used to quantify and measure creativity.

Originally, a deductive approach was used to make predictions about the effect virtual environments have on creativity. Hypotheses were based on Daft, Lengel et al.'s (1984) MRT with support from Suh (1999) and Redlbacher and Hattke (2022). These hypotheses were tested by Guilford's (1967) AUT. After the analysis of empirical findings, it was found that MRT failed to explain critical aspects of the virtual environments' impact on creativity. Thus, additional theories were applied to suggest and explain different interpretations of the results. This alternation between theory and data and back to theory exhibits the use of an abductive approach rather than a deductive one.

4.2. Research Design

This research paper used a concurrent mixed methods design (Saunders, Lewis et al. 2019). Data was collected through an experiment with quantitative measures and qualitative observations. In addition, qualitative data was collected through interviews. The choice of research design is discussed in section 7.6.

4.3. Sample

The sample used in this study consists of Swedish native-speaking university students attending SSE. It consisted of 80 individuals divided into 20 experimental trial groups with four people in each group. 16 randomly selected individuals participated in a 15-25 minute interview after the completion of the experiment.

In the thesis, two factors affecting creativity were kept constant for all trial groups, both face-to-face and virtually. This was done to ensure the comparability of the groups with and without treatment.

- The number of females (2) and males (2) in a group, since gender has an impact on verbal creative performance (Matud, Rodríguez et al. 2007). Considering that SSE's Bachelor programs have a (60-40%) ratio between men and women (Norrby, Spath 2022), the most representative ratio between the two genders is 2-2 (50-50%).

- The use of participants whose native language is Swedish. All experiments were held in Swedish due to the pronounced impact of language on people's ability to express creative ideas and thoughts (Rollof 2009).

The sample was selected through two procedures. Firstly, the researchers contacted students in digital group chats from previous projects (grouped at random by faculty at SSE). Secondly, all students present in the atrium of SSE (a large hall where SSE students study) were approached at two given times. Targeting everyone studying in the atrium during a set period reduced the amount of personal bias from the researchers in the selection. The fact that some people might be more likely to study at school than others had the effect that, the sample was not able to constitute an exact representation of the population. Still, this sample selection was adopted because it was deemed an efficient way for the researchers to access a large number of students.

After all sign-ups had been collected, individuals were randomly grouped in same gender pairs. This was followed by randomly grouping all pairs with a pair of the other gender, creating teams of four people. Half of the groups were randomly assigned to the treatment (meeting virtually). Participants who, for some reason, were unable to attend the experiment in person were removed from their set group and randomly assigned to a virtual group. This further damaged the randomization process. In view of the difficulties finding participants, the researchers nevertheless resolved to use this method to optimize the number of times the experiment was able to be carried out.

There were several practical reasons for using students studying at SSE. The researchers of this paper were at the time of the study students of SSE. Hereby adequate ways were accessible for the researchers to find and communicate with potential participants attending the school. Further, the power dynamics between the participating students and the researchers were weakened since both parties were part of the same organization and on the same hierarchical level. This decreased the risk of participants changing their behavior during the experiments due to being observed (Saunders, Lewis et al. 2019).

4.4. Interviews

Interviews were held in direct connection with the end of the experiment with one of four participants per group (see exceptions in 7.5.2.). The interviews followed a semi-constructed format. The interviews consisted of 15 predetermined questions (Appendix 1). In addition, in some cases follow up questions were added whereby the interviewees were asked to elaborate on their thoughts. A scale of 1-7 was used for rankings (Appendix 1), as it has been deemed optimal when examining students of higher education (Weijters, Cabooter et al. 2010).

4.5. Experiment

In order to investigate co-creativity in groups, a number of four participants per group was chosen with the aim of minimizing the number of participants per group while maximizing the number of trials conducted. Four participants is the minimum group number still allowing for a (50-50%) ratio between men and women.

The experiment conducted in this study was the AUT (Guilford 1967). In the test, participants were instructed to come up with as many alternative uses for a wooden plank as possible during the period of 2 minutes. All groups worked with the same item. Before the test, each group conducted a short ice-breaking exercise to ensure that participants did not waste time with courtesies once the test had begun, thus heightening creative performance (Fullwood, Derrer-Rendall et al. 2006)

Half of the teams executed the experiment virtually and the other half face-to-face. One member of each group was randomly assigned to be the secretary. The secretary's job was to write down all suggestions of the group. Both virtual and offline secretaries wrote with pen and paper to ensure that groups with and without treatment had the same conditions.

To replicate the conditions of a “normal” virtual meeting, the virtual participants were instructed to sit in an environment, using the same devices (headphones and computer) and settings of an “ordinary virtual group meeting”. The normality of the face-to-face meeting was mirrored by using a room on SSE grounds commonly used for studying and group assignments.

4.6. Measures

4.6.1. Independent Variable

This study aims to investigate the impact virtual versus face-to-face environments have on the effectiveness of creativity in the sense of idea generation. The independent variable of the study is thus the environment in which the meeting is being conducted; virtually or face-to-face. Control groups are subject to the face-to-face environment and experimental groups are subject to the treatment of conducting the experiment in a virtual environment.

4.6.2. Dependent variables

The dependent variables of the research are the quantitative measures of creativity categorized into Fluency, Flexibility, Originality, and Elaboration.

of ideas conceived by group = Fluency Score = Flu

of idea categories covered by group = Flexibility Score = Fle

of original ideas conceived by group = Originality Score = O

average # of words used to describe an alternative use by the group = Elaboration Score = E

4.6.3. Control variables

Control variables consisted of:

Time of day (Time): The different experiments were conducted at different times of the day. This involved potentially affecting the group's performance, with groups meeting later in the afternoon being negatively affected (Breslin 2019).

How well the participants knew each other (Familiarity): The level of familiarity within the teams may have affected creativity, since it has been shown that participants with low prior connections have increased creative performance (Perry-Smith 2006). In consideration hereof, the interviewees were asked to give scores on how well they knew the other participants (Appendix 1). The average of these scores were turned into a control variable, referred to as Familiarity score, which controlled how well people in the group knew each other before the experiment.

4.7. Data Analysis

The most commonly used p-value threshold for determining statistical significance is $P < 0.05$ and was thus used in this paper (Di Leo, Sardanelli 2020; Saunders, Lewis et al. 2019).

The following actions were taken to minimize researcher bias. The experiment was conducted by one researcher, who later reported the answers from the groups anonymously. Thereafter, another researcher assessed the results of the groups. The researcher assessing the groups, was not aware of which environment the group had been exposed to (virtual or face-to-face).

The data was recorded in excel where it was processed by counting and categorizing the uses generated by the groups. The categorized data was later moved to the statistical software STATA to produce the Ordinary Least Squares (OLS) regressions. The assumptions of the OLS regressions require a test for multicollinearity, which was conducted through a VIF-test. Further, the OLS assumptions included ensuring that residuals were normally distributed and homoscedastic. This was tested through the generation of QQ-plots and a Breusch-Pagan test.

The results showed no multicollinearity or signs of heteroscedasticity in the data (Appendix 2). The residuals of the regressions (in the subjective assessment of QQ-plots) were assumed to be close to normally distributed (Appendix 2). Hence, the OLS regressions could be used for testing the hypotheses.

The following OLS regressions were used:

$$Flu_i = \alpha + \beta_1 \text{Virtual}_i + \beta_2 \text{Time}_i + \beta_3 \text{Familiarity}_i + \varepsilon_i$$

$$Fle_i = \alpha + \beta_1 \text{Virtual}_i + \beta_2 \text{Time}_i + \beta_3 \text{Familiarity}_i + \varepsilon_i$$

$$O_i = \alpha + \beta_1 \text{Virtual}_i + \beta_2 \text{Time}_i + \beta_3 \text{Familiarity}_i + \varepsilon_i$$

$$E_i = \alpha + \beta_1 \text{Virtual}_i + \beta_2 \text{Time}_i + \beta_3 \text{Familiarity}_i + \varepsilon_i$$

See 4.6.2. for definitions of Flu_i , Fle_i , O_i , E_i . α represents the intercept, β_1 represents the independent variable examined, β_2 and β_3 represent the control variables and ε_i represents the error term.

4.8. Qualitative Analysis

All interviews were recorded and transcribed with consideration taken to GDPR. The empirical results were analyzed thematically. Both researchers individually highlighted recurring codes and patterns from all 16 transcriptions. Codes were then compared between the researchers and grouped into four main themes, incorporating ideas related to the research question (Saunders, Lewis et al. 2019). These four themes were presented in the empirical results and then re-grouped in the analysis using MRT and later additional theories as a theoretical lens.

4.9. Ethical Considerations

The experiment and interviews of the study were designed to ensure that participants were not subject to the risk of embarrassment or any other material disadvantage (Saunders, Lewis et al. 2019). This was assured through a detailed manuscript of the procedure of the experiments and interviews (Appendix 3), which aimed at making the participants feel safe and not subjected to mental or social pressure.

Further, all participants consented to participate before being made aware of the aim of the study. Information on the research topic was given upon completion of the experiment. This decreased the participants' ability to make an informed decision before consenting to participate, which can be criticized from an ethical perspective (Saunders, Lewis et al. 2019). However, participants had the opportunity to withdraw from participation and retrieve the data they had provided at any point before or after the research topic had been made known. All participants were informed of their rights under GDPR and were ensured confidentiality beforehand.

4.10. Discussion of Method

Validity in the form of generalisability can only be applied to Bachelor students studying economics, working in groups where everyone has the same native language, since such a

group constituted the sample used in the study (Saunders, Lewis et al. 2019). This is based on the proven impact university degrees (Cheung, S.F et al. 2002) and language fluency (Rollof 2009) have on creativity.

Participant bias was minimized by reminding interviewees of their anonymity, enabling them to act and answer without restraint (Saunders, Lewis et al. 2019). The researchers have continuously aimed to promote accuracy through a sincere and open dialogue regarding the limitations of the study.

Next, in the discussion of researcher bias, a limitation of the experiment includes the subjectivity of the researchers in categorizing and assessing the level of creativity under each of Guilford's criteria. This is a problem with many tests of creativity. However, in this thesis, the impact has been reduced by additional input of data gathered from interviews.

5. Empirical Results

5.1. Quantitative Results

The experiment was conducted on a sample of 20 experimental groups with 4 people in each group. Due to participants canceling meetings, technical difficulties, and one participant conducting the experiment on a phone instead of a computer, four groups have been disregarded.

Table 1. Analysis Sample

	n
Original sample of groups	20
Sample after excluding groups where one participant was absent	17
Sample after excluding groups where participants used a phone	16
Analysis Sample	16

The following descriptive statistics consist of the remaining 16 groups:

Table 2. Descriptive Statistics

	Obs	Mean	Std. Dev.	Min	Max
Fluency	8 (8)	19.5 (13.875)	4.598 (2.997)	16 (9)	28 (18)
Flexibility	8 (8)	14.375 (9.875)	3.852 (1.246)	8 (8)	21 (12)
Originality	8 (8)	1.875 (4)	1.553 (1.309)	0 (2)	4 (6)
Elaboration	8 (8)	1.704 (1.618)	0.586 (0.272)	1 (1.22)	2.63 (1.92)
Familiarity	8 (8)	2.915 (3.458)	1.991 (1.296)	1 (1.33)	6 (5.33)
Time	8 (8)	14 (14.438)	1.852 (3.156)	11 (10.5)	16 (19)

Face-to-face group without parentheses, (virtual groups in parentheses)

The maximum, minimum and mean scores of Fluency are lower in the virtual groups than in the face-to-face groups. The same is true for Flexibility with the exception that the minimum scores for face-to-face and virtual groups are the same. However, maximum, minimum, and mean Originality scores are all higher in the virtual groups in comparison with the face-to-face groups. Neither Elaboration, Familiarity, or Time follow a strict pattern, some values being higher in the virtual groups and others being higher in the face-to-face groups. Correlation has been tested between the four categories of creativity in a correlation matrix (Appendix 4). The strongest positive correlation is between Fluency and Flexibility at

(81.56%) and the strongest negative correlation is between Fluency and Elaboration at (-39.84%).

Table 3. OLS Regressions

	Fluency	Flexibility	Originality	Elaboration
	Regression 1	Regression 2	Regression 3	Regression 4
Virtual	-6.045*** (1.791)	-5.031*** (1.292)	2.069** (0.760)	-0.064 (0.247)
Familiarity	1.246* (0.601)	0.926* (0.434)	-0.017 (0.255)	-0.044 (0.083)
Time	-0.585 (0.390)	0.066 (0.282)	0.148 (0.166)	0.004 (0.054)
Constant	24.054*** (5.256)	10.750** (3.794)	-0.148 (2.232)	1.777** (0.726)
Observations	16	16	16	16
R-squared	0.558	0.603	0.427	0.034
Adjusted R-squared	0.446	0.503	0.283	-0.207

*Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

The regressions testing for a correlation between the virtual environment and the groups' Fluency, Flexibility and Originality scores are all significant. The virtual variable is not found to be significant in the regression examining Elaboration.

The coefficient (-6.045) of Regression 1 is relatively high. The results show that meeting virtually is associated with a group receiving approximately 6 fewer Fluency points than face-to-face groups, holding the time and familiarity variables constant. The virtual variable's effect on Flexibility (Regression 2) is slightly lower with a coefficient of (-5.031), which means meeting virtually results in an approximately 5 points decrease in Flexibility score compared to meeting face-to-face. Regression 3 shows a significant positive coefficient (2.069) which means meeting virtually results in groups getting approximately 2 more Originality points than if they were to meet face-to-face.

Regression 2 possesses the highest R-squared value (0.603) meaning that the independent variables explain almost 60% of the variance in Flexibility scores. Regression 1 has close to the same R-squared value (0.558), while the R-squared value of Regression 3 (0.426) is lower. This means the independent variables of Regression 3 only explain around 43% of the Originality score.

Regression 4, testing for a correlation between the virtual environment and Elaboration scores is not significant. It has a coefficient close to zero (-0.064) and R-squared value close to zero (0.034), suggesting no correlation between meeting virtually and a high (or low) elaboration score.

No control variables were found to be significant with a 95% confidence level in any of the regressions. However, Familiarity has with a 90% confidence level, a positive coefficient in Regression 1 (Fluency) (1.246) and Regression 2 (Flexibility) (0.926). A regression without the control variables were conducted, with similar results (Appendix 5). Even though no coefficient of the control variables were significant in any of the regressions, the control variables are still used since 3 out of 4 regressions gain a higher adjusted R-squared value when including the control variables, the exception being Regression 3.

5.2. Qualitative Results Interviews

The empirical data from the interviews can be used to explain the quantitative results presented above. The results were divided into four categories which were brought up by the interviewees as factors which affect the groups achieved creativity. These categories are Environment, Engagement, Body Language, and Technical Limitations.

5.2.1. Environment

The term environment refers to the rooms in which each individual was sitting when conducting the experiment. Both virtual as well as face-to-face interviewees brought up separate environments of group members as a factor which could enhance the group's creativity. The different environments of those conducting the experiment virtually were described to have played a part in the originality of the ideas which individuals in the group produced. The impressions from the differing environments of those conducting the experiment virtually were described to have a positive impact in inspiring more original alternative uses.

"I have a big window in front of me here in my room and I had an idea about water because I saw the water outside my window. I personally think if you are online and everyone is sitting in their own room, people might get more different ideas than if everyone were to sit in the same classroom."

"It is possible that if we had all been sitting in different environments when conducting this meeting online, that impressions from our respective environments could have played a part in the uniqueness of ideas we generated."

Further, several interviews pointed to a general conclusion that a more stimulating environment, where the group has more varied impressions, could contribute to increased originality in the ideas generated by the group.

"For example, if you were out for a walk, I think you would have come up with a lot more unique ideas because you would have been stimulated in a completely different way and gotten impressions from the surroundings."

5.2.2. Engagement

Some of the interviewees described a feeling of having a common goal, agenda and building a connection when gathered face-to-face.

"It is better to meet face-to-face. If I don't know people and I want to get to know them and also make them feel accountable for our common goals, then I think it's better to meet in person to create a connection."

Many interviewees explained that engagement in the task was affected by face-to-face meetings being more fun than virtual meetings because of the ease of working together face-to-face compared to virtually.

"I have a problem with engaging with other people online since it's so much less personal so I don't think it is as fun."

In addition, interviewees addressed the opportunity to be more informal and personal before and after the meeting when meeting face-to-face.

"It becomes easier to work together when you see each other in person. When you see each other in person, you have this informal meeting both before and after; you have time to talk a little. You meet people in a completely different way."

Further, one of the interviewees claimed engagement to be higher during face-to-face meetings than virtual ones due to the participants of a face-to-face meeting having set aside time to get to the meeting, making them more inclined to engage actively.

"It feels like you give yourself more time and respect for the task when you do it physically because you are not limited by needing or wanting to rush on to something else. Now you have taken the time to go there, you can just as well get involved and focus on the task at hand."

Another aspect impacting engagement, brought up by roughly a third the interviewees, was the ease of zoning out and being distracted during virtual meetings. Moreover, knowing that other people might be doing something else on their computers also contributed to decreased engagement.

"I also find it much easier to zone out when I'm in digital meetings and that's probably the case for many others. If we're on Zoom, there's sure to be someone who could receive a text message and look down for 10 seconds. And maybe open a new tab on the side of the computer and do something else. You really wouldn't have done that in the same way in person."

The interviewees were all asked to describe their perceptions of the others in the group during the experiment as well as how they worked together. The face-to-face interviewees had positive perceptions of the other participants in their groups. Most of the face-to-face interviewees used words such as “engaged” and “motivated” when they described the other participants.

"They seemed happy and hungry, eager to engage and come up with good answers. They wanted to and they tried to perform. It was fun! There wasn't anyone sitting quietly and twiddling their thumbs, and everyone felt motivated."

"It felt like everyone wanted to engage and perform. It felt like everyone thought: now we're doing this! It was a focused atmosphere."

The statements from virtual interviewees regarding their perception of others and the group's teamwork did not once include remarks about participants' active engagement or contribution. Responses from the virtual groups show a less engaged and goal-oriented atmosphere.

"I don't know, we had a friendly atmosphere but I don't think we collaborated that much so maybe that would be easier in another context when we're not sitting so far from each other."

"Everyone wanted to come up with answers, but the atmosphere was not that goal-oriented"

5.2.3. Body Language

About half of the interviewees described the ease of interpreting the body language of other participants face-to-face compared to virtually as a contributing factor to the willingness to express creative ideas. By interpreting each other's body language participants could anticipate others' reactions, which decreased their fear of being judged.

"If we had met online, I would have felt that I could not be as open because I would not have been able to see their movement patterns and how they reacted to what I said in the same way that I could face-to-face."

"I think reading body language and seeing how others interpret and react to what I say is much easier physically, which makes me more comfortable speaking up."

The ease of interpreting body language face-to-face was also described to be encouraging.

"You get more feedback more easily physically when you see other people's reactions and body language. It motivates and stimulates me to want to do my best."

5.2.4. Technical Limitations

Several interviewees brought up technical limitations as a factor that could impact the group's creativity negatively in the virtual environment. Firstly, this was due to fewer ideas being voiced because of fear of interrupting.

"When you do it online, you become aware that if you talk over each other, nothing is heard at all. It makes you care about waiting for others to finish talking and maybe not throwing out as many ideas."

A second reason was the delay in apprehending what participants were saying.

"It feels like it takes time in the virtual environment for the person writing to understand what others are saying and to write it down."

5.3. Qualitative Result Observations

5.3.1. Prioritization of different criteria of creativity

From the observations it is concluded that most groups heavily prioritized Fluency. Most groups talked fast and tried to state as many alternative uses as possible. No group discussed in what way the answers were to be Elaborated. Only a few groups commented on the Originality or Flexibility in their partners' ideas. Except when being specifically asked, none of the interviewees brought up any discussion of Elaboration in the interviews when discussing their groups' performance. In addition, Elaboration was the criteria of creativity that the interviewees rated as their poorest performance.

5.4. Empirical findings

5.4.1. Quantitative findings

From the quantitative results of the experiment it is clear that only one of four hypotheses based on the assumptions of MRT is supported.

Table 4. Hypotheses Results

H1	Groups via virtual medium will exhibit higher Fluency scores than groups via face-to-face medium	Not supported
H2	Groups via virtual medium will exhibit higher Flexibility scores than groups via face-to-face medium	Not supported
H3	Groups via virtual medium will exhibit higher Originality scores than groups via face-to-face medium	Supported
H4	Groups via virtual medium will exhibit higher Elaboration scores than groups via face-to-face medium	Not supported

5.4.2. Qualitative findings

The key findings of the qualitative results can be summarized as follows:

- Different impressions from the environments of those conducting the experiment virtually play a part in the originality of the ideas which the group produce
- Participants feel more engaged face-to-face than virtually through an increased feeling of having fun, personal connection, a common goal, and agenda.
- Face-to-face meetings were perceived as more comfortable than virtual meetings due to the body language of other participants being easier to read
- Technical limitations are in some cases a factor which impacts groups' creativity in virtual meetings negatively
- Fluency was the most prioritized and Elaboration was the least prioritized category of creativity by participants

6. Analysis

From the analysis below it is concluded that MRT (Daft, Lengel et al. 1984; Daft, Lengel 1986) has breaches in explaining the results of this study. As discussed in the criticism of MRT, the theory does not acknowledge social influence and external factors (Fulk, Steinfield et al. 1987), which were both recurring topics in the interviews. Thus, to answer the research question this study splits the analysis into two sections. Firstly, the results are analyzed through the MRT framework. Secondly, the researchers have applied additional literature to suggest and explain different interpretations of the results. The two sections will both consider each of Guilford's (1967) criteria in turn.

6.1. Media Richness Theory

The analysis below includes the results of each of Guilford's (1967) categories of creativity based on the grounds of MRT.

6.1.1. Fluency and Flexibility



Figure 3: Fluency and Flexibility - Media Richness Analysis

Due to the similarities in characteristics and high correlation between Fluency and Flexibility scores (Appendix 4), they are analyzed together.

In contrast to MRT (Daft, Lengel et al. 1984), the results of the Regressions 1 (Fluency) and 2 (Flexibility) show with a 95% significance level, that Fluency and Flexibility scores have a negative correlation, coefficients (-6.045) and (-5.031) respectively, with groups meeting virtually. Thus, Hypotheses 1 and 2 are not supported.

The qualitative empirical results align with the quantitative ones. From the interviews it is suggested that face-to-face groups have an easier time communicating swiftly due to the increased amount of verbal and nonverbal signals exchanged during a face-to-face meeting. The face-to-face medium enables participants to pick up on and send signals of feedback faster than in virtual environments. Furthermore, meeting face-to-face is associated with more easily being able to interpret and pick up on feedback through each other's body language. This in contrast to the virtual interviewees, who conclude that the waiting on their turn to respond due to the inability to hear several people speak, slows down the giving and receiving of feedback. MRT's characteristic of medium richness, 'Feedback' suggests that less rich Feedback is optimal for idea generation (Daft, Lengel et al. 1984). Additionally, the characteristic of 'Language' (Daft, Lengel et al. 1984) is richer face-to-face, since the full

expression of body language is not captured virtually. In the interviews it is found that the faster Feedback and richer Language of face-to-face meetings contribute to explain why face-to-face environments enabled the participants to come up with a larger quantity of alternative uses, thus increasing the Fluency and Flexibility scores. This contradicts MRT's assumption that simpler tasks such as idea generation benefit from less rich media, more specifically less rich in the characteristics Feedback and Language.

6.1.2. Originality



Figure 4: Originality - Media Richness Analysis

Regression 3 (Originality) shows with a 95% confidence level a positive correlation, coefficient (2.069), between meeting virtually and a high Originality score. Thus Hypothesis 3 is supported. This is in accordance with MRT and can be explained by the Source characteristic of medium richness being lower virtually than face-to-face. Low richness is optimal for simpler communication like idea generation (Daft, Lengel et al. 1984). It can be argued that the generation of original ideas does not require the communication of rich information and that face-to-face environments include too many cues, noise, and ambiguity (Daft, Lengel et al. 1984).

MRT's characteristic of medium richness, 'Source' asserts that different media are deemed to be more or less personal (Daft, Lengel et al. 1984). Interviews conclude that participants who attended a face-to-face meeting during the experiment show a stronger connection to their fellow participants. The common words used by people attending face-to-face meetings to describe their teammates are "funny" and "engaged". Interviewees attending virtual meetings described close to no personality traits of their fellow participants. It can be argued that virtual group members feel less connected to other participants (Daft, Lengel et al. 1984) and thus become more independent in their generation of ideas, which increases the originality. This supports MRT's assumption that simpler tasks such as idea generation benefit from less rich media, more specifically less rich in the characteristic Source.

6.1.3. Elaboration

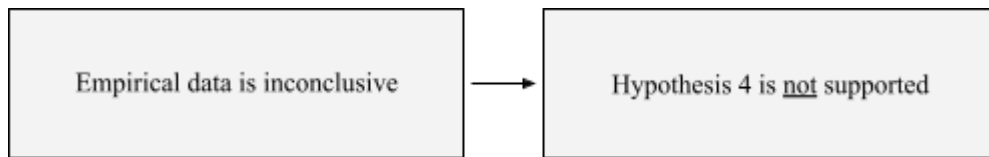


Figure 5: Elaboration - Media Richness Analysis

The result of Regression 4 (Elaboration) does not show any correlation between meeting virtually and higher elaboration scores, thus not supporting hypothesis 4 (Daft, Lengel et al. 1984).

Through observations, it is concluded that most groups prioritized Fluency the most and Elaboration the least. Almost none of them used any time to discuss how to Elaborate their answers and thus the task of Elaboration was left to the randomly assigned secretary. The lack of communication regarding elaboration can explain why the proposed “less rich” (Daft, Lengel et al. 1984) virtual communication medium did not affect the participants' elaboration scores.

Neither the qualitative nor the quantitative results conclude any significant difference in results from the virtual and face-to-face groups with regard to Elaboration. The researchers' conclusion is that the method of measurement used does not properly pick up on how elaboration is affected. Therefore elaboration will not be analyzed in the second part of the analysis.

6.2. Complementing Literature

The analysis below includes the results of each of Guilford's (1967) categories of creativity based on theories and literature outside of the MRT framework.

6.2.1. Fluency and Flexibility

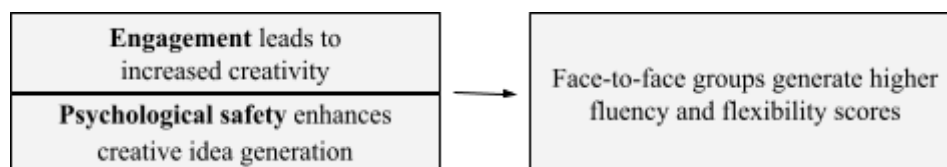


Figure 6: Fluency and Flexibility - Expanded Analysis

Fluency and Flexibility scores are the two criteria most reliant on the number of alternative uses suggested by a group. The high Fluency and Flexibility scores in face-to-face meetings can be a consequence of increased psychological safety and engagement.

Firstly, heightened Fluency and Flexibility scores in face-to-face groups compared to virtual ones can be explained through increased engagement (Bakker, Xanthopoulou 2013). From the interviews, conducting meetings in person was described as being more fun than when meeting virtually. The increased levels of fun and play can explain why the participants face-to-face feel more engaged and in turn generate more ideas than the participants meeting virtually (Gilson, Shalley 2004; Jamaludin, Ahmad et al. 2015). Participants further acknowledged that meeting face-to-face increased the feeling of having a shared goal further enhancing creative performance, this is in alignment with Gilson and Shalley (2004).

Secondly, the interviews reveal that being able to read other participants face-to-face, through body language, facial expression, and tone of voice, results in a strong sense of psychological safety and confidence to express ideas, thus increasing flexibility scores. Another explanation for face-to-face groups feeling more psychologically safe is that a sense of fun and play during work is correlated with strong psychological safety (Tu 2021; Mukerjee, Metiu 2022) which was more prevalent in face-to-face groups. A higher degree of psychological safety leads to higher Flexibility scores, since it increases the willingness to share ideas within a group (Kessel, Kratzer et al. 2012). This argumentation is supported by Catyanadika and Rajasekera (2022). It could further be argued that the same principle should apply to Fluency and Originality. However, these ideas do not require deviating from categories mentioned by other group members and thus not requiring psychological safety to the same extent.

Even though familiarity had a positive coefficient on Fluency and Flexibility, coefficient (1.246) and (0.926) respectively, with a 90% confidence level, no control variable had a significant impact on any of the regressions. Due to the small sample size and the variables not being significant, no conclusions can be drawn about the validity of these variables.

6.2.2. Originality

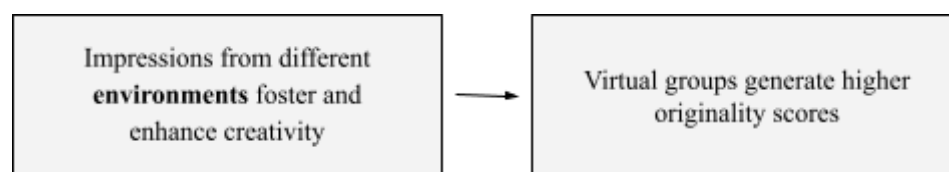


Figure 7: Originality - Expanded Analysis

The interviews suggest an additional explanation for the correlation between high Originality scores and virtual meetings, not covered by MRT. Environments can foster and enhance creativity through the impressions gained from surroundings (Daikoku, Fang et al. 2021; Schertz, Bowman et al. 2022). The interviews manifest that virtual meetings foster Originality of ideas since the participants in a group are exposed to different environments. A consequence of participating virtually is that members of the meeting sit in four different rooms, in contrast to face-to-face meetings where participants are gathered in the same room. This results in the individuals in virtual meetings having different impressions from each of their separate environments and are in turn able to generate more original ideas.

7. Discussion and Conclusion

7.1. Revisiting the Research Question

The aim of this study has been to investigate the impact virtual versus face-to-face meetings have on creative idea generation in groups. Through a mixed methods research design the report answers the following research question:

To what extent is group creativity in the form of idea generation affected by virtual versus face-to-face meeting environments?

From the quantitative and qualitative results, this thesis can conclude that face-to-face communication is the overall optimal medium of communication for creative meetings.

In answer to the research question it can be concluded that the amount of ideas generated (Fluency) and the number of categories covered by these ideas (Flexibility) is negatively affected by group meetings conducted in virtual environments, whereas the uniqueness of set ideas (Originality) is positively affected by group meetings in virtual environments. This study does not conclude whether the level of detail of describing the ideas (Elaboration) in group meetings is affected by the virtual environment or not.

7.2. Practical Implications

Considering the increase in remote work within academia (Chamakiotis, Dekoninck et al. 2013) the results of this study are valuable for students, teachers, and schools to gain insight into the effects virtual meetings versus face-to-face meetings have on creativity. This knowledge is of value to students who want to perform to the best of their abilities. More importantly, the findings help students facilitate the ability to solve problems through innovative solutions which is crucial for both organizational and societal development (Metwaly, Kyndt et al. 2017).

Furthermore, this thesis has provided insight into the advantages of both environments. Face-to-face environments allow for larger quantities of idea generation and categories in sum, whereas virtual environments foster more original ideas. This knowledge can be used by students, teachers and schools in the decision of when it is preferable to meet face-to-face or virtually, adjusting their decision for the given task or goal.

7.3. Theoretical Implications

This study is one of few to investigate remote versus face-to-face meeting environments' effect on creativity using both qualitative and quantitative measures. The results contribute towards less ambiguity in the research field of creative idea generation in virtual meetings.

Similar to other studies it is found that virtual environments have an impact on the generation of ideas compared to meeting face-to-face (Redlbacher, Hattke 2022; Brucks, Levav 2022). This result contradicts the findings of Grözinger, Irlenbusch et al. (2020) who find no significant difference in the creative performance of groups in virtual compared to face-to-face environments. However, Grözinger, Irlenbusch et al. (2020) do commence a discussion of the impact virtual environments have on distancing participants from each other to come up with more original ideas. Our thesis supports this reasoning and includes an alternative explanation for the originality of the ideas, namely the impact impressions from multiple surroundings have on the idea generation of a group. Previous studies have assigned rooms to the virtual participants (Grözinger, Irlenbusch et al. 2020; Brucks, Levav 2022), whereas in this paper, virtual participants themselves chose the room. The method used in this paper better simulates the condition of a “normal” virtual meeting, making the results in the researchers' opinions more accurate than the results of other studies.

Further, since MRT (Daft, Lengel et al. 1984) predicts only one of four criteria of creativity correctly, the results of this thesis restrict the use of MRT for the purpose of recommending which communication medium should be utilised for group meetings with the aim of generating ideas. The results of the thesis show that the less complex task of generating novel ideas is in fact overall enhanced by a face-to-face environment rather than a virtual one, disputing the predictions of MRT (Daft, Lengel et al. 1984).

The deviation from theory can be explained by MRT not considering social and external factors (Fulk, Steinfield et al. 1987). This thesis expands the criticism by further clarifying which external and social factors affect idea generation specifically. The additional social factors relevant to consider for creative idea generation in virtual teams are psychological safety and engagement, which fosters creative idea generation. The external factor relevant to consider is the effect of virtual groups experiencing multiple environments, also fostering creativity. Although this study is not broad enough to completely disregard MRT, it is concluded that MRT needs to be complemented by these three factors when analyzing creativity in virtual environments.

7.4. Discussion of Research Design

The choice of using a concurrent mixed methods design can be discussed with reference to the extensive data collection required of this approach in the short time frame available for the completion of this thesis. It could be argued that focusing on either qualitative or quantitative data collection could have enabled a narrower and more detailed data collection. For example, more experimental trials could have been conducted if interviews were excluded. However, the researchers argue that showing only one type of data does not proficiently capture the data needed to give a complete answer to the research question. The full context of creativity, which does include subjective aspects, could not be captured through a purely quantitative design (Amabile 1982; Amabile, Pillemer 2012) whereas a purely qualitative method would decrease the comparability of answers between respondents due to the subjective nature of creativity. Furthermore, it could be argued that conducting an

experiment before the interviews have helped to place the discussed topic in context (Saunders, Lewis et al. 2019). Thus, a concurrent mixed methods design was chosen to see how the qualitative and quantitative data sets supported one another.

7.5. Limitations

7.5.1. Experiment

Limitations of the experiment include the sample size and selection process. The sample size of this thesis could be increased to achieve more robust and reliable results. Furthermore, the selection process can be criticized for a lack of complete randomness. However, due to time constraints and the difficulty of attracting participants, the chosen method of sampling was used.

The researchers also chose to exclude participants who do not possess Swedish as their native language. The generalisability of the paper was lowered because the result was related to a limited group of SSE students. This was nevertheless found preferable to having the experiment be conducted in English, which would have resulted in uncertainties relating to the extent to which the participants were able to express creativity in a non-native language (Rollof 2009).

7.5.2. Interviews

The initial plan of interviewing participants before they left the virtual or face-to-face experiment room failed as regards two of the participants, since they were time constrained. They were interviewed days after the experiment, which could have impacted their recall of the experiences.

7.6. Suggestions for future research

Arguably, a low number of observations have been conducted in this study. Future research can be designed to conduct this study on a larger scale to allow for more robust conclusions in the measures of Fluency, Flexibility, Originality, and Elaboration in virtual environments. Furthermore, broadening the generalisability through expanding the research to cover other populations would make the information valuable to a larger group.

This thesis focuses on the idea generation aspect of creativity. Examining other forms of creativity, for example the implementation or selection of ideas, could be beneficial in helping students and teachers in the choice of medium. Finally, research is scarce on the effects of hybrid environments (where some members participate virtually and others face-to-face) on creativity. Considering that the results of this study showed advantages of generating ideas in both mediums, there may be an interest to measure the effect on creativity when combining the two environments.

8. References

- AKBARI CHERMAHINI, S., HICKENDORFF, M. and HOMMEL, B., 2012. Development and validity of a Dutch version of the Remote Associates Task: An item-response theory approach. *Thinking Skills and Creativity*, **7**(3), pp. 177-186.
- AMABILE, T.M., 1982. Social psychology of creativity: A consensual assessment technique. *Journal of personality and social psychology*, **43**(5), pp. 997-1013.
- AMABILE, T.M. and PILLEMER, J., 2012. Perspectives on the Social Psychology of Creativity. *The Journal of Creative Behavior*, **46**(1), pp. 3-15.
- AMABILE, T., 2013. *Componential Theory of Creativity*. Sage Publications.
- ANDERS, A.D., COLEMAN, J.T. and CASTLEBERRY, S.B., 2020. Communication Preferences of Business-to-Business Buyers for Receiving Initial Sales Messages: A Comparison of Media Channel Selection Theories. *International Journal of Business Communication*, **57**(3), pp. 370-400.
- AWAN, U., SROUFE, R. and KRASLAWSKI, A., 2019. Creativity enables sustainable development: Supplier engagement as a boundary condition for the positive effect on green innovation. *Journal of Cleaner Production*, **226**, pp. 172-185.
- BAKKER, A.B. and XANTHOPOULOU, D., 2013. Creativity and charisma among female leaders: the role of resources and work engagement. *The International Journal of Human Resource Management*, **24**(14), pp. 2760-2779.
- BRAUN, S., PEUS, C., FREY, D. and KNIPFER, K., 2016. Leadership in Academia: Individual and Collective Approaches to the Quest for Creativity and Innovation. *Leadership Lessons from Compelling Contexts*. Emerald Group Publishing Limited, pp. 349-365.
- BRESLIN, D., 2019. Group creativity and the time of the day. *Studies in Higher Education*, **44**(7), pp. 1103-1118.
- BRUCKS, M.S. and LEVAV, J., 2022. Virtual communication curbs creative idea generation. *Nature (London)*, **605**(7908), pp. 108-112.
- CATYANADIKA, P.E. and RAJASEKERA, J., 2022. Influence of psychological safety and social presence on knowledge sharing behavior in higher education online learning environment. *VINE Journal of Information and Knowledge Management Systems*, **52**(3), pp. 335-353.
- CAULFIELD, B. and CHARLY, A., 2022. Examining the potential environmental and travel time saved benefits of remote working hubs. *Transport Policy*, **127**, pp. 139-147.
- CHAMAKIOTIS, P., DEKONINCK, E.A. and PANTELI, N., 2013. Factors Influencing Creativity in Virtual Design Teams: An Interplay between Technology, Teams and Individuals. *Creativity and Innovation Management*, **22**(3), pp. 265-279.

CHEUNG, C., S.F, A. and YUE, X.D., 2002. Creativity of university students: What is the impact of field and year of study? *College student journal*, **38**, pp. 577-597.

DAFT, R., LENGEL, R. and GRIFFIN, R., 1984. *Information richness: A new approach to managerial behavior and organization design*.

DAFT, R.L. and LENGEL, R.H., 1986. Organizational Information Requirements, Media Richness and Structural Design. *Management Science*, **32**(5), pp. 554-571.

DAIKOKU, T., FANG, Q., HAMADA, T., HANDA, Y. and NAGAI, Y., 2021. Importance of environmental settings for the temporal dynamics of creativity. *Thinking Skills and Creativity*, **41**, pp. 100911.

DE BONO, E., 1999. *Six thinking hats*. Rev. and updated edn. New York, NY [u.a.]: Little, Brown and Company.

DENNIS, A.R., VALACICH, J.S. and FULLER, R.M., 2008. Media, Tasks, and Communication Processes: A Theory of Media Synchronicity. *MIS quarterly*, **32**(3), pp. 575-600.

DI LEO, G. and SARDANELLI, F., 2020. Statistical significance: p value, 0.05 threshold, and applications to radiomics-reasons for a conservative approach. *European Radiology Experimental*, **4**(1), pp. 18.

EDMONDSON, A., 1999. Psychological Safety and Learning Behavior in Work Teams. *Administrative Science Quarterly*, **44**(2), pp. 350-383.

FULK, J., STEINFELD, C.W., SCHMITZ, J. and POWER, J.G., 1987. A Social Information Processing Model of Media Use in Organizations. *Communication Research*, **14**(5), pp. 529-552.

FULLWOOD, C., DERRER-RENDALL, N., MARTINO, O., DAVIS, S. and MORRIS, N., January 1, 2006. The effect of an icebreaker on collaborative performance across a video link

GILSON, L.L. and SHALLEY, C.E., 2004. A little creativity goes a long way: An examination of teams' engagement in creative processes. *Journal of Management*, **30**(4), pp. 453-470.

GUILFORD, J.P., CHRISTENSEN PAUL, R., MERRIFIELD PHILIP, R. and WILSON ROBERT, C., 1978. *Alternate Uses Manual and & Sample*.

GRÖZINGER, N., IRLENBUSCH, B., LASKE, K. and SCHRÖDER, M., 2020. Innovation and communication media in virtual teams – An experimental study. *Journal of economic behavior & organization*, **180**, pp. 201-218.

GUILFORD, J.P., 1967. *The nature of human intelligence*. New York [u.a.]: McGraw-Hill.

HAYTHORNTHWAITE, C., 2002. Strong, Weak, and Latent Ties and the Impact of New Media. *The Information society*, **18**(5), pp. 385-401.

ISHII, K., LYONS, M.M. and CARR, S.A., 2019. Revisiting media richness theory for today and future. *Human behavior and emerging technologies*, **1**(2), pp. 124-131.

PERRY-SMITH, JILL E., 2006. Social Yet Creative: The Role of Social Relationships in Facilitating Individual Creativity. *Academy of Management journal*, **49**(1), pp. 85-101.

KAHAI, S.S. and COOPER, R.B., 2003. Exploring the Core Concepts of Media Richness Theory: The Impact of Cue Multiplicity and Feedback Immediacy on Decision Quality. *Journal of Management Information Systems*, **20**(1), pp. 263-299.

KESSEL, M., KRATZER, J. and SCHULTZ, C., 2012. Psychological Safety, Knowledge Sharing, and Creative Performance in Healthcare Teams. *Creativity and Innovation Management*, **21**(2), pp. 147-157.

KIM, K.H., 2006. Can We Trust Creativity Tests? A Review of the Torrance Tests of Creative Thinking (TTCT). *Creativity Research Journal*, **18**(1), pp. 3-14.

LEDBETTER, A.M., TAYLOR, S.H. and MAZER, J.P., 2016. Enjoyment fosters media use frequency and determines its relational outcomes: Toward a synthesis of uses and gratifications theory and media multiplexity theory. *Computers in human behavior*, **54**, pp. 149-157.

MATUD, M.P., RODRÍGUEZ, C. and GRANDE, J., 2007. Gender differences in creative thinking. *Personality and Individual Differences*, **43**(5), pp. 1137-1147.

METWALY, S., KYNDT, E. and VAN DEN NOORTGATE, W., 2017. Approaches to Measuring Creativity: A Systematic Literature Review.

MUKERJEE, J. and METIU, A., 2022. Play and psychological safety: An ethnography of innovative work. *Journal of Product Innovation Management*, **39**(3), pp. 394-418.

MUKHTAR, K., JAVED, K., AROOJ, M. and SETHI, A., 2020. Advantages, Limitations and Recommendations for online learning during COVID-19 pandemic era. *Pakistan Journal of Medical Sciences*, **36**(COVID19-S4), pp. S27-S31.

NORRBY, C. and SPATH, A., 2022. *Statistics Report Fall 2022*. Registry Education Office SSE: .

PALANICA, A., LYONS, A., COOPER, M., LEE, A. and FOSSAT, Y., 2019. A comparison of nature and urban environments on creative thinking across different levels of reality. *Journal of environmental psychology*, **63**, pp. 44-51.

PROCTOR, R.A., 1991. The Importance of Creativity in the Management Field. *British Journal of Management*, **2**(4), pp. 223-230.

- PUSATERI, K.B., ROACHÉ, D.J. and WANG, N., 2015. The Role of Communication Technologies in Serial Arguments: A Communicative Interdependence Perspective. *Argumentation and Advocacy: Special Issue: 30 Years of Research on Serial Argument in Interpersonal Relationships*, **52**(1), pp. 44-60.
- REDLBACHER, F. and HATTKE, F., 2022. How virtual meetings stimulate process innovations in organisations: mixed-methods evidence from emergency response providers. *Innovation (North Sydney)*, **ahead-of-print**(ahead-of-print), pp. 1-22.
- REITER-PALMON, R., KRAMER, W., ALLEN, J.A., MURUGAVEL, V.R. and LEONE, S.A., 2021. Creativity in Virtual Teams: A Review and Agenda for Future Research. *Creativity : theories - research - applications*, **8**(1), pp. 165-188.
- ROLLOF, J., 2009. Creative meetings. *Innovation*, **11**(3), pp. 357-372.
- RUNCO, M.A., 2010. Testing Creativity. In: P. PETERSON, E. BAKER and B. MCGAW, eds, *International Encyclopedia of Education (Third Edition)*. Oxford: Elsevier, pp. 170-174.
- RUNCO, M.A. and ACAR, S., 2012. Divergent Thinking as an Indicator of Creative Potential. *Creativity Research Journal*, **24**(1), pp. 66-75.
- SAUNDERS, M., LEWIS, P. and THORNHILL, A., 2019. *Research Methods for Business Students*. Eighth edition edn. Harlow: Pearson Education, Limited.
- SCHERTZ, K.E., BOWMAN, J.E., KOTABE, H.P., LAYDEN, E.A., ZHEN, J., LAKHTAKIA, T., LYU, M., PARASCHOS, O.A., VAN HEDGER, S.C., RIM, N.W., VOHS, K.D. and BERMAN, M.G., 2022. Environmental influences on affect and cognition: A study of natural and commercial semi-public spaces. *Journal of Environmental Psychology*, **83**.
- STERNBERG, R.J., 2020. What's Wrong with Creativity Testing? *The Journal of creative behavior*, **54**(1), pp. 20-36.
- SUH, K.S., 1999. Impact of communication medium on task performance and satisfaction: an examination of media-richness theory. *Information & Management*, **35**(5), pp. 295-312.
- TU, X., 2021. The Role of Classroom Culture and Psychological Safety in EFL Students' Engagement. *Frontiers in Psychology*, **12**.
- WEIJTERS, B., CABOOTER, E. and SCHILLEWAERT, N., 2010. The effect of rating scale format on response styles: The number of response categories and response category labels. *International journal of research in marketing*, **27**(3), pp. 236-247.
- WU, C.-., SU, Y.-., CHEN, E., CHEN, P.-., CHANG, Y.-. and CHEN, H.-., 2022. Development and validation of interactive creativity task platform. *Frontiers in Psychology*, **13**.

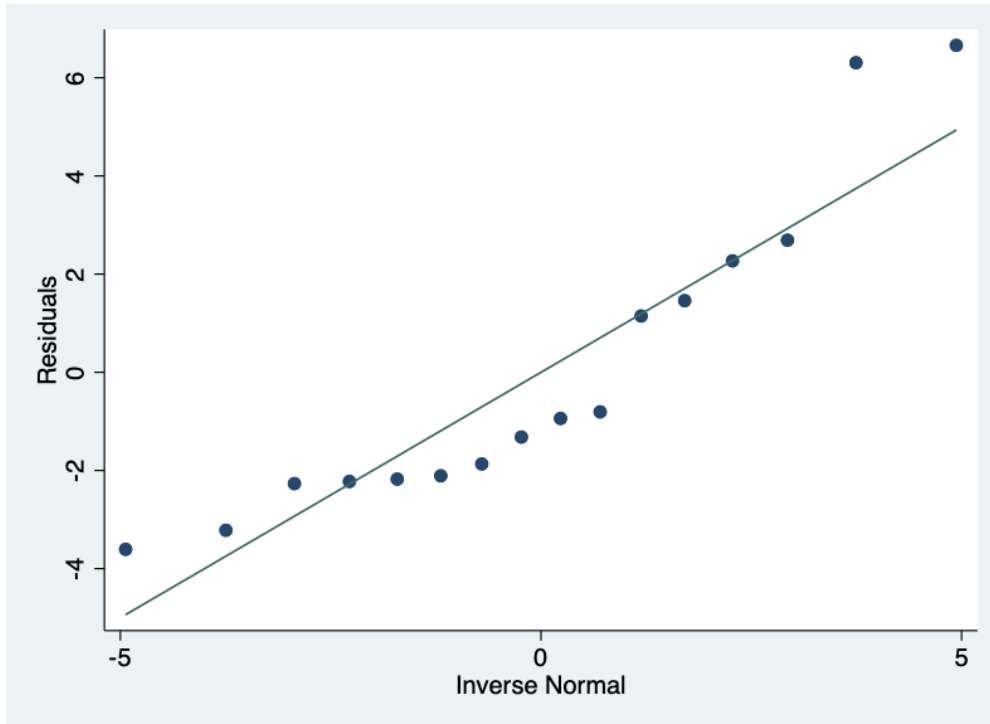
Appendix 1 - Interview Questions

1. Can you think of any factors that affected your individual or group performance today? If so, what were they?
2. What was your strategy when coming up with the alternative uses? Please describe how you went about solving the given task.
3. In your opinion did you work well together as a team? Describe why or why not?
4. Describe the atmosphere within the group during the experiment?
5. Describe your perception of others during the meeting. Were they polite, rude, nice, funny etc?
6. How do you rate your group's performance on a scale of 1-7 in the number of alternative uses which you provided?
7. How do you rate your group's performance on a scale of 1-7 in the originality of the alternative uses which you provided?
8. How do you rate your group's performance on a scale of 1-7 in the variation of the alternative uses which you provided?
9. How do you rate your group's performance on a scale of 1-7 regarding how elaborate your given answers were during the experiment.
10. How do you rate your group's overall creative performance on a scale of 1-7?
11. How well did you know your teammates before the experiment on a scale of 1-7? Give one number for each teammate, you do not need to specify what number is associated with who.
12. Do you believe that you and your group would have been more or less creative if you met virtually/face-to-face? Why is this?
13. Do you believe you and your teammates would dare to speak more and be less socially anxious if the meeting was conducted virtually or face-to-face? Why is this?
14. From your previous experience, do you feel that you are more creative in meetings virtually, face-to-face or that it doesn't matter? What contributes to this view?
15. Do you have any additional reflections from your experience of the experiment?

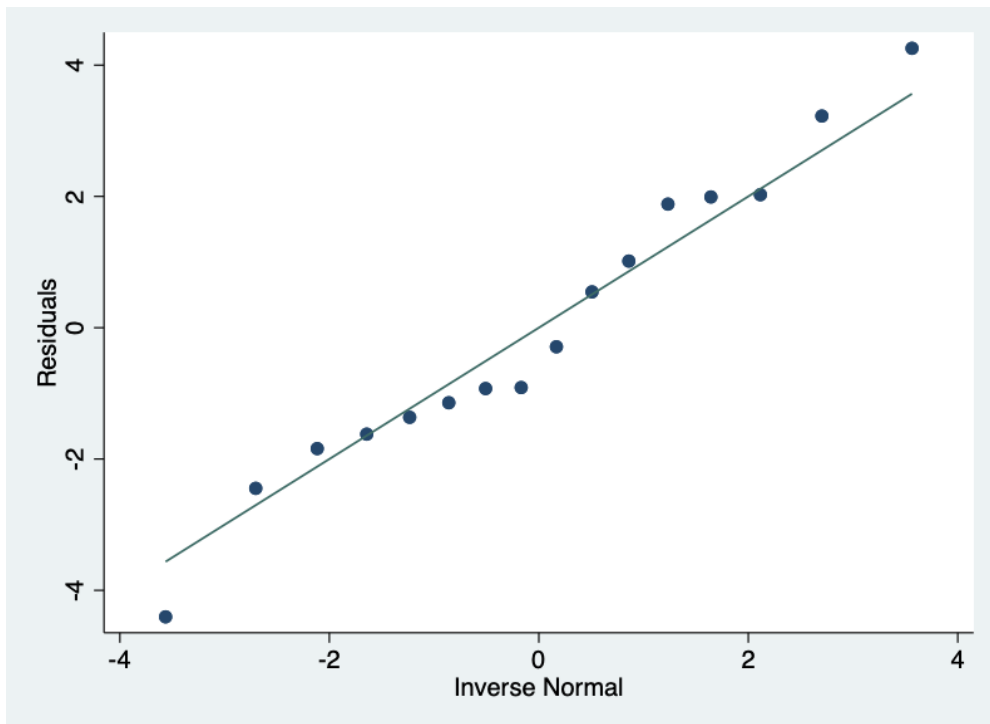
Appendix 2 - OLS Assumptions

QQ-plots

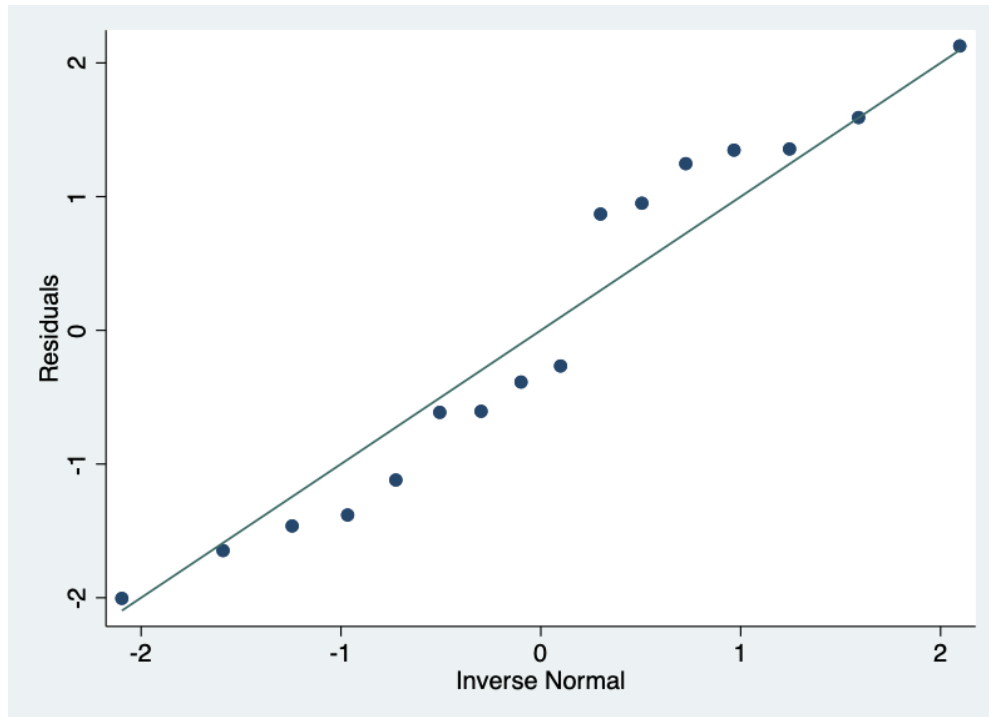
QQ-plot, Fluency



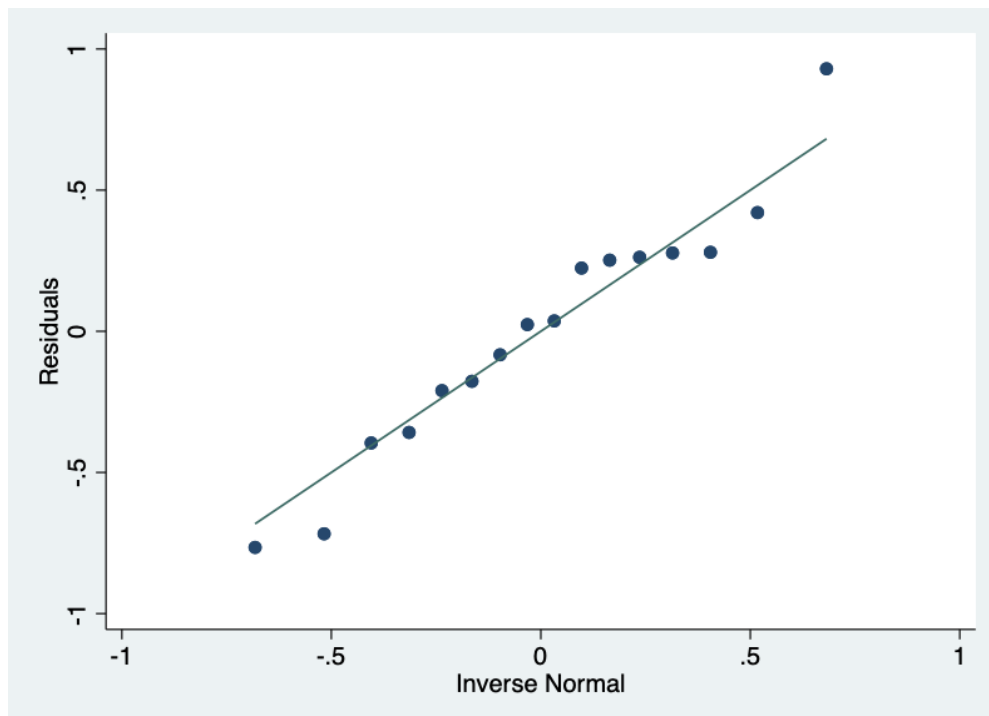
QQ-plot, Flexibility



QQ-plot, Originality



QQ-plot, Elaboration



Breusch-Pagan Test

	Fluency	Flexibility	Originality	Elaboration
chi2(1)	2.21	1.63	0.28	3.68
Prob > chi2	0.137	0.202	0.598	0.055

H0: Constant Variance

VIF-Test

Variable	VIF	1/VIF
Familiarity	1.18	0.846
Time	1.16	0.864
Virtual	1.03	0.970
Mean VIF	1.12	

Appendix 3 - Manuscript

Thank you for taking the time to help us with our experiment. See this as a fun experience and perform to the best of your ability. The experiment will take 5 minutes and you will be anonymous in the report. Does everyone consent to this experiment being recorded? The reason it needs to be recorded is that we want to be able to go back and make observations when writing our thesis. All recordings will be deleted directly after the completion of this thesis, in accordance with GDPR regulation. You all have the option to withdraw from participation and retrieve the data we collect here today at any time.

Just to get things started I thought we'd run a little icebreaker since most of us don't know each other. Everyone gets to say their name and then something about yourself that you think makes you unique in the group. This being something that you don't have in common with any of the others joining us today.

....

Now you will perform a test. When I start the timer, you have two minutes to come up with as many uses as possible for an item that I will give you when the test starts. One person in the group is responsible for writing down the uses you come up with. Only the uses that are written down on the paper will count. So make sure you write everything down. You will be judged on (1) the number of uses you come up with, (2) how original these uses are, (3) how detailed you describe them, and (4) how many different types of uses you come up with (e.g. socks and gloves are different uses but within the same category, clothing).

Do you have any questions or is everything clear?

Appendix 4 - Correlation Matrix

	Fluency	Flexibility	Originality	Elaboration
Fluency	1.0000			
Flexibility	-0.8156	1.0000		
Originality	-0.3839	-0.1448	1.0000	
Elaboration	-0.3984	-0.3559	-0.0399	1.0000

Appendix 5 - Regression Without Control Variables

	Fluency	Flexibility	Originality	Elaboration
	Regression 1	Regression 2	Regression 3	Regression 4
Virtual	-5.625**	-4.5***	2.125**	-0.086
	(1.941)	(1.431)	(0.718)	(0.228)
Constant	19.5***	14.375***	1.875***	1.704***
	(1.372)	(1.012)	(0.508)	(0.161)
Observations	16	16	16	16
R-squared	0.375	0.414	0.3848	0.010
Adjusted R-squared	0.330	0.372	0.341	-0.060

*Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*