A Study to Investigate if Scores on Procedural Memory are Associated with Scores on Kinaesthetic Intelligence

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March 2021

Submission of Thesis and Dissertation

National College of Ireland

Research Students Declaration Form

(Thesis/Author Declaration Form)

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Student Number: 13109332

Degree for which thesis is submitted: B.A. (Hons) Psychology

Title of Thesis: A Study to Investigate if Scores on Procedural Memory are Associate with Scores on Kinaesthetic Intelligence.

Date: 15/03/2021

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Abstract

The present study investigated the relationship between Procedural Memory as assessed by Reaction Time and Kinesthetic intelligence. In addition, the research investigated if there are gender differences regarding these two variables. A total of 33 participants were recruited for the study through snowball sampling technique from social media. Participants were asked to complete the Multiple Intelligence Profiling Questionnaire VII and the Alternating Serial Reaction Time task on Inquisit Web. The results indicated a moderate negative correlation between reaction time and kinesthetic intelligence. The results of the Mann-Whitney U test indicate no significant difference between females and males in reaction time and kinesthetic intelligence. This may have implication in sports and physical rehabilitation and narrow the literature gap regarding kinesthetic intelligence.

Keywords: procedural memory, kinesthetic intelligence, gender stereotypes

Introduction

Intelligence is defined as the "biopsychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture" (Gardner, 2000, p. 45).

It is a concept that has been debated from the time of the introduction of the first IQ test in 1900 and a consensus of the definition of intelligence is still out of sight today. In 1914, Alfred Binet, a French psychologist, following a request from the French government devised a test to identify the children who were most likely to experience difficulties in learning Together with his colleague, Theodore Simon, they developed the Binet- Simon scale that was used to measure children’s attention, memory and problem-solving skills with the purpose of identifying children who struggle and provide a base for tailored programs to support them in their aptitudes (Phillips, 2010). The two psychologists believed that the scale would be useful not so much for children with normal aptitude, but for the students who displayed lower abilities than their peers (Binet & Simon, 1948). Moreover, Binet was interested in testing children`s coping skills in day-to-day life as well as testing them for cognitive abilities such as attention and memory. Binet and Simon (1948) designed a test which was progressively more difficult to test children aged 3 to13. The results showed that children of 8 years old were able to score correctly on the tests for the 6- and 4- years old children and to complete some of the tasks designed for the 10- years-old. They deduced from the results that while different children had the same test score, the correct and incorrect responses varied across the items hence indicating the existence of different mental factors. This would be the first test to measure intelligence as a cognition process.

The Binet- Simon scale (1948) together with the Spearman`s work on general intelligence is at the base of most tests that are used today in measuring intelligence. Charles Spearman (1927) was a British psychologist, and he is well known for the Two Factor Theory of Intelligence that postulates that each intelligence test measures a common factor across all tests and additionally a unique element to that test; he named the common factor general intelligence or g factor (Spearman, 1927). Studies have found that general intelligence is a predictor of work achievement and performance, health in middle and late adulthood and has a positive correlation with duration of life (Deary et al., 2010).

Critics of the general factor of intelligence argue that g factor is restricted to logical, mathematical and linguistic concepts (Singh et al., 2017) and suggests that intelligence is pluralistic in nature: Thorndike (1920) argues that intelligence contains three parts: abstract intelligence, mechanical intelligence and social intelligence (Sternberg ,1985). Sternberg developed the Triarchic Theory of Intelligence which identified three intelligences: analytic, creative and practical. In accordance with his theory, individuals plan and successfully accomplish their plans; while they also take advantage of their strengths and compensate for their flaws in order to adjust and change their environment. Sternberg argues that the correlation of IQ test is unrelated to social settings (Sternberg, 1999). Thurstone (1938) argues that intelligence has seven abilities: reasoning, spatial visualization, word fluency, verbal comprehension, number facility, perceptual speed, and associative memory. Guilford (1967) proposed that intelligence has five operation categories, four content categories and six product categories which interact between them.

From the pluralistic theory, the most well known is Garner`s Multiple Intelligences Theory (1983). Gardner`s theory (1983) is an alternative theory to the g factor of intelligence, and it has received a great deal of attention from the teachers and the psychology community (Perez et al., 2014; Shearer & Karanian, 2017). Gardner (1983) developed a multiple intelligence theory which proposed that each person has their own learning style. The theory suggests that the concept of intelligence based on Intelligence Quotient is limited and emphasises the linguistic and mathematical skills only ignoring people such as architects, musicians, naturalists, dancers and therapists (Gardner, 1983). Instead, Gardner (1983) proposed 8 types of intelligence: linguistic intelligence, logical-mathematical intelligence, spatial intelligence, bodily kinaesthetic intelligence, musical intelligence, interpersonal intelligence (people smart) and intrapersonal intelligence (self-smart), and naturalistic intelligence. The researcher made a distinction between intelligence and domains and the relationship between them, for example in the musical domain a person may use musical intelligence as well as bodily-kinesthetic intelligence and interpersonal intelligence (Gardner, 1993). He argues that any person owns the eight intelligences but to varying degrees, but that is not to say that each individual is gifted into one intelligence or more and no person shares exactly the same intelligence profile with another person (Gardner, 1999). Critics of Gardner`s MIT are arguing that when tested, MI shows a three factors structure for subjects with high performance and 2 factors structure for individuals who achieved low scores (Almeida et al., 2011). Visser et al., (2006) suggests that a single factor is identified across several task and Barnard & Olivares (2007) have similar findings for linguistic and logic mathematical intelligences.

Windsor and colleagues (2008) conducted a study to assess the learning styles in medical students, surgeons and trainees. The MIDAS questionnaire, which is a self-report questionnaire, showed high scores regarding kinaesthetic and spatial intelligence in surgeons, lower in trainees and very low scores in student. This finding suggests that kinesthetic intelligence can be learned and it is possible to enhance a person`s skills through training. The participants who scored high on kinesthetic intelligence performed better on simple and complex laparoscopic procedures that the participants with lower scores, regardless of experience (Windsor et al., 2008). Three factors are involved in KI: motor logic which is about articulation and ordering of movement; kinaesthetic memory and kinaesthetic awareness which is related to information processed by the brain regarding the body's posture, movement and equilibrium changes.

Communication through gestures is observed through adulthood, metaphoric gestures, illustrators and a wide range of procedural knowledge and skills (Ekman &Friesen, 1969).

Research is still scarce in the domain of KI due to the difficulty to assess kinaesthetic intelligence and the lack of reliable tests. Ardila (1999) calls for the introduction of fine movements tests such as finger tapping test and praxis ability test, to assist the measurement of kinesthetic intelligence which ais missing from the tests like the WAIS (Wechsler, 1939).

In support to the MIT, Shearer & Karanian (2017) investigated 318 neuroscientific reports and reported evidence that MI are linked to specific neural regions, for example, for Bodily-Kinesthetic the main groups of skills were identified as Motor Cognition, Dexterity, Whole body movement, Body awareness and Other movements (Brown et al, 2008). Research identified as primary regions the frontal and parietal areas, further divided in three subregions related to kinesthetic intelligence namely cerebellum, subcortical and temporal. The findings suggest that Dexterity and Whole-Body skills share regions such as the cerebellum and subcortical regions, while the temporal cortex is unique to Dexterity and missing for Body awareness and Motor cognition (Shearer, 2019). Results pointed that each skill originates from a particular and a shared region of the brain, and exhibits a general factor for logical-mathematical and linguistic intelligence (Shearer, 2019)

When it comes to KI, it appears that it shares with the Procedural Memory the ability to acquire skills through practice without conscious recollection of how the learning stages unfold (Cohen & Squire, 1980). The cerebellum, basal ganglia, and frontal cortex are regions of the brain that are involved in acquisition of new skills (Willingham, 1998) and are associated with Bodily-Kinesthetic Intelligence (Shearer, 2019).

Procedural memory is described as the implicit development of the motor skills through practice, and it occurs automatically. However, it is independent of cognitive skills as the case of H.M., a patient who had the medial temporal lobe removed in order to control seizures demonstrates (Squire, 2009). Following his surgery H.M. lost the ability to form new memories but retained all his memories 3 years prior the surgery. Consequently, he showed learning on a Mirror Drawing task, a motor task, suggesting the existence of a skill-based memory beside the declarative memory (Milner et al., 1968).

Control is not required in procedural knowledge and researchers suggests that once a skill has been learned, performance becomes automatic, and the involvement of the attention process on the task is no longer necessary (Kal et al., 2018; Beilock et al., 2002). Bailock et al. (2002) found that in advanced performers, engaging attention in step- by- step task performing may even be detrimental. They argue that an advanced performer may use the task performing knowledge as a well-defined operation and focusing the attention on the performance may interrupt this operation. This is not the case for a novice, where attention is still needed in consolidation of the skill.

Implicit or procedural knowledge as well as Kinesthetic Intelligence is important in many fields, ranging from language, to playing musical instruments, performing sports and to rehabilitating after brain injuries (Howard et al., 2004, Shearer, 2019; Shearer & Karanian, 2017). Differences in skill acquisition indicate that implicit motor learning may decrease after childhood, the peak being around age 12 and the skills in childhood may predict skills in adolescence (Barnett et al., 2013, Nemeth et al., 2013). While the process of acquiring implicit knowledge, is not completely understood by researchers, some evidence points that its composed of the unintentional learning of patterns from environment (Cleermans & Jimenez, 1998).

Research indicates that gender may play a role in the process of skill acquisition with males performing better than females in reaction time tasks in both auditory and visual stimuli and it is reported that persons who are involved in practicing regular physical activity may have a faster reaction time as compared with participants who have a sedentary lifestyle (Jain et al, 2015). Nevertheless, findings are inconsistent, with some research pointing at an enhanced male's dexterity in surgical settings while other researchers finding superior surgical skills in females and others finding no gender difference at all (Elneel et al., 2008, Chiu et al., 2020, Hendrie et al., 2016).

The aim of this study is to observe if there is a relationship between Bodily-Kinesthetic Intelligence and Procedural memory (RQ1) and if there is gender related differences in both Bodily-Kinesthetic Intelligence and Procedural Memory (RQ2).

Hypothesis 1 states that there will be a relationship between the predictor variables (PVs) of procedural memory as assessed by reaction time and the criterion variable (CV) bodily-kinesthetic intelligence. Based on previous findings that have claimed that male participant performs better than females on surgical skill tasks (Elneel et al., 2008), the second hypotheses states that there will be gender differences in kinesthetic intelligence and procedural memory.

Methods

Participants

For the purpose of the present study, 108 participants were recruited, through convenient sampling and snowball sampling techniques using the researcher`s social media accounts including Facebook, Instagram, Telegram and What`s Up. However, 75 participants were excluded from the study as they did not finish the Alternating Serial Response Time task (Howard & Howard, 1997) or they quit before the completion of the task. The final sample for the present study consisted of 33 participants (Males: n= 9; Female: n =24) all of whom were adults. The average age of the participants was 39 (SD= 6.66) years, ranging from 24 to 52 years. No demographic information was collected from the participants apart from gender and age; participants were required to be at least 18 years of age and to provide informed consent. Participants were mostly from Dublin and a minority from Italy.

Measures

Demographics

Participants were requested to indicate their age and their gender (male, female or other). All participants were over 18 years of age. Twenty-two participants were from Ireland (87.87%) and 4 from Italy (12.12%). The sample consisted of 29 Females (72.7%) and 9 Males (27.3%).

Multiple Intelligence Profiling Questionnaire VII (MIPQ-VII)

MIPQ VII was used to measure kinaesthetic intelligence. The MIPQ VII is a continuous scale developed by Tirri and Nokelainen (2008) and it is based on Gardner's Multiple Intelligence Theory (1983, 1999). The MIPQ uses a 5-point Likert scale ranging from 1 to 5 (1=strongly disagree; 2=disagree; 3=neither agree or disagree; 4= agree; and 5= strongly agree) and it consists of 28 questions measuring intelligence on seven domains: (1) Linguistic intelligence; (2) Logical –mathematical intelligence; (3) Musical intelligence; (4) Spatial intelligence; (5) Bodily/Kinaesthetic intelligence; (6) Interpersonal intelligence; (7) Intrapersonal intelligence. Each Type of intelligence is assessed by 4 questions. The psychometric properties of MIPQ test are validated in previous studies with Cronbach Alpha score between .64 and .93 (Linguistic Intelligence α=.64; Logical-mathematical Intelligence α=.76; Musical Intelligence α=.93; Spatial Intelligence α= .73; Bodily/kinaesthetic Intelligence α=.74; Interpersonal Intelligence α= .82; and Intrapersonal Intelligence α=.70 (Tirri & Komulainen, 2002). An example of an item measuring for bodily-kinesthetic intelligence is I am handy; where the participant must choose one answer from 1 *totally disagree* to 5 *totally agree*. The authors did not establish a cut of point for the scores and high scores indicate high levels of intelligence.

Alternating Serial Response Time task

The ASRT task (Howard & Howard, 1997) was used to assess Procedural Memory or implicit learning in term of reaction time. In the ASRT task (Howard & Howard, 1997), 4 grey rectangles appeared on the screen on a horizontal axis. On every trial the target stimulus was one of the rectangles that would change colour in red. The participants were asked to show the stimulus position by pressing the corresponding key as fast and precise The keys corresponding from left were D, F, J and K. The stimulus remained on the screen until the participant pressed the correct key. Each block would have 90 trials and there was a total of 10 blocks. The blocks would start with 10 random trials (pattern or random trials) followed by 80 trials of patterns and random trials (one random trial followed by one pattern trial followed by random again and so on). The interchangeability of the random and pattern stimulus is demonstrated to reduce the participants` awareness of the pattern trials, thus avoiding the knowledge bias for the procedural memory to occur (Saevland & Norman, 2016). At the end of each block, the participants were informed of the speed and accuracy of their performance compared to the last two completed blocks and, they were asked to focus more on these two factors. There was a 20 second break before moving on to the next block. The ASRT task measures procedural memory through change in the reaction time over the course of 10 blocks (Howard & Howard, 1997; Nemeth et al, 2013).

Design and Analysis

The study made use of a quantitative method of data collection, including the administration of a questionnaire and the execution of a computerized task to detect if an association or a relationship between Procedural Memory and Kinesthetic intelligence exists. The present study is a within-subjects design. Spearman`s rho corelation analysis was used to investigate the relationship between Procedural Memory in terms of reaction time and Bodily-

Kinesthetic intelligence. A Mann-Whitney U test was performed to investigate if there are gender effects on Procedural Memory and Kinesthetic Intelligence. Accuracy scores were excluded: in order to move on to the next trial the correct key had to be pressed therefore the reaction time correctly reflects the accuracy also. Failure to press the correct key would result in increased RT.

Procedure

The study was advertised on the researcher's social platforms, namely, Facebook, Instagram, Telegram and What`s Up. Data was collected online through the Inquisit Web platform which the participants were asked to download and install on their electronic device (laptop, computer, mobile phone). After the installation of the Inquisit Web, the participants were prompted with the informed consent form. The details and the purpose of the study were presented in the form, along with the contact details of the researcher, organisation and supervisor of the project in case the participant experienced any distress as a result of the study. Demographics were collected from the participants such as age and gender in order to meet ethical requirements (see Appendix). If the participant, for any reason decided not to complete the survey, they were asked to press ctrl+ Q task and exit Inquisit. If they decided to continue, they were presented with the MIPQ which took approximately 5 minutes to complete. After the completion of the MIPQ the participants were asked to perform on the ASRT task. The average time of completing the ASRT task was 15-20 minutes.

Results

Descriptive statistics

The sample consisted of 33 participants (n=33), Females= 29 (72.7%) and Males= 9 (27.3%) aged between 24 and 52 years (mean= 39). The mean, median, SD, minimum and maximum scored are presented in Table 1 bellow:

Table 1

Descriptive Statistics

	N		Mean	Median	Std. Deviation	Skewness	Kurtosis	Minimum	Maximum
	Valid	Missing							
Reaction Time (Pattern)	33	0	533.2636	478.2000	124.36119	.885	-.398	356.80	784.65
Reaction Time (Random)	33	0	536.8955	493.6500	117.60588	.922	-.266	377.30	787.45
Gender	33	0	1.27	1.00	.452	1.070	-.915	1	2
Age	33	0	39.00	39.00	6.661	-.094	-.392	24	52
Bodily Kinaesthetic Intelligence	33	0	15.9394	16.0000	3.39061	-.585	-.410	9.00	20.00

Inferential Statistics

Using the SPSS software, a correlation was run to investigate whether there was an association between participants' bodily kinesthetic intelligence and reaction time on ASRT task. All variables were continuous, but preliminary exploration revealed outliers as well as violation of the normality and linearity. According to Shapiro-Wilk test, the significance values for reaction time in pattern condition were p=.002, p= .001 for the reaction time in random condition and p=.005 for kinesthetic intelligence. The violation of linearity was determined through exploration of the scatterplot. As the data were considered non-parametric, a Spearman's rho correlation was preferred over Pearson`s correlation.

The analysis implied a significant moderate negative correlation between KI and RT in the random condition, r (31) = -.456, p=.008 and between KI and RT in the pattern condition, r (31) = -.467, p=.006. This indicated that the high score on KI is associated with lower RT. This is presented in the Table 2 bellow.

Table 2. *Spearman`s rho, Significance values and Confidence Intervals*

	Spearman's rho	Significance(2-tailed)	95% Confidence Intervals (2-tailed)	
			Lower	Upper
Reaction_Time_Pattern - Bodily_Kinesthetic_Intelligence	-.467	.006	-.704	-.138
Reaction_Time_Random - Bodily_Kinesthetic_Intelligence	-.456	.008	-.697	-.124

Next, in order to understand the effect of gender on kinesthetic intelligence and reaction time, an independent t- test was planned to be conducted. Preliminary analysis showed that for both types of reaction time (random and pattern) and for kinesthetic intelligence, scores for females were not normally distributed, as assessed by Shapiro- Wilk`s test, $p<.05$.

Moreover, exploration of a box plot for the reaction time in the pattern condition for gender revealed the presence of two outliers within the male group, namely cases 3 and 33, with values of 779.45 and 631.65, respectively. The same two outliers were identified in the box plot for the reaction time in the random condition for gender, were case number 3 had a score of 787.45 and case number 33 scored 631.8. No outliers were found for bodily- kinesthetic intelligence against gender.

As a result of the violation of the assumption of normality, the Mann- Whitney U test was performed as the non-parametric alternative to the independent sample t- test. Distribution of the reaction time and kinesthetic intelligence scores for males and females was not similar as assessed by visual inspection. Reaction time scores in the pattern condition (Mean $Rank_{males}$= 15.61; Mean $Rank_{females}$= 17.52), reaction time in the random condition (Mean $rank_{males}$=16.0; Mean $rank_{females}$=17.38) and kinesthetic intelligence scores (Mean $rank_{males}$= 19.83; Mean $rank_{females}$=15.94) were not statistically different between men and women, U=95.5, z=-.505, p=.619; U=99.0, z= -.364, p=.736; and U=135.5, z=1.08, p=.309, respectively. The exact sample distribution for U was used (Dineen & Blakesley, 1973), see below table 3.

Table 3.Rank scores for Females and Males within each Measure

	Gender	N	Mean Rank	Sum of Ranks
Reaction Time Pattern	Female	24	17.52	420.50
	Male	9	15.61	140.50
	Total	33		
Reaction Time Random	Female	24	17.38	417.00
	Male	9	16.00	144.00
	Total	33		
Bodily Kinaesthetic Intelligence	Female	24	15.94	382.50
	Male	9	19.83	178.50
	Total	33		

Discussion

The purpose of this research was to investigate if there is a relationship between Procedural Memory and Kinesthetic intelligence (RQ1) and, it also aimed to observe if there are any gender differences in terms of procedural memory and kinesthetic intelligence (RQ2). To investigate the first research question correlation analysis was employed. The analysis showed a moderate negative correlation between reaction time and kinesthetic intelligence, as participants who scored high on kinesthetic intelligence had a shorter reaction time than participants who scored low on kinesthetic intelligence. This result supports H1, which foresaw a relationship between kinesthetic intelligence and procedural memory. Prior findings have demonstrated that reaction time is an important factor of skill acquisition and research is demonstrating that athletes have faster reaction time compared to normal healthy subjects (Jain et al., 2012).

The second hypothesis, which predicted gender differences in kinesthetic intelligence and procedural memory was examined using a non- parametric t-test. The present study found no significant differences between females and males in these two areas, supporting previous literature that suggest that males and females do not differ in skill acquisition. Literature review has indicated that the difference between genders disappear if the females are benefiting from one-to-one instructions and feedback (Ali et al., 2015). Moreover, different factors may influence a female`s skill performance such as harassment, lower levels of respect from colleagues, lack of support, gender discrimination, societal pressure, lack of maternity support, and male standards (Lim et al., 2021, Bernardi et al., 2020) Such factors may impair the accuracy of the data in the literature as it is difficult to establish real comparative values between gender.

On Gardner`s MI, intelligences such as logical-mathematic, spatial-visual, and bodily-kinesthetic intelligence are perceived as being more masculine while interpersonal, musical and linguistic are perceived to be more feminine (Bennet et al., 2000). Previous research suggests that self-estimate of intelligence is normally influenced by gender stereotype; people code and organize information in term of gender, which is process called gender schema theory (Bem, 1981, Rammstedt & Rammsayer, 2002). What is more, evidence has shown that in a relative equal educated sample, the males did not estimate themselves as being more intelligent than females, and amongst men, but not in women, certain aspects of intelligence are influenced by gender stereotypes (Rammstedt & Rammsayer, 2002).

Apart from gender differences, physical activity may influence how well a participant performs on reaction time, research has demonstrated that engaging in regular physical exercise results in a faster reaction time (Jain et al, 2015, TP et al., 2012). Those combined factors are showed to influence both skill acquisition as well as reaction time and the relation between them is far more complex than previously thought this is especially true for the female population.

Limitations

The present study, as far as the researcher is aware, is the first to investigate the corelation between kinesthetic intelligence and procedural memory. Despite its innovative nature, limitations of the present study should be recorded and addressed in future research. It is important to consider that the sample consisted of only 33 participants with 24 being females and 9 males. Such a sample distribution may not be representative of the general population and it might influence the trustworthiness of the findings regarding gender differences. Alongside the sample shortcoming, the use of MIPQ, which is a self-report scale, may further threaten the reliability of the present result. According to Fisher and Katz (2000), self-report assessments are suggestible to subjectivity and the intentional misreporting of sensitive information. Apart from the tendency to respond in a manner that is deemed socially desirable, responses may also be impacted by a person`s ability to cognise the questions and make the correct self-assessment, (Fisher &Kats, 2000, Latkin et al., 2017, Timler et al., 2019). In this way, the accuracy of the interpretation of the MPQ scores may be questioned. In addition, the MPIQ has got only four questions assessing kinesthetic intelligence, hence it may not be highly accurate, even though it had been found to have good reliability (Tirri & Nokelainen, 2011). When it comes to reaction time task (ASRT), it is essential to highlight that it was not administered in lab settings to control for events that may have influenced the participants response such as time of day, tiredness and distractions. Alongside, employing more participants, future research could benefit from using a more representative sample for bodily-kinesthetic such as athletes or dancers, who could be compared with a control group to assess the degree of difference in kinesthetic intelligence between groups on a more accurate task.

Another limitation of the study is that it made use of cross-sectional data that do not allow for conclusions about the direction of causality, i. e., it is not clear if Kinesthetic intelligence influences procedural memory or vice versa. Further research may investigate what is the nature of relationship between procedural memory and kinesthetic intelligence: it is a better procedural memory which determines high kinesthetic intelligence or it is an innate kinesthetic intelligence that may influence procedural memory?

A final limitation worth mentioning is the fact that the present study did not analysed the relationship of age with kinesthetic intelligence and procedural memory. Previous research has suggested that learning in an implicit manner decreases after the age of 12 and significantly age differences had been demonstrated by reaction time tasks, implicit learning being replaced by internally structured models of the world (Feeney et al., 2002; Howard et al., 2013; Nemeth et al, 2013).

Conclusion

In conclusion, there is evidence for a correlation between procedural memory and kinesthetic intelligence, but the more research is needed to investigate this relationship. The present study found no gender differences in both kinesthetic intelligence and procedural memory, and if equal learning opportunities are presented, females perform similar to males in skill acquisition. Further studies are needed to replicate this finding and use more precise measures for kinesthetic intelligence. Likewise, more research is needed to observe what is the relationship between PM and KI, i.e., does KI precede PM or vice versa?

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Appendix 1

You are invited to take part in the present research project.

I am a final year undergraduate student at the National College of Ireland. As part of my degree, I am conducting a study to investigate if Procedural Memory is associated with Kinesthetic Intelligence.

Procedural Memory is motor skill memory that helps us perform particular tasks without conscious awareness eg. riding a bike.

Kinesthetic Intelligence is the ability to learn through doing and the ability to duplicate something after doing it once.

To be able to take part in this study, you must be over 18 years of age.

You will be required to complete the Multiple Intelligence Profiling Questionnaire and Alternating Serial Response Time task.

Participation in this study will take approximately 25 minutes and is purely voluntary.

You may withdraw at any stage by pressing CTRL+Q.

If you have any questions please contact me, Carmen Chereches (exppsych2021@gmail.com), or my supervisor Dr Matthew Hudson (matthew.hudson@ncirl.ie)

□ I understand what this study is about, my rights as a participant, and I consent to take part

Appendix 2

What is your gender?

□ Female □ Male □ I prefer not to answer this question □ Other

What is your age?

[ ]

Appendix 3

1. Writing is a natural way for me to express myself.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

2. At school, studies in native language were easier for me.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

3. I have recently written something that i am especially proud of, or for which I have received recognition.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

4. Metaphors and vivid verbal expressions help me learn efficiently.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

5. At school, I was good at mathematics, physics or chemistry.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

6. I can work with and solve complex problems.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

7. Mental arithmetic is easy for me.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

8. I am good at games and problem solving, which require logical thinking.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

9. At school, geometry and various kind of assignments involving spatial perception.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

10. It is easy for me to conceptualize complex and multidimensional patterns.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

11. I can easily imagine how a landscape looks from a bird's eye view.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

12. When I read, I form illustrative pictures or designs in my mind.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

13. I am handy.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

14. I can easily do something concrete with my hands (e.g. knitting and woodwork).

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

15. I am good at showing how to do something in practice.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

16. I was good at handicrafts in school.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

17. After hearing a tune once or twice, I am able to sing or whistle it quite accurately.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

18. When listening to music, I am able to discern instruments or recognize melodies.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

19. I can easily keep the rhythm when drumming a melody.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

20. I notice immediately if a melody is out of tune.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

21. Even in strange company, I easily find someone to talk to.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

22. I get along easily with different types of people.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

23. I make contact easily with other people.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

24. In negotiations and group work, I am able to support the group to find a consensus.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

25. I am able to analyze my own motives and ways of actions.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

26. I often think about my own feelings and sentiments and seek reasons for them.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

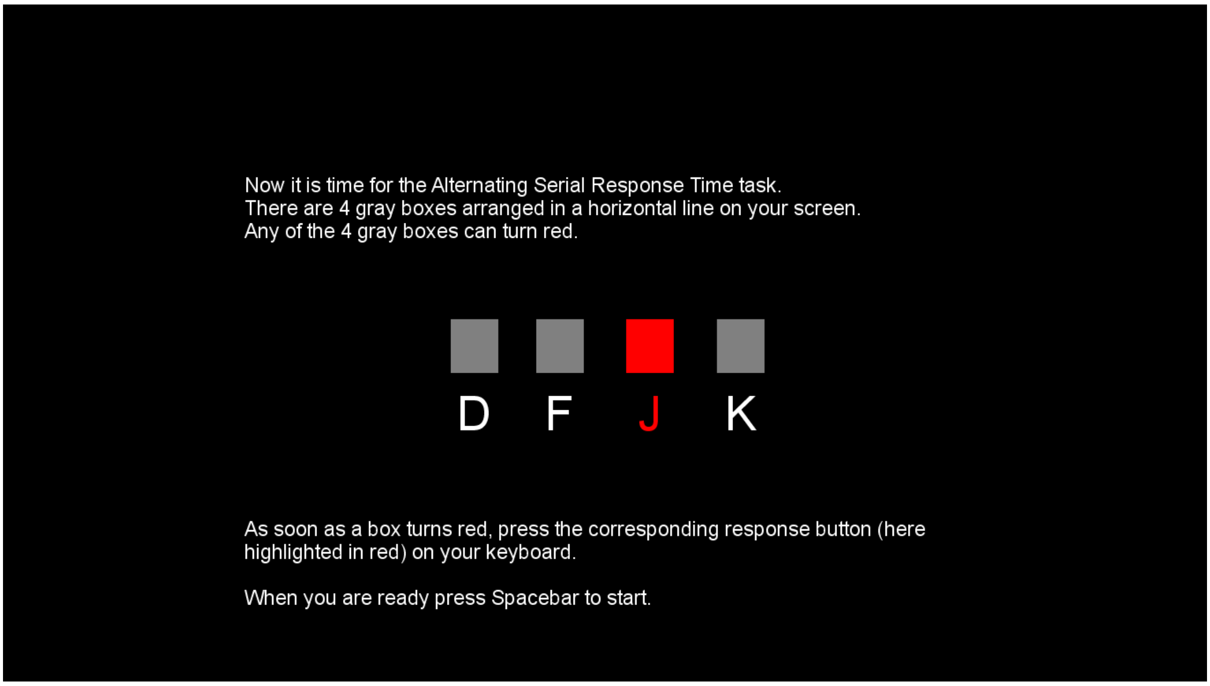
27. I spend time regularly reflecting on the important issues in life.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

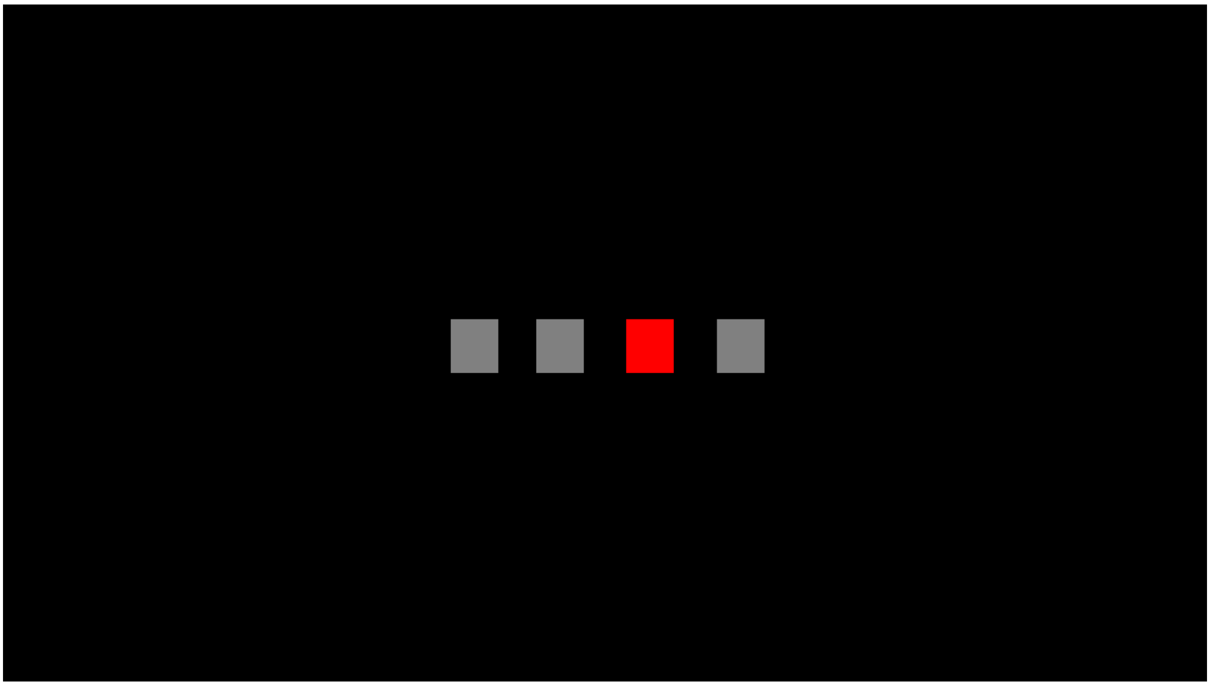
28.I like to read psychological or philosophical literature to increase my self-knowledge.

□ Strongly Disagree □ Disagree □ Neutral □ Agree □ Strongly Agree

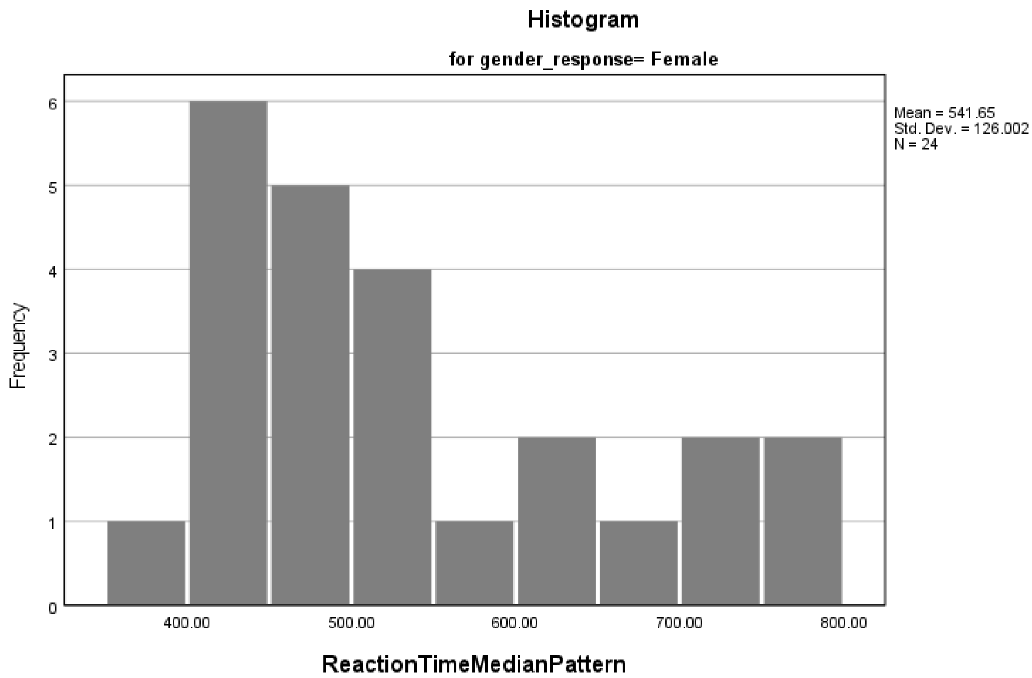
Appendix 4

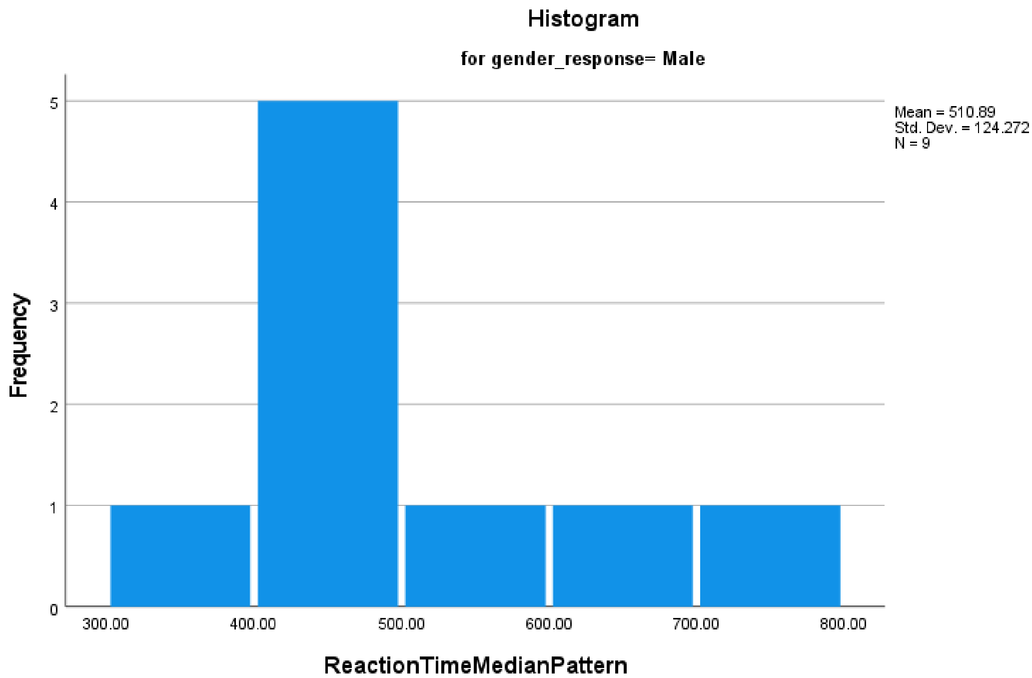

Now it is time for the Alternating Serial Response Time task.
There are 4 gray boxes arranged in a horizontal line on your screen.
Any of the 4 gray boxes can turn red.
D F J K
As soon as a box turns red, press the corresponding response button (here highlighted in red) on your keyboard.
When you are ready press Spacebar to start.

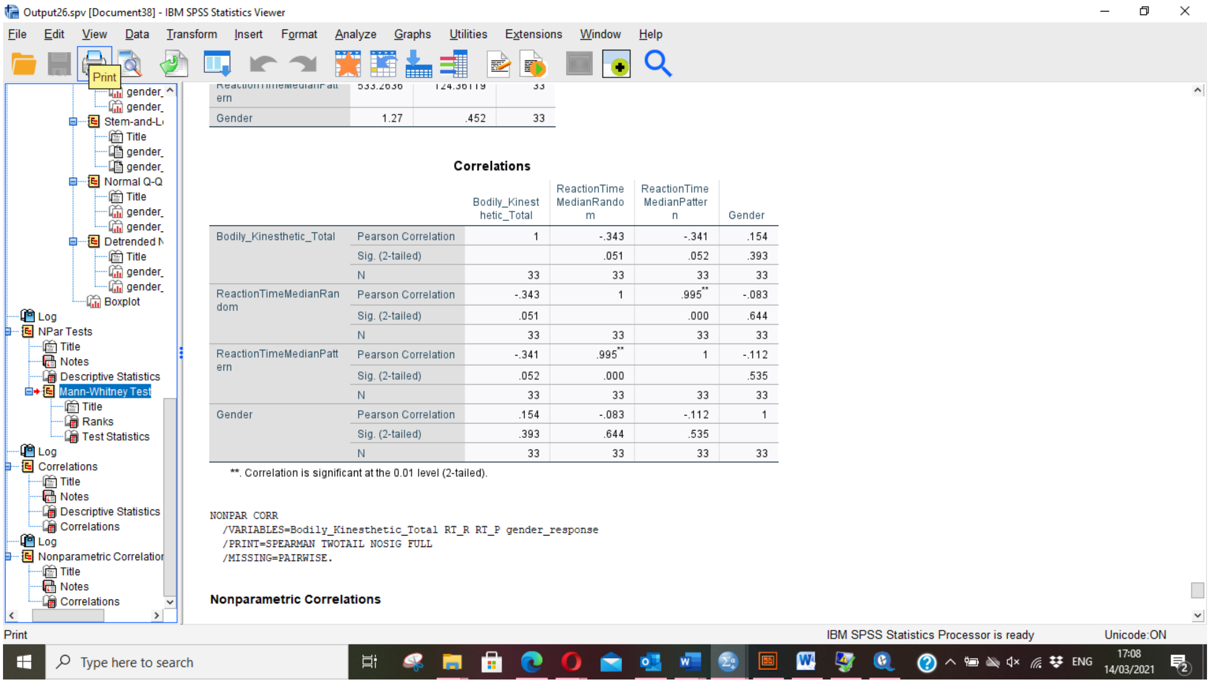

Get Ready:
place your left middle and index finger on the 'D' and 'F'
place your right index and middle finger on the 'J' and 'K'



Appendix5


Histogram
for gender_response= Female
Mean = 541.65
Std. Dev. = 126.002
N = 24
Frequency
0
1
2
3
4
5
6
400.00
500.00
600.00
700.00
800.00
ReactionTimeMedianPattern


Histogram
for gender_response= Male
Mean = 510.89
Std. Dev. = 124.272
N = 9
Frequency
0
1
2
3
4
5
300.00
400.00
500.00
600.00
700.00
800.00
ReactionTimeMedianPattern



Gender	1.27	.452	33

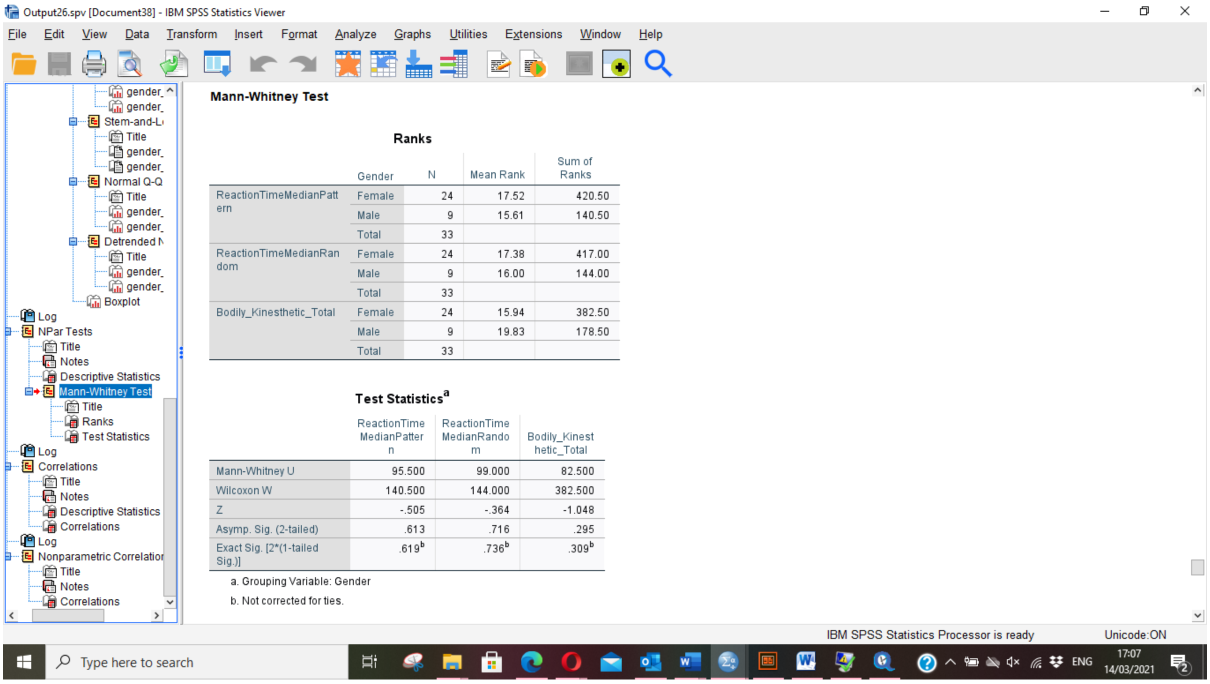
Correlations

		Bodily_Kinesthetic_Total	ReactionTimeMedianRandom	ReactionTimeMedianPattern	Gender
Bodily_Kinesthetic_Total	Pearson Correlation	1	-.343	-.341	.154
	Sig. (2-tailed)		.051	.052	.393
	N	33	33	33	33
ReactionTimeMedianRandom	Pearson Correlation	-.343	1	.995**	-.083
	Sig. (2-tailed)	.051		.000	.644
	N	33	33	33	33
ReactionTimeMedianPattern	Pearson Correlation	-.341	.995**	1	-.112
	Sig. (2-tailed)	.052	.000		.535
	N	33	33	33	33
Gender	Pearson Correlation	.154	-.083	-.112	1
	Sig. (2-tailed)	.393	.644	.535	
	N	33	33	33	33

**. Correlation is significant at the 0.01 level (2-tailed).

```
NONPAR CORR
  /VARIABLES=Bodily_Kinesthetic_Total RT_R RT_P gender_response
  /PRINT=SPEARMAN TWOTAIL NOSIG FULL
  /MISSING=PAIRWISE.
```

Nonparametric Correlations



Mann-Whitney Test

Ranks

	Gender	N	Mean Rank	Sum of Ranks
ReactionTimeMedianPattern	Female	24	17.52	420.50
	Male	9	15.61	140.50
	Total	33		
ReactionTimeMedianRandom	Female	24	17.38	417.00
	Male	9	16.00	144.00
	Total	33		
Bodily_Kinesthetic_Total	Female	24	15.94	382.50
	Male	9	19.83	178.50
	Total	33		

Test Statistics[a]

	ReactionTimeMedianPattern	ReactionTimeMedianRandom	Bodily_Kinesthetic_Total
Mann-Whitney U	95.500	99.000	82.500
Wilcoxon W	140.500	144.000	382.500
Z	-.505	-.364	-1.048
Asymp. Sig. (2-tailed)	.613	.716	.295
Exact Sig. [2*(1-tailed Sig.)]	.619[b]	.736[b]	.309[b]

a. Grouping Variable: Gender

b. Not corrected for ties.