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Differences of Cognitive Function Between Genders Among University Students

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ABSTRACT

Differences in cognitive ability and brain anatomy have been observed between genders, attributed to a combination of genetic, hormonal, and environmental factors. It is important to note that these variations do not imply any overall superiority of one gender over the other. Previous research has explored inhibition capacities and gender-specific differences in risky decision-making. The central question remains: do men or women excel in specific cognitive activities? This study aimed to compare the cognitive function between males and females among university students. A convenience sample of 42 university students (21 female, 21 male) voluntarily participated in this study. A Stop Signal Task was used to assess the cognitive performance of the participants. The stop-signal paradigm explored motor inhibition in a laboratory setting using a computerized test. Visual cues were used in the task. The computerized test used E-Prime 3.0 software and all the data was merged using E-Merge 3 and E-Data Aid 3. The Statistical Package for the Social Sciences (SPSS) version 26 was performed independent sample t-test to analyze all the data. Results showed that there are no significant differences in cognitive function between both genders. Regardless of the mean differences for reaction time and accuracy, the *p*-value was greater than 0.05 and proved that there are no significant cognitive function differences. Uncertainty still exists regarding the correlates of the cognitive differences between the genders. The limitations arising from the convenience sample size may restrict the generalizability of the findings to the broader population of university students. Future studies might focus on other populations particularly gender differences. Specifically, enhancing the Stop Signal Task to more closely replicate real-world human activities related to inhibitory control could be beneficial. In conclusion, this study has yielded important findings of inhibition ability between female and male of university students.

Keywords: *Cognitive functions, inhibition, gender, university students*

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INTRODUCTION

Every area of life is impacted by cognitive processes, including profession, relationships, and education. Cognitive control has been traditionally considered an integral mechanism, which usually functions in various cognitive tasks (Sun et al., 2019). Cognitive inhibition, on the other hand, is the mechanism responsible for minimizing and obstructing the interference of thoughts, images, and memories unrelated to the current task (Diamond, 2013). In order to choose the best course of action for achieving goals in a changing environment, several components of decision-making can be linked to the blockage of irrelevant information (Mansouri et al., 2009). There are gender differences in cognitive function. The big question is whether men or women are better at different cognitive activities. Cognitive ability and brain anatomy have been found to differ between sexes (Cosgrove et al., 2007). These variations can be linked to a variety of genetic, hormonal, and environmental elements, and they do not convey any general superiority to either sex. However, one may not conclude that there are no sex differences in brain structures as stated in a study reporting that women have a larger gray matter volume in the frontal pole, inferior/middle frontal gyrus, planum temporal/parietal operculum, anterior cingulate gyrus, right insular cortex, Hescl's gyrus, thalamus, precuneus, parahippocampal gyrus and lateral occipital cortex (Ruigrok et al., 2014). Meanwhile males' brain gray matter volume was more in the amygdala, hippocampus, parahippocampal gyrus, precuneus, putamen and temporal poles, the cingulate gyrus and also the cerebellum (Ruigrok et al., 2014). A study done by Ritchie and colleagues (2018), on differences in subregional brain volume, surface area and cortical thickness found that compared to women, men had greater variation in brain volume measurements. Uncertainty still exists regarding the correlates of the cognitive differences between the sexes. Men do better than women in terms of mental rotation, computing efficiency, and orientation, according to some of the most reliable research (Jones et al., 2003; Li & Singh, 2014). Males typically exceed females in spatial, working memory, and mathematical capabilities, while females typically surpass males in verbal fluency, perceptual speed, accuracy, and fine motor skills (Zaidi, 2010). Women tend to rate faces more positively, recognize emotions better, and have a liking for the faces of young children and the elderly (Proverbio, 2017). In this study, we focused more on the role of response inhibition. Response inhibition refers to the suppression of actions that are inappropriate in a given context and that interfere with goal-driven behavior. In accordance with gender, which is a biological trait, men and women behave differently due to differences in the way their brains work (Korzhyk et al., 2019). Women have demonstrated that they are more adept than men at using executive control in complicated cognitive tasks, according to a study (Mansouri et al., 2016). Rubia et al. (2013), study also mentioned that gender variations in the post-adolescent functional development of these brain regions contribute to the superior dependence on functional frontal mechanisms in males and functional parietal mechanisms in females during inhibitory control. A study by Saunders et al. (2008), also states that men exhibit poorer response inhibition. According to Haghighi et al. (2015), there were no sex differences in interference inhibition at any age. The contradictory results on the risky decision and inhibition capacities of men and women point to the necessity for additional research. Thus, this study compares the cognitive function between male and female of university students.

METHODOLOGY

This study utilizes a cross-sectional research design. The stop-signal task is used in this study's experimental test to look at how gender affects inhibitory control. Before taking part in the trial, all participants received consent forms and information about their rights and obligations. The Faculty of Sport Science and Recreation (FSR) students from Universiti Teknologi MARA's Perlis Branch compose the sample selection. This study employ a convenient sampling technique. In total, 48 participants (male FSR student = 24, female FSR student = 24) aged 18 to 25 years old were recruited for this study. This age range represents the university students. 24 male and 24 female FSR students were recruited randomly in this study. The sample selection are students from Universiti Teknologi MARA, Perlis Branch. The inclusion criteria of the participant: Age between 18 to 25 years old, a student of the Faculty of Sport Science and Recreating in UiTM Perlis, physically healthy to participate in the activity, possess normal-to-corrected eyesight. Meanwhile, exclusion criteria include suffering neurological disorder, prescription of psychiatric medication and refusal to give consent. After recruiting the participant, a preliminary survey was done to establish their health condition. To ascertain what factor(s) contributed to the students' cognitive performance, it is important to comprehend the students' health backgrounds. Once the grant is awarded, this study received ethical approval from the UiTM Ethical Committee. The Stop Signal Task is a unique version of classic approach to measure response inhibition. The stop-signal paradigm explored motor inhibition in a laboratory setting using a computerized test. Visual cues were used in the task. The test included a primary go task in which the participant had to press a button in response to a stimulus, most frequently a visual signal (GO cue). Key press or mouse movement condition would be the only component in our between-subjects design. The decision to use this design was made with the presumption that a within-subjects approach would have resulted in more than a thousand trials for each participant, possibly leading to participant weariness and instructional misunderstanding. In this study, participant will be doing their stop signal task in a stop signal task software, E-Prime Go 3.0. Their participation would take approximately 13 to 15 minutes. All the data obtained from this study will be analyzed in IBM SPSS Version 26 by IBM Corporation Business Analytic Software. This study will use two types of data analysis: descriptive and inferential statistics. The descriptive statistic will describe the demographic data such, as age, weight, height, and gender. All data will be presented as mean standard deviation. Meanwhile, interferential statistic will interpret the value resulting from the Stop- Signal Task. The level of significance is set at $p < 0.05$. This study was approved by Research Ethics Committee of University with reference number REC/196/2022.

RESULTS AND DISCUSSION

The aim of this study was to compare the cognitive function between genders among FSR students. All the subjects have completed the computerized test to measure their reaction time on go trials, stop signal reaction time and accuracy in go and stop signal. This study was conducted in UiTM Perlis. After some withdrawal and unable to fully commit to participate, only 42 students managed to complete the experiment. All students that participated in this study were FSR Diploma and Degree studying at UiTM Perlis. The participant were briefed to the test and already answered the Google Form of the preliminary survey before beginning the test. The computerized test used E-Prime 3.0 software and all the data merged using E-Merge 3 and E-Data Aid 3. The SPSS Version 26 performed Independent-Sample t-test to analyse all the data findings. The demographic analysis showed bachelor participant has the highest frequency with 29 and percentage of 69.05%. Both data entry accumulated to 42 participants. The results of comparison showed that there are no significant mean differences for variables “Mean Go Trial Reaction Time”, $t(40) = 0.82$, $p = .416$ (Female: M = 365.36), (Male: M = 351.74), “Stop Signal Reaction Time”, $t(40) = -1.47$, $p = .151$ (Female: M = 518.051, Male: M = 546.33). Meanwhile, result from Mean Go Trial Accuracy show that there are no mean differences, $t(40) = -0.49$, $p = .630$ (Female: M = .93, Male: M = .95) and “Mean Stop Signal Accuracy”, $t(40) = -0.3$, $p = .764$ (Female: M = .98, Male: M = .98).

Table 1. Comparison inhibition stop signal test of female and male university students.

Variables	**Gender**	**Mean**	***t***	***df***	***Sig.* (2-tailed)**
Go Trial Reaction Time	Female	365.36	0.82	40	$p = 0.416$
	Male	351.74			
Stop Signal Reaction Time	Female	518.05	-1.47	40	$p = 0.151$
	Male	546.33			
Go Trial Accuracy	Female	0.93	0.49	40	$p = .630$
	Male	0.95			
Stop Signal Accuracy	Female	0.98	-0.3	40	$p = .764$
	Male	0.98			

***p** > 0.0.5

The outcomes of this study have provided the insight of cognitive function in female and male FSR students. It was hypothesized that there were no significant differences in cognitive function between female and male FSR students. According to the result, female and male did not differ in response inhibition as indicated by the Stop Signal Reaction Time. However, female students show a faster response to stop signal task than the male students. Usage of fine motor skills need to be consider as this study used the key press experiment method to inhibit response. Previous study stated that women in late follicular or midluteal phases showed the best efficiency of fine motor skills task (Maki et al., 2002; Rosenberg & Park, 2002). This finding also can be supported with a study of 30 adult females underwent repetitive unilateral finger tapping while completing anagram during both menses and midluteal phase resulting in enhanced recruitment of left-brain sources when performing lateralized verbal task (Wong-Goodrich et al., 2020). This occurrence can also be linked with female's ability to multitasking. Multitasking involves switching between task alternating attention from one task to the next (Judd, 2013). Being able to respond to new, more time sensitive tasks and interruptions and then returning to prior tasks are inhibition elements. In a study of gender differences in media-based multitasking, a sample of 14 to 16-year-old were taken and resulting in girls spend more time multitasking than boys (Foehr, 2006). In contrast to another recent study, found that men have an advantage in concurrent multitasking (Lui et al., 2021). Specifically, contrary with the Stop Signal Reaction Time, male students showed a lower mean of Go Trial Reaction Time. Male took less time to response to the "go" cue. In comparison to female participants, male participants saw their actions as less dangerous, allegedly took more chances and were less sensitive to unfavourable results (stop cue). Despite that, these results fit with previous study stating that males are reportedly more focused on the potential beneficial outcome of a risky decision and are more impulsive than females, while females are found to be more sensitive to punishment and uncertainty and are more risk averse (Lee et al., 2009). In addition, others study provide evidence in favor to females in which they are more proactive and cautious cognitive processing, meanwhile males are more reactive and fast cognitive processing (Bianco et al., 2020). A study by Nikam and Gadkari (2012), on a group of 30 males and 30 females resulted in female with higher body mass index has longer reaction time than males. Female sex hormones that alter sensorimotor coordination could be the cause of longer reaction times and higher BMI in females. Apart from that, both gender appeared to have minor differences of mean in accuracy of response. Subject may have a good reaction time but they may not have the accurate response to the cue. From the data findings of this study, it revealed only slight differences of mean resulting in no significant differences of accuracy for both female and male FSR students. In this case, subject may have focuses more on speed of finishing the task rather than the accuracy of responding to the cue. When motion strength was varied in randomly go and stop trials, accuracy decrease with motion strength, whereas reaction time increase. Recent studies indeed does mention that speed and accuracy instruction have influence on decision making. According to Wenzlaff et al. (2011), the mean reaction time difference between situations of high and low levels of sensory evidence was greater for individuals who were given accuracy instructions than for those who were given speed instructions. These finding were supported with study from Herz et al. (2017), in a moving dots test, the reaction time disparities between high and low coherence conditions were greater with accuracy instruction than with speed instructions.

CONCLUSION

A variety of behaviour essential for adaptive functioning are driven by response inhibition, the capacity to suppress a reaction in the face of shifting internal or external stimuli. Response inhibition has emerged as a key candidate in genetic and neurobiological investigations of executive functioning due to its significance in the capacity to respond adaptably in a dynamic environment and the abundance of evidence supporting the role of impaired inhibitory control in many psychiatric illnesses. The limitations arising from the convenience sample size may restrict the generalizability of the findings to the broader population of university students. Future studies might focus on other populations particularly gender differences. Specifically, enhancing the Stop Signal Task to more closely replicate real-world human activities related to inhibitory control could be beneficial. In conclusion, this study has yielded important findings of cognitive function between female and male of university students, particularly among FSR students. Results showed that there are no significant differences of cognitive function between both genders.

Regardless the mean differences for reaction time and accuracy, the *p*-value was greater than 0.05 and proved that there are no significant cognitive function differences.

CONFLICT OF INTEREST

No conflict of interest involves in this research among authors or respondents chosen in this research.

AUTHORS' CONTRIBUTION

Sarah Nabahah Ismail was involved in the study concept, design, data acquisition, data analysis, preparing and writing the manuscript as well as participated in all study processes. Nohd Azim Nural Azhan was involved in the study design, logistics of data acquisition and data analysis of raw data. Syed Shahbudin Syed Omar and Mohd Syafiq Miswan were involved in the study concept, and idea. Nurul Farha Zainuddin was involved in interpretation of data, designing search strategy, critically reviews, monitored overall flow of study and final approval of the manuscript. All authors contribute an important intellectual input and agreed in all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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