**Extended Essay**

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**Research question :** To what extent do video games enhance perceptual motor skills in young adults?

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## Introduction

In today's highly digitalized and evolving world, where artificial intelligence is being considered to take over human responsibilities and jobs, video games emerge to be one of the biggest industries with an enormous revenue of $180 billion, more than the Hollywood and music industry combined. Video games are a highly preferred form of entertainment as they are visually appealing and easily accessible, ranging from phones to consoles. Though video games are also labeled to be 'addictive' and 'problematic' due to the negative effects they impose, such as lower psychosocial wellbeing (Lemmens et al., 2011) or resistance to academic excellence (Chiu et al., 2004), they have proven to be beneficial as well, like an increase in productivity when performing fine motor tasks (Hobbolog, 2017).

Fine motor skills refers to "the ability to control and coordinate muscles of the hand for precise movements" (Strong et al., 2020). This involves everyday activities, like writing, tying shoelaces, using scissors, etc. Video games, being a visually demanding stimulus, make use of a bit more complex ones, including anticipation timing and peripheral perception, coming under the umbrella term 'perceptual motor skills'. Often related to fine motor skills, it is just as important to practice these skills in everyday life, otherwise it could result in the absence of basic functionality required to lead a normal life.

One of the initial studies to examine this link in the absence of current technological fabrications was conducted with video game players (VGPs) and non-video game players (NVGPs) who were required to locate a flash. Reaction time, which was a measure of divided attention, was faster in VGPs compared to NVGPs (Greenfield et al., 1994). However, there are conflicting

results as well which question this link as presented by Klicka et al., (2006) and Kennedy et al., (2011).

Perceptual motor skills are useful and beneficial in the completion of everyday tasks, so to examine the fluidity of this cognitive functioning and how it is affected by such an intriguing activity in young adults can be interesting to study. Society firmly considers video games to be childish and associates it with adolescents, while being unaware about its benefits and drawbacks. This essay also has particular emphasis on the role video games play in enhancing perceptual motor skills for the age group of 18 to 26 - 'young adults'. This is to discuss a demographic very well known for their engagement with video games. Additionally, it provides a well detailed and focused exploration into a specific age group and not just vaguely investigates everyone, as results might differ. Articles from various academic journals and sources of psychology with different research methods (McMahon et al., (2020), Li Li et al., (2016) and Green et al., (2003)) will be used for this. Additionally, this essay serves to raise awareness on this topic and ultimately answer the research question :'***To what extent do video games enhance perceptual motor skills in young adults?'***

## Theoretical model for video games and perceptual motor skills

To subsidize the correlation of perceptual motor skills and video games, an apt model to consider is Attentional Network Theory (ANT). The presence of this theory is very evident in young adults, as this is the age where the brain performs at its best. ANT proposed that the brain consists of three unique attention networks that enact and justify the different aspects of attention. The alerting network is activated when we need to pay attention and make split second

decisions to maintain a constant state of readiness. This network is a major requirement during video gaming to complete a desired goal (Posner & Posner, 1990).

A study showed that reaction times, measured by pressing a button after a visual stimulus appeared, were faster when a warning cue was given. This demonstrated that this network prepares the brain to act in a way the stimulus demands (Fan et al., 2002). The orienting network responds to the need of focusing on something specific out of many objects. VGPs in general are very often situated into such a process as they need to face many challenges, but only proceed successfully if dealt one by one, sequentially. Video games demand their players to keep diverting attention from one thing to another repeatedly to play efficiently. Lastly, the executive control network is held responsible for managing multitasking and eliminating external distractions. The need to attend to different attentional methods are demonstrated by video games as means to challenge players to handle multiple operations at once, and the players' aim should be to get rid of these distractions by using strategic methods and mainly attention.

The ANT has been backed up by various methods of research, including clinical, behavioral and neuroimaging. A neuroimaging study presented evidence to hint the activation of the orienting network after participants were given a cue on which location to focus on by showing increased activity in specific areas of the brain (Corbetta & Shulman, 2002). Altogether, the ANT explicitly answers the research question by providing a utilitarian framework for interpreting the different types of attentional networks and how they connect. This theory can also be leveraged to design video games in a tactical way that enhances perceptual motor skills in a more effective manner in an attempt for highly skilled performance.

## Positive effect of video games on perceptual motor skills

The growing evidence in this field has shown that diverse video games impose unique features on its players, both negatively and positively (Murphy et al., 2009; Ferguson et al., 2007). Although as video games advanced its features, it gradually found itself getting caught up in the loop of stereotypes, resulting in negative publicity. Research does exist to justify the same, such as action video games encourage aggressive behavior, induce seizures and become a reason for poor school performance (Anderson, 2004). Despite the association of negative stigma and video games, researchers have gained insight on the positive effects of playing video games as well, and this section of the essay will discuss such studies.

McMahon and Luke (2020) used a multiple object tracking (MOT) task to investigate whether video game playing would result in enhanced visual attention abilities. The MOT task likely had participants tracking multiple moving objects simultaneously, very similar to how video games operationalize perceptual motor skills. This would activate their visual attention capacity. The study took place in a public setting. Young adults aged between 18-23 were recruited and divided into VGPs and NVGPs. The results of the study indicated that VGPs performed significantly better than NVGPs (McMahon & Luke, 2020).

The study had a well defined hypothesis and statistical analysis, which gives clarity to the study. The use of MOT might have provided an objective measure of visual attentional abilities. However, this study was hosted in a public setting without any efforts to reduce outside stimuli. The higher chances of confounding variables, such as prior experience, might affect participants' performance. Replicating this study in a laboratory setting where the participants can be asked to

engage in a video game activity might enhance the internal validity. The research also emphasized only on one visual attention task - MOT. This makes it harder for the study to be generalized to broader perceptual benefits of playing video games. In order to solve this, multiple cognitive tasks should be integrated. Lastly, there was also no information on what basis the participants were categorized into VGPs and NVGPs. More detailed gaming information might provide a more focused interpretation of the results.

Another similar study led by Li Li established a causal relationship between action video games and visuomotor skills. After distinguishing young adults into VGPs and NVGPs by their history of video game playing, they were made to perform four experiments to assess precision, visuomotor control, effects of driving games and the effect of first person shooter (FPS) games. In experiment-1, participants had to maintain a visual car in a straight lane. The results showed as expected, action VGPs displayed better precision compared to the NVGPs. To measure visuomotor control, experiment-2 assigned participants with a visuomotor control task- to control the horizontal movement of a red dot and keep it as close to the center of the screen as possible by using a joystick. Even in this task, action VGPs had better performance having a 16% smaller precision error and a 10% shorter response time. The last two experiments focused on manipulating game play in NVGPs, evaluating the effects of driving games and FPS games. In experiment-3, one group was asked to play Mario Kart, a driving game and the control group was asked to play Roller Coaster Tycoon III, a strategy game. The last experiment needed the participants in one group to practice ‘Unreal tournament’, a FPS game and the control group to practice ‘The Sims 2’, a strategy game. They were tested 3 times in total with the dot task (experiment-2), before training, after five hours of training and after final 10 hours of training in

both the experiments in order to track the improvement in skills of practicing these games. No significant difference in game engagement was observed in the initial testing. Later, the FPS and driving game players showed improvement in visuomotor control but the control group from both the experiments didn't (strategy game players) (Li Li et al., 2016).

This study provides rich evidence on the connection of video games and the extent to which they enhance visuomotor skills. Though the research wasn't able to come up with an explanation for not having a reduction in the reaction time, for which the reason might have been the limited 10 hours of playing. The tasks stood relevant to real-world scenarios and gave insights into participant's abilities. The study successfully established a cause and effect relationship because of the manipulation of gaming (IV) and visual motor skill (DV).

Skills developed from video games can be applied in real life. One of them that is very important for young adults is essay writing, as such tasks are frequently given for college assignments. Sanchez (2012) wanted to investigate whether there were positive correlations between video games and visuomotor ability. Sixty university students were divided into 2 groups- spatial training group and non-spatial training group. Participants in the first group were asked to play the FPS game, "Halo: Combat Evolved" and the other group were asked to play "Word Whomp", a word making game. After playing the game, participants read a 3500-word text about plate tectonics and volcanic eruptions with no illustrations. The task assigned after reading this text was to write an essay entitled "What caused Mt St Helens to erupt?". The essays were marked by independent scorers on the basis of the extent to which the essay demonstrated a clear understanding of plate tectonics and volcanic eruptions. The results showed that participants

from the spatial training group scored higher points on the essay, demonstrating a better understanding of plate tectonics and volcanic eruptions. Hence, it was concluded that the visuospatial ability could be enhanced with the training of video games (Sanchez, 2012).

However, a limitation of this result is that the essay was written almost immediately after the game was played, hence the findings from this study project only the short-term effects of spatial video gaming. The sample size of the study is comparatively large, hence making it easily generalizable. Additionally, it should be considered that the training manipulation might have activated visuospatial abilities in the participants, inducing a training effect. As the text was presented to participants without any illustrations, it could be said that the FPS game helped to encode verbal information and translate it into spatial representations, also reflecting in the results. The study also has limited construct validity as there isn't a clear link between writing essays and perceptual-motor skills.

In another study, Green & Bavelier (2003) hypothesized that video game playing increases the capacity of the visual attentional system. Participants aged between 18 and 23 were divided into VGPs and NVGPs based on their consumption of video games for the last 6 months. Then, their visual skills were tested through five experiments. The first two experiments measured attentional capacity but with different methods. Experiment-1 employed a flanker compatibility task in which a distractor (larger distractor = larger capacity of residual attentional resources) was used as a measure of attentional capacity whereas experiment-2 used an enumeration task in which the subitizing range (number of squares noticed at the same time without error) was as assessor. Experiment-3 was a 'useful field of view task' to examine spatial attention. The fourth

experiment was called attentional blink which was a measure of attention over time. The last experiment was hosted with a new population of subjects, who were all NVGPs. They were assessed twice, before and after 10 days of video game training, on all the aforementioned experiments except the first one. The experimental group played a FPS game but the control group was trained with Tetris as it does not change the aspects of visual attention. VGPs outperformed the NVGPs in the first four experiments. Findings from the last experiment showed that the FPS game training led to a greater improvement in all the 3 tasks than the control group training (Green & Bavelier, 2003). Hence, it was concluded that video game training does have the potential to increase visual attentional capacity in young adults, confirming the research question.

The researchers concluded that action video games require players to simultaneously engage in a number of varied tasks, like detecting enemies, avoiding getting hurt, etc. Such demands may result in brain changes that improve visual attention capacity specifically and perceptual motor skills as a whole. It is also possible that video games could be used in treatment programs to help people with visual problems. On the other hand, experiment 1-4 had only male participants whereas in experiment-5, both males and females NVGPs went under training. This justifies a possible gender bias that might have made the results unreliable. The study, while being an experiment, doesn't establish a causal relationship because of a correlational nature of the study design.

Esports is an emerging and evidently one of the most important applications of perceptual motor skills in real life. People are even pursuing competitive video gaming as a career. Esports

demands various perceptual motor skills such as anticipation, peripheral perception and hand-eye coordination in order to perform at a competitive level and ultimately win. It is a form of sports which is very popular among young adults and these reasons make it adequate to discuss a study and relevantly expound on the research question.

To investigate the proficiency levels of esports gamers in perceptual motor skills with comparison to amateurs, Kim et al., (2022) conducted a study with various tests that assessed perceptual motor skills. Participants were eight right handed male esports professionals and eight male amateurs, all young adults with no history of physical or neurological issues. The first test was to measure anticipation timing where participants were supposed to press a button in front of them when they had come to know that the light stimulus arrived at the end of the runway. Every participant completed 20 trials for 4 different speeds. For measuring hand-eye coordination, participants used an electric stylus to pursue a moving target for 30 seconds. Lastly, peripheral perception was measured using the Vienna test system, where participants had to respond to straight lines of stimulus light among random blinking lights while limiting head movement. This helped know how good a participant's field of vision was when head movements were limited. Later, several statistical analyses were hosted to conclude differences between esports players and amateurs. As expected, professional gamers performed better at the anticipation task, having a negative timing across all the speeds. Though surprisingly, there was no significant difference between the two groups for hand-eye coordination. The esports players also had a broader field of vision than the amateurs (Kim et al., 2022).

Although the study provides insight on how intensive video gaming training can lead to a modification in perceptual motor skills, such as field of vision and anticipation, it had its own limitations. Firstly, all the participants in the study were males and the esports players primarily practiced only StarCraft, a strategy game. The recruitment of such a constrained sample makes it hard for the study to be generalizable to females and esports players who play other genres, like action video games. In addition, the researchers didn't consider the number of years the esports players had experience in their field. It might have been possible that some esports players had more than 10 years of experience, whereas some started much later. Despite displaying a causational link, a problem with the research method was that the experiment was conducted in a laboratory based setting, lacking ecological validity and decreasing the replicability of esports gamers in real life situations. The measurement of perceptual motor abilities were only limited to three tasks due to limited equipment. A confounding variable could be that esports players might have had better perceptual motor skills compared to the amateurs prior to training for becoming a professional which might have contributed to the differences between the two groups.

When accumulated, all these findings from different studies demonstrate how skills that are developed from practicing video games for young adults can be applied in real life. It is very evident that active VGPs are more likely to perform better than NVGPs at perceptual tasks among young adults.

**Do video games always enhance perceptual motor skills?**

The essay till now had mainly focused on the beneficial effects of video games on perceptual motor skills, but it is important to acknowledge studies that serve insight on the negative effects

of video games. Some argue that video games can enhance psychomotor ability, but can't influence visuospatial or perceptual ability (Kennedy et al., 2011). The study's aim was designed with context to laparoscopic situations. The researchers wanted to investigate whether video game playing would enhance psychomotor skills on a laparoscopic simulator, which tested perceptual abilities. The independent sample of 38 undergraduate medical students with no surgical experience explained their gaming experience using a questionnaire. Participants were made to perform tests that assess psychomotor, visuospatial and perceptual abilities. Results demonstrated that VGPs who played for at least 7 hours per week performed better in psychomotor assessment than NVGPs. Although, no differences were captured between NVGPs and VGPs when it came to perceptual abilities (Kennedy et al., 2011).

However, the study has a relatively small sample size. It also lacks ecological validity because the participants didn't perform under natural conditions. These reasons contribute to the limited generalizability of the findings. Though the study points to a potential benefit of video games on future career in surgery, regardless of whether it requires perceptual motor skills. It also suggests that specific surgical skills might actually be useful outside the contextual use of surgeries.

Another evidence of questioning the relationship between video games and reaction time as well as hand-eye coordination was conducted with two equal groups of VGPs and NVGPs college students. The amount of time spent on playing video games was used as a criteria to put them in their respective groups. Participants with less than an average of 4 hours in a week were considered NVGPs and more than an average of 4 hours in a week 3 months prior to the study were considered VGPs. Before being trained with video games for 1 week, participants had to go

through 3 tests that would act as a measure of improvement in hand-eye coordination and reaction time. In the ruler test, participants had to catch a ruler as fast as possible after it dropped. In the second test, an online reaction time test was conducted. Lastly, participants performed a pop can test for coordination in which they were supposed to flip pop cans into alternate circles on a sheet of paper and then flip them back to their initial starting point with only one hand. From all the 3 tests, an average score from five trials was recorded. So the same three tests had to be done after video game training in order to compare the average results and see if there was an improvement. Subjects were retested after they were asked to play 'Medal of Honor' or 'Call of Duty' or something similar for one week. The findings of this study demonstrated an insignificant improvement in reaction time and hand-eye coordination with increased video game playing (Klicka et al., 2006). This questions the ability of video gaming for enhancing the fine motor skills of young adults.

As the results were very insignificant, it would be advisable to further test this theory. One of the limitations of the study was that the status of the participants' training were self-reported, hence a concern of inaccuracy. It might have been better if participants were kept in a controlled environment and were measured with their playing time. The accuracy of the tests and methods of data collection are also questionable. Another limitation could be the allocation of football players irrespective of the position they play. For example, a striker might possess better perceptual motor skills as they have to dribble and take the ball forward, compared to defenders who have more emphasis on clearing. Necessities of a sport might also play a role in the development of perceptual motor skills.

## Discussion and conclusion

The studies used various tests and tasks such as MOT to grasp an understanding of one's perceptual skill. Based on this, researchers were further able to come to a conclusion whether video games are advantageous for tasks that require perceptual motor skills. Hence, from the results of the studies that were investigated above (Klicka et al., 2006; Li Li et al., 2016; Sanchez, 2012; Green et al., 2003; Kim et al., 2022), it is very evident that video games accelerate the enhancement of perceptual motor skills in young adults. In addition to these studies, the ANT model suggested that the brain consists of three attentional networks - Alerting, orienting and executive control. The model successfully demonstrates a relationship between these three networks and video games and provides logical explanations for why perceptual motor skills are superior in VGPs compared to people who don't often practice video game playing. However, the model is not supported by enough evidence. No studies have been conducted with regards to video games that try to add evidence for the ANT model.

The studies discussed above are also limited because all of them use the same research method, experimentations. This means that all the studies lack ecological validity because they have been conducted in an artificial environment, and hence makes it harder to come to the conclusion that participants will reflect the same performance in their natural environment as well. Although, it might be difficult to incorporate other methods such as observations or interviews, because they present insight on one's behavior and not cognitive skills. All the researchers used appropriate tests that helped them get a measure of perceptual motor skills. So from this perspective, experiments prove to be useful and the best option. Other than the research method, one major limitation of the sample is that all the data is reliant on self- reported data. For example, many

experiments involved answering questions about their video game playing history, based on which they were categorized into VGPs and NVGPs. There is a chance for bias. Unlike behaviors, cognitive skills cannot be replicated and hence the researchers will be able to spot the outlier in the results. Furthermore, all the studies have demonstrated short-term effects. It can be questioned whether the perceptual benefits from video games can be long-lasting or permanent.

The association between the two variables discussed in this essay cannot always be identified as a causal relationship, as it is not objectively predictable that every young adult that plays video games will have exceptional perceptual motor skills. However, in conclusion, it can be stated to a large extent that video game practice paves the path for enhanced perceptual motor skills when not affected by confounding variables. The researchers that investigate the same relationship in the future should attempt to find the real life applicability of perceptual motor skills that are developed from constant video game practice. This can guide parents and institutions in instilling video games as a form of educational training.

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