THE EFFECTS OF VIDEO GAMING ON VISUAL SELECTIVE ATTENTION IN EARLY ADULTHOOD

by

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To my father,

whom I will never forget.

“Unable are the loved to die

For love is immortality.”

– Emily Dickinson

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DECLARATION

I, **Michael Frank Matern**, hereby declare that this dissertation is my own work and that, where applicable, every effort has been made to correctly reference the work of other authors. Furthermore, I declare that this dissertation is to be submitted to the University of Pretoria and has not previously been submitted to this university or any other tertiary institution.

Signed this ___________ day of ____________ 2017

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Signature

Abstract

A growing body of research shows that video games may be used to enhance cognitive skills, with particular reference to attentional abilities. This research study explored the effects of video game playing on visual selective attention (VSA) on a sample of participants in early adulthood. A secondary research objective explored the possibility that participants' gender acted as a moderating variable with regard to their VSA. This was achieved by means of a quantitative research design, which consisted of a survey research design to recruit participants and a quasi-experimental research design to test a participant's VSA. Participants were sampled using quota sampling, which resulted in a final sample size of 80 participants. To test the effects of video game playing and gender on VSA, participants were exposed to a computerised version of the Stroop task. Data was analysed using a two-way between-group ANOVA. Results indicated that the difference in VSA abilities between the participants who played video games and the non-players was statistically significant. Video game players exhibited more advanced attentional skills than non-players. There were no interaction effects between video game playing and gender. Furthermore, the variable of gender did not have a statistically significant main effect on a participant's VSA.

Keywords:

Early adulthood, gender, Stroop task, theory of visual attention, video games, visual selective attention.

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Chapter 1

Introduction

This chapter serves as an introduction to the current study conducted on the relationship between video game playing and visual selective attention (VSA). The research problem is discussed, followed by a description of the research questions that guided this study. The aims and the objectives of the study are elaborated, followed by a justification section. The research methodology and the primary theory are then elaborated upon, followed by a structural outline of the study and a glossary of terms.

1.1 Research Problem

A number of different terms are often used in the literature to describe electronic forms of entertainment, including "video games", "computer games", "electronic games" or "digital entertainment" (Tavinor, 2008). For the purposes of this study, the act of playing visual electronic games for entertainment, either on computers, console devices, or handheld console devices will be referred to as "video game playing". Video game playing is defined as a visual form of electronic entertainment that is highly engaging (Tavinor, 2008). Video game playing is an extremely popular recreational activity in the developed world (Prot, Anderson, Gentile, Brown, & Swing, 2014). Research on video game playing—and the effects that it has on the player—should be taken seriously due to its implications on the player's health, both positive and negative (Griffiths, 2005). The effects of video game playing on the player's cognition has particularly garnered a significant amount of attention in recent years, partly because of the increased focus on video game playing and its relation to violence and aggression (Pohl et al., 2014). As increasingly more individuals engage in video game playing for recreation (Prot et al., 2014), researchers such as Dye, Green, and Bavelier (2009), and Pawlikowski and Brand (2011) have increasingly been devoting time and resources to investigating the effects that video game playing has on the player. These studies often have a pessimistic outlook, focusing on the negative effects of video game playing such as heightened aggression (Ferguson & Olson, 2014), the development of obsessive gaming behaviours that interfere with other life responsibilities (Ferguson & Ceranoglu, 2014; Keser & Esgi, 2012), the inability to pay attention (Swing, Gentile, Anderson, & Walsh, 2010), and reduced decision-making abilities (Pawlikowski & Brand, 2011).

An examination of the literature on video game playing reveals that video gaming also has beneficial effects on the player. This includes faster and more accurate decision making (Dye et al., 2009), improved reading abilities (Franceschini et al., 2013), enhanced learning through creativity and visualisation (Amory, Naicker, Vincent, & Adams, 1999), and improved attentional abilities, with particular reference to VSA (Bavelier, Achtman, Mani, & Föcker, 2012). While studies have shown that individuals who play video games have exhibited superior VSA compared to individuals who do not play video games (Granic, Lobel & Engels, 2014), other research (Murphy & Spencer, 2009) has been unable to replicate these findings. Considering how widespread video game use has become (Prot et al., 2014), and that VSA represents an integral part of an individual's perception (Chelazzi, Perlato, Santandrea, & Libera, 2013), understanding the link between VSA and video game playing has received increasingly more research focus.

There have also been debates about the influence of gender and age with regard to video game playing. Research by Mezzacappa (2004) revealed that male and female video game players exhibit notable differences in their attentional abilities. In contract, Dye et al., (2009) found no meaningful associations between video game playing and gender. With regard to the variable of age, many research studies investigating the effects of video game playing tend to employ only an adolescent sample (such as Brawer & Buckwalter, 2015; Desai, Krishnan-Sarin, Cavallo, & Potenza, 2010; Franceschini et al., 2013). According to

Pawlikowski and Brand (2011), the focus on adolescents is because the majority of video game players tend to fall within this age group. Problematic gaming behaviours and attentional problems have been identified in both an adolescent and an early adult sample, with both age groups showing similar symptoms with regard to the severity and prominence of negative behaviours (King, Delfabbro, & Griffiths, 2013). Considering that adults have been largely neglected in studies investigating the effects of video game playing, this study utilised a sample of individuals in early adulthood, as discussed in section 4.3.1.

1.2 Research Questions

The purpose of this study was to determine if video game playing has an impact on the VSA of individuals in early adulthood. Furthermore, the variable of gender was incorporated in the study to test for possible interaction effects. These aspects have given rise to the following research questions that guided this study:

- **Primary research question**

  Do video game players and non-players differ in their ability to engage in VSA during early adulthood?

- **Secondary research question**

  If there are differences in VSA between video game players and non-players, does gender constitute an interaction effect?

1.3 Aims and Objectives of the Study

The primary aim of this study was to investigate the effects of video game playing on an individual's VSA. The two objectives of the study were as follows:

1. To measure the difference in VSA between video game players and non-players using the Stroop task.
2. To explore the relationship between VSA, video game playing, and gender.

1.4 Justification for the Study

Video game playing is a growing phenomenon, especially among adolescents and individuals in early adulthood (Pawlikowski & Brand, 2011). However, according to King, Delfabbro, and Griffiths (2013), there exists a notable gap in the research literature on how video game use affects the player. King et al. (2013) also highlighted that studies investigating this issue tended to vary significantly with regard to the type of methodology employed and the sample size. An overview of the literature on video game playing reveals that there is a lack of agreement among researchers on how exactly the player's cognition is affected by video game playing. Some authors (Ferguson & Ceranoglu, 2014; Keser & Esgi, 2012; Swing et al., 2010) have argued that continuous play could have deleterious effects on the player, especially in terms of developing addictive behaviours and attention problems. On the contrary, other researchers (Amory et al., 1999; Dye et al., 2009; Franceschini et al., 2013) have argued that video game playing is associated with more positive outcomes, such as heightened learning ability, increased reading capabilities, and improved attentional skills. Furthermore, considering that some researchers (Irons, Remington, & McLean, 2011; Murphy & Spencer, 2009) have been unable to replicate previous studies (Green & Bavelier, 2003) that investigated the effects of video game playing on VSA, further research is needed to understand how the attentional process is affected by video game playing (Ferguson & Olson, 2013; Murphy & Spencer, 2009). The results of this research may help researchers gain a deeper understanding of how video game playing affects the player. Although it is beyond the scope of this study, the results of the current investigation may also be useful in understanding the growing problem of attention deficit disorders that some players may experience (Mazurek & Engelhardt, 2013).

As discussed in chapter two, males and females tend to differ in their responses to video game playing (Desai et al., 2010; Olson et al., 2007). However, research that investigates these differences tends to result in conflicting evidence (Dye et al., 2009; Mezzacappa, 2004). Considering that previous research findings have been inconsistent, Ferguson and Olson (2013) argued that the variable of gender should always be included in video game research. The inclusion of gender is because a participant's gender may act as a moderating variable (Ferguson & Olson, 2013). While there is evidence to show that selective attention differs between males and females, Merritt et al. (2007) argued that limited research has been conducted on gender differences in selective attention, and as a result, definitive conclusions cannot yet be reached. In an attempt to clarify these inconsistencies, the variable of gender was investigated in this study to ascertain if gender constitutes an interaction effect between video game playing and VSA.

1.5 Research Design and Methodology

The research design of this study was guided by positivism. According to positivism, information and knowledge is derived from the interpretation and the analysis of sensory experiences (Collins, 2010). Positivistic studies focus on empirical data obtained through the observation and measurement of phenomena (Trochim, 2006). Using the positivistic background, a two-phase quantitative design was implemented, including a survey research design and a quasi-experimental research design.

During the first phase of the research, participants completed an online survey. This online survey was used to collect demographic information from participants and determine their video game playing habits. The results of the survey were also used to screen participants and determine if they had met the selection criteria of the current study. Once eligible participants had been identified, they were contacted via email and invited to participate in the second phase of the research. During the second research phase, participants completed a computerised version of the Stroop task. While completing the Stroop task, the response time of participants was recorded by the computer. This gave the researcher an indication of each participant's VSA. Data analysis involved descriptive as well as inferential statistics, with a two-way between-groups analysis of variance testing for significance and interaction effects. A total of 124 participants completed the online survey, however only 80 of these participants qualified to participate in the second phase of research.

1.6 Paradigmatic Approach and Theoretical Point of Departure

To situate and contextualise the study, a brief explanation of the paradigmatic approach and theoretical point of departure is provided. This study operated primarily from the cognitive paradigm, meaning that the following assumptions were made: That the effects of video game playing can be understood using cognitive theories, that certain cognitive processes are, or are not, triggered when an individual plays video games, and that the functioning of these cognitive processes is directly related to the presence, or lack of, video game playing. The theoretical point of departure of this research was the theory of visual attention (TVA), first proposed by Bundesen (1990). In this study, TVA was applied to conceptualise the attentional process and explain why some sensory information fails to reach conscious awareness, particularly when one's attentional process is under strain (Galotti, 2008; Goldstein, 2011). TVA provides a comprehensive framework from which to understand the capacity model of attention and is also a useful tool for explaining the findings of selective attention measures such as the Stroop task (Bundesen, Vangkilde, & Petersen, 2015).

1.7 Structure of the Study

Chapter two provides a review of the literature on attention, specifically on selective attention. Furthermore, the effects of video game playing are discussed. Research concerning the association between VSA and video gaming is also elaborated on. Chapter three explores the paradigmatic and theoretical point of departure used in this study. This includes a discussion on the cognitive paradigm, positivism, and a discussion of the theory of visual attention. Chapter four outlines the study's research methodology and design, including sampling, data collection and analysis, and ethical considerations. The results of the study are presented in chapter five. Chapter six concludes the study with a discussion of the results, limitations, and recommendations for further research.

1.8 Glossary of Terms

Action video games: Video games that are fast-paced, require high levels of attention, and often require the player to track numerous visual targets (Green & Bavelier, 2006a).

Adolescence: The period between 13 and 18 years of age (Louw & Louw, 2007).

Attention: The cognitive process of perceiving the world by mentally analysing sensory information held within a person's memory (Goldstein, 2011).

Console video games: Video games played on an electronic device that projects a video signal onto a television screen. Popular examples include the *Playstation* and *Xbox* (Demaria & Wilson, 2003).

Early adulthood: The period between 18 to 25 years of age (Arnett, 2000; Padilla-Walker, Nelson, Carroll, & Jensen, 2010).

FPS: First-person shooters are video games that consist of projectile-based combat viewed from a first-person perspective (Claypool, Claypool, & Damaa, 2006).

MMORPG: Massively multiplayer online role-playing games are a genre of video games where the player assumes the role of an in-game character while interacting with other human players in the virtual world (Hsu, Wen, & Wu, 2009).

MOBA: In a multiplayer online battle arena video game, the player controls a single in-game character. The player joins one of two teams with the objective of destroying the enemy team's headquarters (Yang, Harrison, & Roberts, 2014).

Non-violent video games: Video games, such as puzzle or trivia games, that do not involve aggressive or harmful actions or events (Bushman & Anderson, 2002).

Simulation video games: Video games that attempt to recreate real-world activities and simulate real life. Examples include airplane flight simulators or vehicle racing simulators (Jones, 2013).

Strategy video games: Video games where the player needs to employ skilful thinking and careful planning in order to achieve victory (Rollings & Adams, 2003).

Video game playing: The act of playing visual electronic games for entertainment, either on computers, console devices, or handheld console devices. Video game playing is defined as a visual form of electronic entertainment that is highly engaging (Tavinor, 2008).

Violent video games: Video games that depict or that have the player enact intentional attempts to inflict harm on others (Anderson & Bushman, 2001).

Chapter 2

Literature Review

This chapter provides an overview of the literature on attention and video game playing. The concept of attention is explained, specifically with regard to the differences between divided attention and selective attention. Visual selective attention (VSA) and the way in which individuals use VSA in their everyday lives will also be discussed. A summary of the literature on video game playing and the positive and negative consequences associated with video game playing are also discussed. Currently, researchers are unable to definitively claim if video game play is overall either beneficial or detrimental to the player's attentional capabilities (Dewar, 2013). This uncertainty exists because video game playing has been found to both improve and negatively impact attentional skills, as will be shown in section 2.2.3 of this chapter. A comprehensive overview of the literature will be presented. Considering that the outcomes associated with video games have been shown to differ with regard to gender and age (Griffiths, Davies, & Chappell, 2004; Olson et al., 2007), these two variables will be discussed in the context of video game playing. Finally, video game playing in the South African context will be examined.

2.1 Defining Attention

Attention has been studied in psychology from as early as 1890, when William James first pondered the question of what constitutes attention (Nketsai, 2013). James (1890) remarked that attention is a process whereby individuals makes sense of their surroundings. According to James, this process involves the forming of a "clear" and "vivid" (p. 381) mental picture that is created from the vast amount of sensory stimuli with which the individual is confronted. James also highlighted that in order to effectively pay attention to something, it is necessary for the individual to "withdraw" (p. 381) their attentive capabilities from other aspects of the environment and focus on the task at hand. This implies that other stimuli should be neglected, if the individual is to effectively focus on one stimulus. As will be shown later in this section, this idea of sacrificing some stimuli to selectively focus on another stimulus would eventually play an integral role in research on the attentional process (Kahneman, 2011).

James' (1890) initial definition of attention has since been refined by various authors (Anderson, 2005; Bernstein, Penner, Clarke-Stewart, & Roy, 2006; Goldstein, 2011; Passer et al., 2009) and as a result, a number of theories and definitions for the concept of attention have been presented. Bernstein et al. (2006) defined attention as the process of directing and focusing one's mental abilities for the purposes of enhancing perception, performance, and mental experiences. What this definition means is that individuals' attentional abilities directly influence their awareness of their surroundings and determine the richness of an individual's sensory experience (Goldstein, 2011). For example, when a person plays a video game, they are confronted with various sights, sounds, and sometimes even tactile responses from the game controller used to play the game. If an individual's attentional system becomes overloaded, they will likely fail to perceive certain sensory input, such as visual cues in the game or the music playing in the background (Wells & Matthews, 2014). However, an individual with a greater attentional capacity would likely notice these stimuli and experience more aspects of the game, resulting in a more complete sensory experience (Galotti, 2008).

While the definition for attention proposed by Bernstein et al. (2006) succinctly highlights the role that attention plays in an individual's perception of the world around them, it fails to incorporate the crucial role of a person's memory. According to Goldstein (2011), memory is intricately linked to attention, because an individual's sensory and working memory form part of the greater attentional process (Anderson, 2005). Sensory memory briefly holds incoming sensory stimuli before it is processed, while working memory is a temporary memory store for recently processed stimuli (Passer et al., 2009). Without these memory processes, individuals would not be able to perceive the world around them (Passer et al., 2009). Therefore, attention may be described as the interplay between sensory stimuli and a person's cognitive manipulation of these various stimuli using memory (Goldstein, 2011).

Bearing the aforementioned conceptualisations of attention in mind, Goldstein (2011) defined attention as the cognitive process of perceiving the world by mentally analysing sensory information held within a person's memory. Attention involves selectively concentrating on one or a few pieces of information while ignoring other stimuli in the environment (Anderson, 2005; Bernstein et al., 2006; James, 1890; Passer et al., 2009). Attention is thus a process that is directly linked to perception, forms part of individuals' interpretation and experience of the world around them, and is regarded as a key component of an individual's sense of consciousness (Bench et al., 1993).

While these definitions are valuable in that they provide a framework to understand the nature of the attentional process, they fail to clarify how and why individuals use the attentional process in everyday life. Wickens and Carswell (1997) theorised that individuals use the attentional process for five primary reasons, namely:

- To direct perceptual and sensory structures towards certain stimuli.
- To select environmental stimuli for further processing at a later stage.
- To ignore or filter out unimportant stimuli.
- To allocate the necessary mental effort required to process the selected stimuli.
- To regulate the stream of resources necessary for performing one or many tasks at the same time.

More recently, Pilli, Naidu, Pingali, Shobha, and Reddy (2013) identified four major components that constitute the process of attention, namely:

- Initiation or focusing.
- Sustaining attention or vigilance.
- Inhibiting responses to irrelevant stimuli.
- Shifting attention from one stimulus to another.

The research by Wickens and Carswell (1997) and Pilli et al. (2013) both contain a common thread, namely the use of mental resources in an efficient manner. Wickens and Carswell highlighted the importance of directing mental resources towards certain stimuli in such a way that irrelevant stimuli are neglected. Pilli et al. discussed sustained focus on stimuli and inhibiting responses towards unrequired stimuli. These examples describe attention as an economical process that efficiently makes use of a person's mental resources, because individuals are believed to only have a limited amount of cognitive resources available (Kahneman, 1973, 2011). The implications are that a person can only pay attention to a limited amount of stimuli before they begin to neglect sensory input from their environment (Kahneman, 1973, 2011).

As researchers such as Broadbent (1958), Deutsch and Deutsch (1963), James (1890), Kahneman (1973), and Treisman (1964) investigated attention, they realised that the amount of stimuli with which participants were confronted, impacted their attentional performance (Matlin, 2005). Furthermore, studies by Broadbent, Gray and Weddeburn (1960), and Schneider and Shiffrin (1977) show that when engaging in attention, individuals may approach an attentional task in one of two ways. Firstly, individuals may intensely concentrate on one stimulus at the cost of neglecting other stimuli, or secondly, they may attempt to concentrate on a number of different stimuli in exchange for poorer task performance (Goldstein, 2011). According to Goldstein (2011), individuals choose either the first or the second approach depending on the nature of the task. Trivial tasks, such as tying shoelaces, generally do not require much focus (Galotti, 2008). However, a difficult, more complicated task, such as playing a video game, tends to require a high degree of concentration (Galotti, 2008). When a person is faced with a trivial task, they usually engage in automatic processing (Goldstein, 2011). When a person is faced with a complicated task, they tend to rely on controlled processing (Goldstein, 2011). These two types of processing are described below.

2.1.1 Automatic processing. This refers to behaviours that occur without conscious intention and at little cost to the individual's cognitive resources (Bargh, Schwader, Hailey, Dyer, & Boothby, 2012). Automatic processing is usually associated with tasks that the individual often repeats, such as shifting gears in a car or the tying of shoelaces (Goldstein, 2011). However, when individuals are confronted with a complicated or novel task, they are unable to rely on previous experiences or prior knowledge. Consequently, this forces them to make use of controlled processing (Galotti, 2008).

2.1.2 Controlled processing. This refers to when an individual must pay close attention at all times and intensely focus on the task at hand (Scheider & Chein, 2003). For example, when a novice driver requires intense concentration to drive a vehicle. When a person is confronted with a novel situation, the amount of focus and concentration that they dedicate to a single task would most likely cause them to fail to perceive some stimuli in their environment (Goldstein, 2011).

Considering that individuals use different types of processing depending on the task at hand, the same approach was applied to the attentional process (Galotti, 2008). Different types of attention that people use at different times and in different ways were identified

(Galotti, 2008). While a number of different types of attention have been identified, two main types are commonly described in the literature, namely divided attention and selective attention (Goldstein 2011). Although the focus of this study was specifically on selective attention, a discussion of divided attention as well as selective attention will now follow to clarify the variables examined in this study.

2.1.3 Divided attention. Divided attention refers to an individual distributing their attentional abilities between two or more separate tasks (Goldstein, 2011). For example, a student who attends a lecture while simultaneously writing a message on a mobile phone. This type of behaviour is commonly referred to as "multitasking" and usually relies on automatic processing (Sana, Weston, & Cepeda, 2013). For most mobile phone owners, the task of typing on one's mobile phone has become highly practised and requires little attention. With regard to the example above, the student would not need to utilise a large number of mental resources to easily complete the task on the mobile phone. Although the student manages the task with ease, they may fail to perceive sensory input from the classroom setting, such as the lecturer's spoken words or the information written on the blackboard. A greater deal of mental resources would likely be required to perceive and understand the complicated study material presented by the lecturer, implying that the individual would need to engage in controlled processing (Anderson, 2005).

Research by Matlin (2005) showed that when individuals engaged in divided attention, they tended to make more mistakes and perform tasks more slowly than when they focused on a single undertaking. This is because mental resources are being distributed simultaneously across the various tasks, rather than each specific task individually receiving the necessary degree of focus (Anderson, 2005). Goldstein (2011) added that an individual’s ability to divide their attention across different activities depends on a number of factors such as expertise and the complexity of the task. For example, expert drivers find it relatively easy to listen to music or have conversations while managing to safely steer their vehicle. Novice drivers, however, or those learning to drive, tend to be easily distracted and require intense concentration to remember the correct procedures required to effectively navigate the road. When a task demands intense focus, a person is forced to rely on controlled processing and as a result, they will usually engage in selective attention.

2.1.4 Selective attention. Galotti (2008) defined selective attention as the process of focusing on one or a few tasks or events rather than on many. Furthermore, selective attention involves focusing mental resources in such a way that tasks deemed irrelevant or unnecessary are shut out or only partially processed (Karlsson, Loewenstein, & Seppi, 2009). Individuals engaging in selective attention usually make use of controlled processing (Goldstein, 2011). For example, a student taking a test would likely ignore ambient noises in the test venue to enable them to focus their attention on answering the required questions.

The following quote by Pashler (1998) succinctly summarises the concept of selective attention: "At any given moment, [a person's] awareness encompasses only a tiny proportion of the stimuli impinging on their sensory systems" (p. 2). Throughout the day, a person encounters a substantial amount of sensory stimuli, much of which is irrelevant to the task at hand (Pashler, 1998). Consider the example of a call-centre agent who is required to ignore the chatter of their surrounding colleagues to concentrate on the customer's voice. Successfully focusing and sustaining one's attention on relevant stimuli, while also ignoring irrelevant stimuli, are often crucial in order to quickly and effectively complete tasks (Pashler, 1998).

2.1.4.1 Visual selective attention (VSA). As attention is a process that is linked to the individual's senses, Goldstein (2011) and Galotti (2008) highlighted different types of selective attention, one of which is VSA. Chelazzi et al. (2013) defined VSA as “the brain function that modulates ongoing processing of retinal input in order for selected representations to gain privileged access to perceptual awareness and guide behaviour" (p. 1). VSA is, therefore, the process of neglecting certain visual stimuli in such a way that only certain objects in the visual field reach consciousness (Bundesen et al., 2015). There are a number of reasons why individuals use VSA. Firstly, the individual may be faced with a complex visual scene, causing their attentional capacity to become depleted, thus forcing them to engage in VSA (Luck & Ford, 1998). The individual may also actively decide to focus on some stimuli while ignoring others, such as when trying to find a specific person in a crowd of people (Galotti, 2008). Research by Chelazzi et al. (2013) showed that visual stimuli that were considered to be salient or relevant to the task at hand were often prioritised over less salient visual input, the latter of which were often suppressed. This relates to the previously discussed idea of an individual's limited attentional capacity. The prioritisation of certain stimuli referred to by Chelazzi et al. (2013) occurs because difficult, novel tasks require a high degree of focus and concentration to be successfully completed (Goldstein, 2011). The need to engage in controlled processing forces the individual to assign their mental resources to the task at hand, and as a result, insufficient resources remain for other objects in the visual field (Wells & Matthews, 2014). This causes these other objects to be neglected by the individual (Kahneman, 2011). Consider the example of a driver who fails to perceive the colour of an oncoming car: To safely drive the vehicle, the driver focuses their attention on the road ahead, rather than on irrelevant visual stimuli such as the surrounding environment, or the colour of the oncoming car.

An important distinction between divided attention and selective attention refers to the amount of information that is being perceived by the individual (Goldstein, 2011). Divided attention splits cognitive resources in order to engage in and perceive a number of different stimuli, while selective attention prioritises certain stimuli at the cost of neglecting other stimuli (Galotti, 2008). These two types of attention are used at different times, depending on the nature of the task that the individual is attempting to perform (Hahn et al., 2008). When playing a video game for example, the player is faced with a high number of visual distractions from the game's video displays (Achtman, Green, & Bavelier, 2008). Complicated tasks—such as playing a video game—require a high number of attentional resources (Liu & Li, 2012). Consequently, an untrained player would likely be forced to make use of controlled processing and then engage in selective attention. The player may then experience cognitive overload and finally experience diminished attentional performance speeds and reduced accuracy (Moisala et al., 2015). Therefore, considering that the attentional process is intricately linked to the playing of video games, video game playing and its association with attention is discussed in the following section.

2.2 Video Game Playing

The playing of video games is becoming increasingly prevalent throughout the developed world (Prot et al., 2014) and it has attracted increasing research attention in the field of cognitive and behavioural psychology (King, Haagsma, Delfabbro, Gradisar, & Griffiths, 2013; Sim, Gentile, Bricolo, Serpollini, & Gulamoydeen, 2012; Weinstein & Lejoyeux, 2010). A number of studies (Ito et al., 2008; Lenhart et al., 2008; Olson et al., 2007; Roberts, Foehr, & Rideout, 2005) have shown that video game playing is highly prevalent in the lives of children and adolescents in the developed world. Video game playing is not an activity that is limited to the youth however. Research (Griffiths et al., 2004; King et al., 2013; Mentzoni et al., 2011) has shown that video game playing during adulthood is also common in developed countries.

Studies concerning video game playing tend to focus on the negative consequences that it may have on the player, as researchers and clinicians are increasingly being confronted with problematic behaviours linked to video gaming (Bioulac, Arfi, & Bouvard, 2008). Currently, there is little agreement on whether or not video games primarily have a positive or negative effect on an individual's overall functioning, with literature supporting both positions. Both the negative and the positive consequences of video game use are discussed below.

2.2.1 Negative consequences of video game use. The development of video game addiction (VGA) is a concern that has garnered increased research attention in recent years (Pawlikowski & Brand, 2011). VGA refers to the compulsive or excessive use of video games in such a way that the player neglects his/her life responsibilities (Weinstein, 2010). VGA and internet addiction are often interlinked, as a large majority of modern video games require an internet connection to play (Petry & O'Brien, 2013). VGA often leads to significant disruptions of social and work responsibilities (Pawlikowski & Brand, 2011). Furthermore, excessive video game users often use video games as an escape from real-life problems, sometimes causing them to neglect their responsibilities (Kaczmarek & Drążkowski, 2014). Regular video game use has also been associated with heightened aggression and a tendency to perceive everyday occurrences as more violent (Sherry, 2001). Regular video game players have also shown a lower likelihood of engaging in pro-social behaviours, such as helping a peer in an emergency (Bushman & Anderson, 2009). However, the effect that video games have on the individual appears to be moderated by the player's age. For example, regular video game use among adolescents has been shown to result in poor school performance (van Rooij et al., 2014) as well as clinically significant sleep disruptions (King et al., 2013). While regular video game usage has been shown to have some deleterious effects on the player, other researchers have found evidence that video game playing is also associated with a variety of positive outcomes. These outcomes are discussed in the following section.

2.2.2 Positive consequences of video game use. Video games have been found to cultivate an optimistic motivational style (Granic et al., 2014). Optimistic motivational styles are key contributors to success and achievement in life, implying that video games could be used to motivate and encourage the player to reach their life goals (Dweck & Molden, 2005). Furthermore, video games have been shown to improve the player's mood and increase experiences of positive emotions (Russoniello, O'Brien, & Parks, 2009; Ryan, Rigby, & Przybylski, 2006). Video game playing has also been shown to foster cooperative behaviours amongst players (Ewoldsen et al., 2012) and assist the player in developing various social skills through online interaction (Gentile & Gentile, 2008; Gentile et al., 2009). Besides the social benefits of video game play, some researchers (Amory et al, 1999; Franceschini et al., 2013; Watson, Mong, & Harris, 2011) stated that video games could be used as valuable educational tools. According to Amory et al. (1999), video games may be used as tools to enhance and improve an individual's problem-solving skills. Franceschini et al. (2013) argued that video games improved the reading abilities of children. In addition, Watson et al. (2011) have shown that the use of video games in a classroom setting increased student engagement with study material.

Considering that there is evidence to support both the positive and the negative impacts of video game playing, it appears that the outcome of video game playing is dependent on undiscovered moderating variables. One possibility, presented by Ferguson and Olson (2013), refers to the impact of the player's social circle, be it online or in the real world. Research has found that family influences are central to the relationship between the playing of video games, motivation, and behavioural outcomes (Ferguson & Olson, 2013). It has been shown that children who played violent video games—such as *Call of Duty* (Infinity Ward, 2003) or *Unreal Tournament* (Epic Games, 1999)—together with their guardians, showed the most positive outcomes with reference to pro-social and civic behaviours compared to children who played the games by themselves (Ferguson & Garza, 2011). Furthermore, individuals who played game genres that were highly social in nature—such as the highly popular massively multiplayer online role-playing game (MMORPG), *World of Warcraft* (Blizzard Entertainment, 2004)—reported a tendency of wanting to help other players, to make friends, and to socialise in the virtual world (Smyth, 2007). However, the effects of video game playing are not only limited to emotional and social concerns. Murphy and Spencer (2009) highlighted that there is also a clear link between the playing of video games and the attentional process.

2.2.3 Video game playing and attention. When individuals engage in a complicated task such as playing video games, their attentional system is placed under extreme strain (Goldstein, 2011). Figure 1 represents a screen capture from the highly popular game by Blizzard Entertainment entitled *World of Warcraft* (Blizzard Entertainment, 2004).

Figure 1. Screen capture of game play in World of Warcraft (Blizzard Entertainment, 2004).

As shown in the screen capture (Figure 1), playing the game involves focusing on various elements, such as (1) the team's health status, (2) identifying and tracking the position of allies, (3) tracking the amount of damage done, (4) reading the chat box in order to communicate with other players, and (5) selecting an appropriate action from the user interface. Players are therefore required to simultaneously focus on a number of different tasks while playing the video game, which places immense strain on the player’s attentional system (Galotti, 2008). Currently, researchers do not fully understand how video game play such as that shown in Figure 1 affects the player’s attention (Ferguson & Ceranoglu, 2014; Wilms, Petersen, & Vangkilde, 2013). Therefore, both the negative and positive consequences of video game use, specifically regarding attention, are discussed below.

2.2.3.1 Negative consequences of video game use on attention. The playing of video games has, in some instances, been found to be related to attentional difficulties in adolescents (Ferguson & Ceranoglu, 2014) and adults (Swing et al., 2010). Furthermore, Brawer and Buckwalter (2015) asserted that video game playing has been associated with concentration and attention problems. These include difficulties in maintaining focus on less interesting tasks and a shorter attention span in everyday life, compared to individuals who did not engage in video game playing. This assertion is based on the findings from studies (Bailey, West, & Anderson, 2010; Gentile, Swing, Lim, & Khoo, 2012; Swing et al., 2010) which concluded that individuals who played video games were considerably more likely to exhibit attentional problems in everyday life than participants who did not play video games.

Various suggestions have been made to attempt to explain why electronic media—such as television and video games—are associated with attention problems. Gentile et al. (2012) proposed four hypotheses known as (a) the excitement hypothesis, (b) the displacement hypothesis, (c) the attraction hypothesis, and (d) the third variable hypothesis.

Excitement hypothesis. Due to the exciting and stimulating nature of electronic media, other activities such as work or school, seem considerably less interesting by comparison. The reason for this is that video games and TV shows tend to include attention-grabbing cues such as flickering lights, sound effects, and strategic editing (Kubey & Csikszentmihalyi, 2002). On the other hand, less stimulating—yet highly important—tasks such as work obligations or schoolwork, lack this high level of engagement. According to the excitement hypothesis, continued engagement in exciting behaviours may change an individual's expectations with regard to the desired level of stimulation required. As a result, a notable divide begins to form between "exciting" electronic media and "boring" work. The end result is that individuals tend to become distracted and disinterested when confronted with low-engagement activities (Gentile et al., 2012).

Displacement hypothesis. The development of attentional problems due to electronic media use is not necessarily due to the nature of electronic media. Rather, it may be due to the amount of time that individuals devote to electronic media. Thus, time that would normally have been spent on other activities that promote the development of impulse control is instead being spent on engaging with electronic media, which do not exhaust self-control measures. Consequently, the individual fails to learn and develop the adequate self-control measures needed to maintain focus and attention during tasks that are perceived as boring (Baumeister, Vohs, & Tice, 2007).

Attraction hypothesis. The assertion that the use of electronic media is associated with attentional problems may simply be due to the direction of the relationship between video game playing and attention. In other words, electronic media do not necessarily cause attentional problems, rather, individuals with attentional problems tend to be more attracted to electronic media. Such individuals are thus more likely to engage in these behaviours because electronic media activities are highly stimulating (Baumeister et al., 2007).

Third variable hypothesis. It may be possible that the observed association between electronic media and attention problems is simply the by-product of a greater cause-and-effect relationship which is not yet fully understood. For example, a third variable such as gender may explain this relationship more effectively (Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004). The association between video game playing and gender is further discussed in section 2.2.6 of this chapter. According to Gentile et al. (2012), further experimental research is needed to clarify the exact variables involved in the association of attention problems and electronic media more effectively. Furthermore, video game playing has also been associated with a plethora of positive associations, further suggesting that other variables influence the association between video game playing and attention. The positive consequences of video game use on attention are discussed in the following section.

2.2.3.2 Positive consequences of video game use on attention. Wilms et al. (2013) indicated that the playing of video games had been shown to improve an individual's visual attention by heightening their ability to encode information into short-term memory. This improvement appears to depend on the amount of time that is devoted to gaming, with long-term players demonstrating improved performance at selective attention tasks. The improved performance implies that video games train an individual's attentive abilities to some extent (Belchior et al., 2013). Furthermore, video games have been shown to improve basic attentional functioning, not only when individuals are playing the games themselves, but also, in their daily life (Wilms et al., 2013).

Research has revealed that video game players of all ages have enhanced attentional skills which allow them to make faster, more accurate decisions (Boot, Kramer, Simons, Fabiani, & Gratton, 2008; Dye et al., 2009). These decision-making tasks appear to require less cognitive effort for video game players than for non-players (Dye et al., 2009).

Furthermore, regular video game playing has been shown to improve the process of allocating attentional resources (Granic et al., 2014). This is especially relevant to attention, as individuals only have limited cognitive resources at their disposal when they engage in attentional processes (Kahneman, 1973, 2011). Consequently, video game players have a more effective attentional system as they are able to filter out irrelevant information more efficiently than non-players (Granic et al., 2014).

The positive effects of video game use can also apply to a classroom setting. Video games have been shown to hold the attention of students better than traditional teaching methods (Tobias & Fletcher, 2011). Video games have been found to be particularly effective in enhancing engagement and motivation in individuals with learning or attention difficulties (Annetta, Minogue, Holmes, *&* Cheng, 2009). Another benefit of incorporating video games into the classroom environment is that it allows learners to explore otherwise impossible or dangerous situations—such as outer space or the ocean floor—from the safety of the classroom. The incorporation of video games not only increases engagement with learning material and attentiveness, but also, exposes students to concrete examples of abstract concepts (Farrington, 2011; Girard, Ecalle, & Magnan, 2013; Westera, Nadolski, Hummel, & Wopereis, 2008).

The manner in which video games affect the player's cognitive abilities is not fully understood. However, Greenfield (1994) suggested that video games affect the player due to two major reasons: Firstly, most video games are goal-orientated, and therefore, require concentration and focus. Secondly, video games provide instant feedback, allowing the player to instantly change their approach in order to attempt the challenge again. These two factors result in a learning experience that trains the player's cognitive abilities (Green & Bavelier, 2007). For example, in the highly popular multiplayer online battle arena (MOBA) game, *League of Legends* (Riot Games, 2009), players compete in a team of five to defeat an opposing five-player team. The objective of the game is to increase the strength of one’s in-game character by defeating the enemy team, eventually allowing one to destroy one’s opponent's headquarters. For the player's in-game character to survive, the player would have to quickly and correctly identify various threats in the virtual world, such as hostile enemies. Failing to take various stimuli into account—such as a hidden enemy—could result in the player's in-game character becoming incapacitated, which may result in defeat. Although the player would have lost the match, they would be able to play the game again, only this time, they would consider their previous experiences and change the manner in which they approach the task. It is specifically this kind of instant feedback that results in cognitive training, as feedback is immediate and allows the player to promptly learn from previous mistakes and correct them in future attempts (Greenfield, 1994).

2.2.4 Video game playing and selective attention. Bavelier et al. (2012) highlighted that the playing of video games has been shown to improve various dimensions of the player's VSA. Video game players have been shown to exhibit superior spatial selective attention (SSA) in visual search tasks compared to non-players (West, Stevens, Pun, & Pratt, 2008). SSA refers to the ability to select, recognise, and prioritise a specific region within the visual field and this represents an integral part of VSA (Heinze et al., 1994). These improvements in SSA are not simply limited to general spatial recognition however, as research has shown that video game players also exhibit an enhanced ability to track objects within the visual field (Bavelier et al., 2012). For example, during a visual search task, video game players are, generally, able to track a greater number of moving objects than non-players (Dye & Bavelier, 2010). Another aspect of attention that video game players excel at is the ability to correctly identify a visual target from a random sequence of irrelevant stimuli, an ability that Bavelier et al. (2012) referred to as "temporal attention" (p. 133). Temporal attention refers to an individual's ability to quickly and correctly detect the visual features of an object, while also being confronted with a variety of irrelevant objects, such as when the Stroop task is being completed (Bavelier et al., 2012). Research by Bavelier et al. showed that the attentional abilities of video game players were inclined to recover more rapidly compared to non-players. Video game players are thus able to not only shift their attention more quickly, but their attentional capacity also recovers faster compared to non-players (Bavelier et al., 2012). As a result, video game players tend to give faster, more accurate responses to attentional tests (Dye et al., 2009).

As Goldstein (2011) highlighted, the attentional process does not only include the receiving of information, but also the suppression of irrelevant information not needed for the current behaviour. In a study by Mishra, Zinni, Bavelier and Hillyard (2011), it was found that video game players exhibited a greater suppression of distracting, unattended stimuli than non-players. In the experiment, Mishra et al. (2011) presented participants with a high-load visual presentation while recording electrophysiological readings. Results showed that, while both video game players and non-players similarly processed the attended information, video game players suppressed unattended information more efficiently than non-players. According to Mishra et al. (2011), this enhanced ability to supress unattended information results in players exhibiting faster reaction times to visual tasks such as the Stroop task. These findings are significant because research has shown that greater distractor suppression is associated with more efficient attentional control (Clapp, Rubens, Sabharwal, & Gazzaley, 2011; Serences, Yantis, Culberson, & Awh, 2004; Toepper et al., 2010). Considering that video game players are inclined to show enhanced suppression of irrelevant stimuli, these findings suggest that video games train the attentional mechanisms of the player (Bavelier et al., 2012) and show that video game players have a faster, more efficient attentional system compared to non-players (Mishra et al., 2011).

Research by Clark, Fleck, and Mitroff (2011) showed that video game players and non-players used different search patterns when exploring a three-dimensional visual scene. Video game players were more likely to broadly search the visual scene, and thus, perceive more of their surroundings. On the other hand, non-players tend to hone in on a specific region in their visual field, thereby neglecting various perceivable objects in the broader visual scene (Clark et al., 2011). Furthermore, Clark et al. (2011) showed that video game players were significantly more likely to detect small changes in the environment based on visual cues, in comparison to non-players (Clark et al, 2011). This finding also suggests that the attentional capabilities of video game players are more efficient than those of non-players (Clark et al, 2011; Dye et al., 2009). Green and Bavelier (2007) hypothesised that the superior performance exhibited by video game players in VSA tasks is due to changes in the fundamental characteristics of the visual system, with video game players being able to process objects that are present in the visual field more effectively than non-players. These changes are thought to occur due to prolonged video game play. However, the reasons for, and the exact nature of these changes, are not yet fully understood (Green & Bavelier, 2007; Karle, Watter, & Shedden, 2010).

Despite evidence that video game players tend to outperform non-players at VSA tasks (Cohen, Green, & Bavelier, 2007; Feng, Spence, & Pratt, 2007; Green & Bavelier, 2003, 2006a, 2006b; Spence, Yu, & Marshman, 2009), Murphy and Spencer (2009) and Irons et al. (2011) were unable to replicate the findings of earlier studies, such as research conducted by Green & Bavelier (2003). Murphy and Spencer (2009) highlighted that these contradictory findings might be due to the type of games played by participants in their study, a variable that Green and Bavelier (2003) limited to action video games. Another possibility for these contrasting findings is that gender was not included as a variable in Murphy and Spencer's (2009) study. This omission of the gender variable is important because the outcomes of video game play appear to differ between the two genders (Amory & Molomo, 2012), as discussed in section 2.2.6. As a result of this discrepancy, researchers have called for further investigation into the impact of video game playing on VSA (Ferguson & Olson, 2013; Murphy & Spencer, 2009). Furthermore, researchers are currently investigating the possibility that an interaction effect from unknown variables such as age or gender may be the cause of this discrepancy (Christakis et al., 2004; Gentile et al., 2012). Video game playing and its relation to age and gender are discussed in the following sections.

2.2.5 Video game playing and age. The majority of video game players tend to be adolescents and as a result, video game designers often do not consider adults in the design and marketing of video games (Boot et al., 2013). With regard to research studies, focus tends to be placed on children and adolescents, as many studies have failed to include an adult sample in their research (Boot et al., 2013). This is regrettable, considering that video games have been found to have educational benefits for both younger and older players (Farrington, 2011; Green & Bavelier, 2007; Greenfield, 1994; Girard et al., 2013; Westera et al., 2008).

As individuals grow older, their overall cognitive functioning gradually declines (Deary et al., 2009; Salthouse, 2009). Given the right circumstances, however, the brain has been shown to adapt to and even undo damage caused by injury or age (Su, Veeravagu, & Grant, 2016). This phenomenon is referred to as neuroplasticity (Su et al., 2016). Research by Anguera et al. (2013) showed that video game training can stimulate neuroplasticity in older adults. Anguera et al. (2013) showed that a video game intervention can improve the cognitive abilities of older adults— adults between 60 and 85 years of age—to such an extent that the older group demonstrated improved performance at an attentional task after exposure to a video game intervention, compared to a group of untrained 20-year-olds. Furthermore, these improvements were documented to last up to six months after exposure to a video game intervention (Anguera et al., 2013). Research by Basak, Boot, Voss and Kramer (2008) revealed similar findings. They found that video game training improved the memory, executive functioning, and reasoning ability of an adult sample.

Griffiths et al. (2004) conducted research on the difference between adolescent and adult video game players. Their study found that adolescents were significantly less likely to engage in gender swapping—the playing of an in-game character of a different gender—than adults. Adolescents were also much more likely to list violence as their favourite part of the game, while adults tended to list violence as one of their least favourite game aspects. Interestingly, both groups mentioned that the social aspect of the game was very important to them. The manner in which older or younger individuals are affected by the playing of video games is determined by the type of games that these individuals play (Boot et al., 2013). Older adults often report a preference for video games that involve mental stimulation and intellectual challenge, as opposed to the fast-paced action games that younger players generally enjoy playing (Boot et al., 2013). Contrary to popular belief, intellectually stimulating games—such as flight simulators or trivia games—are not the most effective game genre for skills development (Boot et al., 2013). Fast-paced action games—such as *Call of Duty* (Infinity Ward, 2003)—tend to produce the broadest amount of skills transfer with regard to memory, executive functioning, and reasoning ability (McKay & Maki, 2010; Nap, de Kort, & Isselsteijn, 2009; Pearce, 2008).

In light of research that has shown that the variable of age changes the way in which an individual responds to video game use (Boot et al., 2013; Griffiths et al., 2004), Gentile et al. (2012) highlighted the importance of broadening a study's research focus when conducting research on video gaming to account for a number of possibly confounding variables. One of these confounding variables is the gender of the participant (Ferguson & Olson, 2013).

2.2.6 Video game playing and gender. Previous research has found a number of differences related to video game play between the genders, with some studies revealing contradictory findings (Amory & Molomo, 2012). A number of these differences are discussed below.

Research has consistently found that males tend to play more video games than females (Cherney & London, 2006; Ogletree & Drake, 2007; Olson et al., 2007). Furthermore, males tend to be more motivated to play video games and their attitude towards gaming tends to be more positive compared to those of females (Bonanno & Kommers, 2008). Males are also more likely than females to report that they have experienced problematic behaviours due to their video game play, a finding which may suggest that males are more at risk than females of eventually developing problematic consequences as a result of video game play (Desai et al., 2010). Research by Desai et al. (2010) found that although males were more likely to develop problematic video gaming tendencies, there were no significant health repercussions for male players. Female players, however, often displayed higher levels of externalising behaviours, such as becoming involved in serious fights or carrying a weapon.

Male and female video gamers do not only differ with regard to their responses to gaming, but also with regard to their gaming preferences and gaming choices (Bonanno & Kommers, 2005). Males and females often have different game preferences and differ in their play styles, with females preferring games that have clear rules or instructions and males preferring games that are competitive (Karakus, Inal, & Cagiltay, 2008). Females also tend to shy away from violent video games, a genre that males often enjoy playing (Olson et al., 2007). These gender differences may be due to biological or evolutionary differences between the two genders, in which males are more inclined to behaviours that are action-orientated (Olson et al., 2007). Furthermore, females are significantly less likely than males to play in-game characters of a different gender (Griffiths et al. (2004). Griffiths et al. (2004) hypothesised that this might be because females tended to be hesitant to break gender stereotypes.

When specifically focusing on cognitive abilities, there are discrepancies in the literature, as research findings on the topic have been mostly inconsistent. For example, Mezzacappa (2004) found that male video game players were inclined to have more advanced attentional abilities than female players, while Dye et al. (2009) found no meaningful associations between video game use and gender. Research by Feng et al. (2007) found that playing video games differentially enhanced the performance of males and females on spatial tasks, with females showing larger improvements than males. Furthermore, exposure to video games has been shown to improve mental rotation skills in both males and females (Cherney, 2008). This contradicts earlier findings by Quaiser-Pohl, Geiser, Christian and Lehmann (2006) who found that male video game players outperformed female players at a mental rotation test. In light of the fact that researchers do not fully understand how video game players' gender affects their response to gaming, Ferguson and Olson (2013) argued that the variable of gender should always be included in video game research.

As video game playing is so highly dependent on technology and socio-economic status, it is a phenomenon that is primarily observed in the developed world (Prot et al., 2014). Therefore, researchers tend to focus on countries in North America, Europe, and Asia when conducting research on video gaming (Vorderer, Hartmann, & Klimmt, 2003). The current study researched video gaming within the South African context. Considering the multicultural nature of the South African population, it would be unwise to assume that international research can fully explain a phenomenon within the South African context (Hook, 2012). Therefore, in order to contextualise the current study, the following section will discuss the current state of video game playing within the South African context.

2.2.7 Video game playing in the South African context. Although a large number of South Africans are still without the necessary technology needed for video gaming—such as desktop computers and access to the internet—this number is experiencing notable growth (Statistics South Africa, 2012). In 2011, 21.4% of South African households had access to a computer and 74.5% had access to a television set. These values rose dramatically from 8.5% and 52.6%, respectively, in the year 2001 (Statistics South Africa, 2012). Furthermore, 88.9% of the population had access to a cellular device and 35.2% had access to the internet in 2011 (Statistics South Africa, 2012). This value rose significantly, considering that in 2000, only 5.5% of South Africans had access to the internet (World Wide Stats, 2012). More recent statistics on internet access in the country predict that there will be 27 million internet users in South Africa by 2019, compared to 15 million internet users in 2014 (Cisco, 2015). The average speed of broadband in the country will grow to ten megabits per second (mbps) by 2019, an increase from 3.5 mbps in 2014 (Cisco, 2015).

Increasingly, more South Africans are engaging in video gaming (PwC Southern Africa, 2014). This is evident from the significant growth of the country's video game market (PwC Southern Africa, 2014). The South African video game market grew by 47% between the years 2009 and 2013, where their collective net worth was R1.6bn and R2.4bn respectively (PwC Southern Africa, 2014). Subsequent research by PwC Southern Africa (2014) forecasts that this market is expected to rise to R3.7bn by the year 2018.

The implication of the aforementioned statistics is that increasingly more South Africans are being exposed to technological equipment and infrastructure—such as desktop computers, game consoles, cellular devices, and high-speed internet access—needed to engage in video gaming. As a result, it is likely that the number of video game users in South Africa will increase in the future (PwC Southern Africa, 2014). It is therefore pertinent that more research on video game playing is conducted within the South African context, to not only expand the local body of knowledge, but to also investigate how South Africans respond to the effects of video game playing.

2.3 Chapter Summary

This chapter introduced the concept of attention, particularly in what manner and for what reason individuals make use of the attentional process in their daily life. The function of the attentional process is to initiate, sustain, and shift awareness onto relevant stimuli while inhibiting responses to irrelevant stimuli (Pilli et al., 2013). While a number of different types of attention exist, this study focused on VSA. VSA refers to the processing of visual stimuli in such a way that certain task-irrelevant stimuli are ignored (Bundesen et al., 2015).

The phenomenon of video gaming was also discussed. Video game playing is becoming increasingly prevalent throughout the developed world (Prot et al., 2014). Furthermore, the playing of video games is becoming increasingly prominent in the lives of South Africans (PwC Southern Africa, 2014). The playing of video games has been shown to have both positive and negative effects on the player, both in terms of psychosocial functioning and the player's attentive abilities (Ferguson & Ceranoglu, 2014; Granic et al., 2014; Pawlikowski & Brand, 2011; Wilms et al., 2013). It has been argued that, because there is such widespread disagreement between researchers on how video games affect the player, other variables such as the player's gender and age should be accounted for when conducting research on the topic (Christakis et al., 2004; Gentile et al., 2012). This is necessary because a player's age and gender have been shown to affect the manner in which they use video games and how they respond to them (Bonanno & Kommers, 2008; Griffiths et al., 2004).

Considering that one's paradigmatic approach directly influences the way in which research is conducted, it is crucial that a researcher is aware of his/her own paradigmatic approach and the effect that it has on the research study (Willig, 2009). A researcher's paradigmatic approach represents only one of many means of viewing reality (Jordaan, 2013). The following section will provide an overview of the paradigms and theories that guided this research project.

Chapter 3

Paradigmatic Approach and Theoretical Framework

The current study was guided by the cognitive paradigm. Furthermore, a capacity model of attention called the theory of visual attention (TVA) was used to conceptualise the attentional process. The cognitive paradigm, capacity models of attention, and TVA are discussed below.

3.1 Cognitive Paradigm

Jordaan (2013) defined a paradigm as a specific representation of reality that guides perception and behaviour. A paradigmatic viewpoint influences the manner in which the researcher views the world, meaning that certain systems of meaning and ways of interpreting the world are prioritised (Maree & Van der Westhuizen, 2009).

The overarching paradigmatic approach in this study was the cognitive perspective. According to Jordaan (2013), the cognitive perspective assumes that the human brain acts as an information-processing unit which governs and influences behaviour through cognition. Thus, the cognitive paradigm examines the nature of the mind and attempts to study the mental processes—attention, consciousness, and perception—that guide behaviour. Furthermore, according to the cognitive approach, individuals are viewed in terms of which mental processes are at work, how the thinking individual makes sense of themselves and their surroundings, and how the mind processes, analyses, and stores information (Passer et al., 2009). A fundamental assertion made by the cognitive paradigm is that individuals are not simply passive observers of stimuli from the external environment. Rather, incoming information is mentally manipulated and actively processed by the individual as they attempt to make sense of the world around them (Bernstein et al., 2006).

Considering the fact that a researcher's paradigmatic approach has a direct effect on the way in which research is conducted, it is important to note two assumptions that were made in this study. Firstly, that the effects of video game playing on visual selective attention (VSA) may be measured and conceptualised using cognitive theories and measures. Secondly, that cognitive processes, such as VSA, are directly impacted on by the existence, or the lack, of video game playing. Considering that video game playing is an activity that is highly demanding on a person’s cognition (Spence & Feng, 2010), the cognitive paradigm was chosen to most effectively conceptualise the cognitive processes, such as VSA, that are at work when an individual plays video games. This approach coincides with previous research, as a wide range of authors have relied on the cognitive paradigm to investigate the diverse effects of video game playing on cognition (Bavelier et al., 2012; Cohen et al., 2007; Dye et al., 2009; Feng et al., 2007; Green & Bavelier, 2003, 2006a, 2006b; Mishra et al., 2011; Spence et al., 2009; West et al., 2008).

3.2 Theories of Attention

To understand the complex method by which individuals take note of the world around them, researchers have developed a number of different theories in an attempt to explain the attentional process (Goldstein, 2011). These theories range from the filter theory of attention—which would later be expanded to attenuation theory—to late selection theories (Galotti, 2008). Using this background, a number of attention theories have been developed or modernised (Goldstein, 2011). These theories include capacity models of attention such as the theory of visual attention (TVA). Considering that TVA was utilised in this study, a brief summary of earlier theories is provided below. What follows is a discussion of capacity models, and specifically, of TVA to explain how this theory may be utilised to conceptualise the attentional process.

3.2.1 Earlier theories. One of the first and perhaps the most well-known theories of attention is the filter theory, first proposed by Donald Broadbent (1958). Broadbent (1958) proposed that there were limits to the amount of information that an individual could process at any given time. This means that if a person were to be confronted with too much information at once, they would use an attentional filter to let some stimuli through while ignoring the rest. Broadbent's (1958) theory was later modified by Anne Treisman (1964), who developed the attenuation theory of attention. Treisman (1964) suggested that information was not simply either fully processed or completely blocked, but rather that unattended stimuli were analysed to a lesser degree than the attended stimuli. To explain this, Treisman replaced Broadbent's (1958) notion of a filter with an attenuator. Treisman's idea suggests that some meaningful information of unattended stimuli could be available, since the stimuli were attenuated rather than completely blocked (Galotti, 2008). Deutsch and Deutsch (1963) proposed a different approach in the form of late-selection theories of attention. According to late-selection theories of attention (Deutsch & Deutsch, 1963; Norman, 1968), all messages are routinely processed by an individual for at least some aspects of meaning, however, the selection of which message the individual will respond to occurs later during processing (Galotti, 2008). Pashler (1998) mentioned that individuals did not willingly choose what information they wanted to identify or recognise. Rather, the individuals' sense organs bombarded them with information, all of which was processed.

The aforementioned theories (Broadbent, 1958; Deutsch & Deutsch, 1963; Norman, 1968; Treisman, 1964) have viewed the attentional system as a process revolving around the kind of stimuli that people fail to notice. Researchers have since shifted their approach and have begun to examine the kind of information that people choose to focus on, as opposed to determining whether they can or cannot process the information. Kahneman's (1973) model of attention (Figure 2) is a widely-known example of this way of thinking, commonly referred to as a capacity model (Nketsai, 2013).

3.2.2 Capacity model of attention. According to Kahneman (1973), the attentional process is guided primarily by an individual's attentional capacity and their allocation of cognitive resources (Goldstein, 2011). Much like the models of attention discussed previously, Kahneman (1973) maintained that an individual only has a certain number of cognitive resources available when trying to pay attention to something (Lee & Faber, 2007). When these resources are depleted, the individual fails to take note of other stimuli in their surroundings (Galotti, 2008; Kahneman, 1973). Figure 2 provides a visual breakdown of Kahneman's (1973) model of attention and effort.

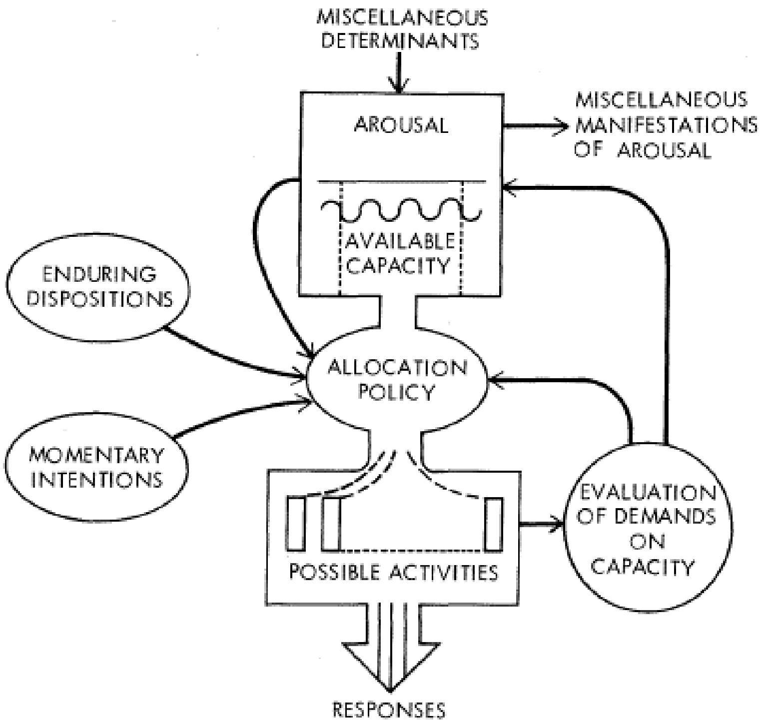

Figure 2. Kahneman's model of attention. From *Attention and Effort* (p. 31), by D. Kahneman, 1973, Englewood Cliffs, NJ: Prentice Hall. Copyright 1973 by Prentice Hall.

A major distinction of Kahneman's model of attention is that individuals can choose what information they want to focus on and they can then actively devote their mental effort to the chosen task (Galotti, 2008). According to Kahneman (1973), the allocation of an individual's mental resources is said to be dependent on the following:

- The availability of mental resources.
- The individual's level of arousal or alertness.
- The difficulty of the task.

The other major component of Kahneman's (1973) theory was explaining what kind of information people choose to focus on. According to Kahneman (1973), an individual focuses on certain stimuli in preference over other stimuli. This process is called the allocation policy, and occurs due to three factors. The first factor is an individual's enduring dispositions. This refers to individual preferences or inclinations toward certain tasks (Galotti, 2008). Secondly, the factor of momentary intentions, which refer to the person's current state of mind and what they consider important at that particular moment (Goldstein, 2011). And finally, the last factor is the individual's evaluation of how demanding the task will be on their capacity (Lee & Faber, 2007). Therefore, according to Kahneman's (1973) theory, people are more likely to pay attention to things that interest them, or that they have judged as being important (Galotti, 2008).

While capacity models of attention are widely used in cognitive research (Goldstein, 2011), it is difficult to pinpoint a specific theory and claim that it sufficiently explains the attentional process more successfully than any of the other theories mentioned previously. In light of this, researchers have suggested that one should not view the different approaches as polar opposites. Rather, modern theories such as capacity models, should supplement earlier theories instead of representing a complete replacement (Friedenberg & Silverman, 2012).

One such theory is the theory of visual attention, as it integrates elements of various other theories in an attempt to form a comprehensive understanding of attention (Bundesen, 1990; Bundesen et al., 2015).

3.2.3 Theory of visual attention. TVA was the primary theory that guided the current study. TVA was first proposed by Bundesen (1990) and its claims are primarily grounded in literature surrounding capacity models of attention. Figure 3 illustrates the various steps of attention proposed by TVA.

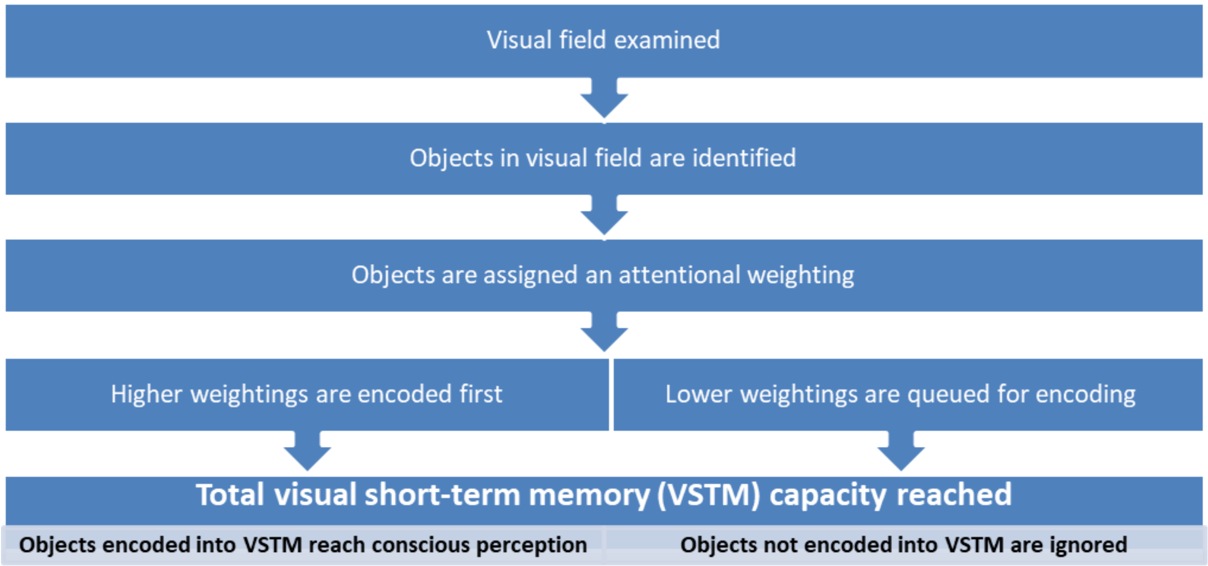

Figure 3. Steps in the theory of visual attention (Bundesen, 1990).

According to TVA, the attentional process consists of a cognitive selection process where the stimuli that are most useful and salient to the current behaviour are the first to be encoded into visual short-term memory (VSTM) (Bundesen, 1990). VSTM is a temporary holding space for visual stimuli before they are utilised or encoded into long-term memory (Goldstein, 2011). Therefore, an object will only be perceived by the individual if it enters into VSTM (Bundesen, 1990). In turn, objects that fail to reach VSTM cannot be perceived or encoded into long-term memory (Goldstein, 2011).

According to Bundesen et al. (2015), the most basic assumption made by TVA is that the visual recognition and visual selection of objects in one's visual field consists of various categorisations. When individuals examine their visual field, objects in the field of vision are identified and categorised into a specific category based on the features of the object, such as its colour, shape, or size. This categorisation process occurs as a processing race, where all possible categorisations of an object compete for access into VSTM (Bundesen et al., 2015). The concept that governs this metaphorical race is referred to as the principle of biased competition (Desimone & Duncan, 1995). Biased competition refers to the fact that although each of the possible categorisations of an object is supported by sensory stimuli, attentional weights and perceptual biases result in some categorisations being prioritised over others (Bundesen et al., 2015). Vested interests, previous experiences, and personal preferences are examples of these attentional weights and perceptual biases that may increase or decrease the likelihood of some objects taking preference in the encoding process (Wilms et al., 2013). It is important to note that VSTM storage only has a limited amount of space (Galotti, 2008). This limitation of space results in some information being excluded from awareness, as only those objects that finished first in the metaphorical processing race enter VSTM and then reach conscious awareness (Wilms et al., 2013).

Although the categorisation of objects plays a major role in whether the object will be perceived or not, this only represents half of the attentional process, according to TVA. The next step in this process includes an analysis of the object's attentional weight, which Bundesen et al. (2015) refer to as the weighted sum of various pertinent factors associated with the object. After objects in the visual field have been categorised, they are assigned an attentional weighting based on the saliency and the relevance of the object, as well as the individual's unique biases (Bundesen et al., 2015). Objects with a high attentional weight are encoded first, while objects with lower weightings are deprioritised (Bundesen, 1990).

Objects with lower attentional weightings will not reach conscious awareness if they are not selected before the individual's total VSTM capacity has been reached (Bundesen et al., 2015).

The following practical example is given to illustrate TVA in a video game setting: When playing *World of Warcraft* (Blizzard Entertainment, 2004), an individual may fulfil one of three roles, namely a "tank", "healer", or "damage dealer". The tank's responsibility is to protect the group and prevent weaker players from being attacked. Healers cast spells in order to shield or rehabilitate players who are losing health points. Damage dealers attack the enemy in order to defeat certain foes or complete various objectives (Blizzard Entertainment, 2004). An individual playing as a healer needs to constantly monitor the state of their team and react accordingly, to ensure the survival of teammates playing as tanks or damage dealers. Depending on the skill level of the player, this action requires a high degree of concentration to successfully complete. According to TVA, the visual stimuli from the game that correspond to the player's intention to ensure the survival of the group—such as the current health points of each individual team member—will be categorised as important and therefore prioritised over other visual stimuli, such as noticing certain landmarks in the in-game environment. As focusing on the group's survivability was deemed most pertinent and salient to the current situation, the attentional weights assigned to another player's health points will be higher than the weightings associated with the in-game environment. Therefore, visual stimuli related to the in-game environment would be deprioritised by the player's attentional system. Furthermore, if the player's VSTM had reached its capacity during this time, the visual information from the in-game environment would have failed to reach conscious awareness and would not have been encoded into the individual’s memory.

3.2.3.1 Justification for the use of TVA. In this study, TVA was used to conceptualise the attentional process and to explain why some sensory information may have failed to reach conscious awareness, particularly when participants' attentional process was under strain (Galotti, 2008; Goldstein, 2011). According to Petersen (2013), TVA is an extremely thorough and comprehensive method of understanding the manner in which individuals make use of the attentional process. This makes TVA an appropriate theory for the current study. Furthermore, TVA provides a comprehensive framework from which to understand the capacity model of attention and is a useful tool to explain the findings of selective attention measures, such as the Stroop task (Bundesen, 1990; Bundesen et al., 2015).

Research by Bundesen (1990) has shown that TVA can account for a number of psychological findings in the field of attention, including differing reaction times and error rates. This made TVA specifically suited for this study as the Stroop task—which assesses a participant's reaction time—was utilised to test the VSA of participants. Furthermore, TVA succinctly explains why some participants give slower or incorrect responses when completing the Stroop task (Bundesen, 1990). According to TVA, the VSTM of these participants exceeded its capacity, resulting in them failing to notice the correct stimuli to which they needed to respond. TVA also states that individuals with more advanced VSA will be more likely to assign their attentional resources in an efficient manner (Bundesen et al., 2013). Individuals with better VSA will also assign greater attentional weightings to relevant stimuli, allowing them to complete the Stroop task with relative ease. Thus, TVA provides a framework for conceptualising the underlying mechanisms that are at work during the attentional process, specifically when utilising the Stroop task as a data collection tool (Bundesen, 1990).

Another benefit of utilising TVA is that the results of this study may be related to other phenomena that have already been studied using TVA (Nordfang, Dyrholm, & Bundesen, 2013). This is because studies that follow the same theoretical and paradigmatic approach make similar assumptions and have similar research methods (Jordaan, 2013). Therefore, studying the role of video gaming on attention through the use of TVA allows for greater standardisation and makes this research more comparable to other studies that also utilised TVA as a theoretical background.

3.3 Chapter Summary

This chapter discussed the paradigmatic approach used in this study. In order to study the effects of video game playing on VSA in early adulthood, this study relied on the cognitive paradigm. The human mind was thus viewed as a data processing unit which actively manipulates and interprets incoming stimuli (Passer et al., 2009). Furthermore, individuals were viewed in terms of how the mind processes, analyses, and stores information and how the thinking individual makes sense of themselves and their surroundings (Passer et al., 2009).

The theoretical point of departure was also examined in this chapter. This study utilised a capacity model of attention called the theory of visual attention (TVA). To describe how capacity models of attention were developed, a brief discussion of earlier attention theories—namely the filter theory, attenuation theory, and late selection theories—was provided. Capacity models of attention and TVA were then examined in detail. According to capacity models of attention, a person's level of attention is determined by their ability and intention to process certain information (Goldstein, 2011). Furthermore, capacity models postulate that individuals only possess a limited capacity to pay attention to anything (Galotti, 2008). Once this capacity has been exceeded, the individual fails to perceive certain stimuli (Goldstein, 2011). TVA represents a modern and widely-used theory of attention that is based on the capacity model (Petersen, 2013). According to TVA, the attentional process consists of various steps (Bundesen et al., 2015). Firstly, the individual examines the visual field.

Secondly, various objects within the visual field are identified. Thirdly, objects within the visual field are assigned an attentional weighting. This attentional weighting is a biased process where objects receive higher weightings based on the individual's preferences or previous experiences. Fourthly, objects with higher attentional weightings are encoded into VSTM in preference of objects with lower attentional weightings. This fourth step continues until the individual's total processing capacity is reached. Once this capacity has been reached, objects of lower attentional weightings that have not been encoded into VSTM will not be perceived by the individual (Wilms et al., 2013).

Considering that the research methods chosen by a researcher directly influence the outcome of a study and the manner in which the research study is carried out, it is crucial that these methods are discussed and explained clearly (Gravetter and Forzano, 2012; Jordaan, 2013). In light of this, the following chapter will focus on the research methodology used in the current study.

Chapter 4

Research Design and Methodology

To contextualise the results of this study, this chapter discusses the aim of the study, research design, sampling, data collection, data analysis, the validity and reliability of the study, and ethical concerns that were observed throughout the research process. The research methods described below were chosen to best answer the research questions and aims of this study.

4.1 Aims and Objectives of the Study

As noted in the first chapter, the aim of this research study was to investigate the effects of video game playing on visual selective attention (VSA) in early adulthood. The objectives of the study were as follows:

1. To measure the difference in VSA between video game players and non-players using the Stroop task.
2. To explore the relationship between VSA, video game playing, and gender.

4.2 Research Design

Considering the experimental nature of psychological concepts such as VSA (Galotti, 2008), a quantitative design was utilised in order to best answer the research questions stated. This is in line with previous research conducted on attention (Bavelier et al., 2012; Clapp et al, 2011; Dye & Bavelier, 2010; Mishra et al., 2011; Serences et al., 2004; Toepper et al., 2010; West et al., 2008). The quantitative design is based on positivism, an approach that considers information and knowledge to be derived from the interpretation and analysis of sensory experiences (Collins, 2010). Positivistic studies focus on empirical data that is obtained through the observation and measurement of phenomena (Trochim, 2006).

In the current study, research was conducted in two phases consisting of a survey research design followed by a quasi-experimental research design. These two research designs are described below, while specific details regarding sampling for the research designs employed in this study are discussed in section 4.3.2 of this chapter.

The first phase of this study implemented a survey research design. This design was utilised to categorise participants into either an experimental or a control group. Participants who played video games were assigned into the experimental group while participants who did not play video games were assigned into the control group. According to Gravetter and Forzano (2012), the survey research design entails the use of a survey or questionnaire to obtain self-reported answers about attitudes, opinions, behaviours, or personal characteristics. An advantage of the survey research design is that it allows the researcher to access a large number of possible participants (Wright, 2005). Furthermore, when surveys are administered online, they can be easily individualised based on a participant's responses (Gravetter & Forzano, 2012). This individualisation is especially convenient when participants are required to fill out different sections of the survey based on certain criteria, as the survey can then be coded and presented in a more flexible manner. In this manner, different sections of the survey can be presented depending on the participant's answers (Boyer, Olson, Calantone, & Jackson, 2002). However, because the survey research design relies on self-reporting, the information obtained may be inaccurate or incomplete. This occurs because the survey relies on participants’ understanding of the questions as well as their willingness to be truthful (Beam, 2012).

The second phase of this study consisted of a quasi-experimental research design, specifically the posttest-only design with non-equivalent groups. The posttest-only design with non-equivalent groups obtains a posttest observation of two groups of participants, namely those who have been exposed to a treatment and those who have not been exposed to a treatment (Shadish, Cook, & Campbell, 2002). The treatment in this study refers to the playing of video games. Participants who were regularly exposed to the treatment—those who played video games—were assigned to the experimental group, while participants who were not regularly exposed to the treatment—those who did not play video games—were used as a control group. According to Shadish et al. (2002), this design is particularly useful in instances where a treatment begins before the researcher is involved in the study. Considering that video game players had already been playing video games for any number of years before data collection began, gathering pretest observations on existing video game players was not possible. Therefore, the posttest-only design with non-equivalent groups allowed the researcher to investigate the VSA abilities of existing players and non-players.

4.3 Sampling

Acharya, Prakash, Saxena, and Nigam (2013) asserted that, to ensure valid results in research, it is essential that a sound and scientific sampling methodology is utilised. This is advisable because the outcome of a study may depend on the way in which participants are selected from the greater population (Levin & Fox, 2011). While different sampling methods have their own advantages and disadvantages, issues regarding sampling should be discussed to contextualise a study (Trochim, 2006). The selection criteria of the sample, the sampling method, and sample size are discussed next in order to contextualise the findings of the current study.

4.3.1 Selection criteria. As discussed in chapter two, research studies on video game playing tend to neglect adult samples, despite the fact that negative outcomes associated with video game playing appear to be just as prevalent in adulthood as in adolescence (King et al., 2013; Pawlikowski & Brand, 2011). The result is that existing literature on video gaming and attention tends to focus on adolescents (Boot et al., 2013). The current study focused on participants in early adulthood as defined by Arnett (2000). Participants were selected for participation if they could be categorised within the age range of 18 and 25 years. There were two reasons for choosing this particular age range. Firstly, to help fill the research gap that exists on video game playing research and individuals in early adulthood. Secondly, to avoid possible threats to the validity of the study due to confounding variables associated with age, such as age-associated cognitive decline (AACD) as described by Deary et al. (2009) and Salthouse (2009). AACD affects an individual's performance on attention measures such as the Stroop task, with older individuals performing more poorly than younger individuals (Malek & Amiri, 2013). While researchers do not currently agree on when exactly AACD begins, cognitive performance generally remains stable through adult life, until the age of 60 years when cognitive functions begin to decline (Salthouse, 2009). When there is notable variation in the age of participants, AACD may hinder the performance of older participants (Salthouse, 2009). This represents a threat to the study's validity, as younger participants were not subjected to the same impediment as older participants. It is unlikely that AACD presented a threat to the current study's validity, as participants all fell into a similar age category.

In order to qualify as a regular video game player in the current study, participants had to play video games for an average of five hours per week. This criterion is based on research by Mathiak and Weber (2006). Participants who infrequently played video games—less than five hours a week—or those who did not play video games at all were classified as non-players. While research has shown that regular exposure to video games does improve the player's attentional abilities, these studies often relied on different qualifying criteria for what is deemed as regular exposure to video game playing (Bavelier et al., 2012; Dye & Bavelier, 2010; West et al., 2008). For this reason, the current study relied on the methodology employed by Mathiak and Weber (2006).

4.3.2 Sampling method. Participants were selected using quota sampling. Quota sampling is a form of non-probability convenience sampling which is used to ensure a proportional number of participants based on a certain characteristic (Trochim, 2006). This sampling method was used to ensure an equal number of male and female participants. Acharya et al. (2013) warned that non-probability sampling techniques such as quota sampling are not as robust as true random samples. Despite this, however, convenience sampling is a timely, inexpensive, and widely-used method of sampling in behavioural science research (Acharya et al., 2013).

With regard to this study, participants were sampled from the University of Pretoria's (UP) online student portal, which is known as ClickUP. Students who were registered for psychology modules at UP were invited to participate in the study. The use of students limits the representativeness of the sample and it is therefore one of the limitations of the study. This limitation is discussed in chapter six. However, a number of international studies have made use of students when conducting research on video gaming and attention (Bavelier et al., 2012; Green & Bavelier, 2006a; Karle et al., 2010; Murphy & Spencer, 2009). Despite this limitation, the use of students was appropriate in the current study as university students generally fall within the age criterion previously described in section 4.3.1.

4.3.3 Sample size. To investigate the relationship between video game playing and gender, participants in this study were categorised into four sub-groups, namely (a) female video game players, (b) female non-players, (c) male video game players, or (d) male non-players. Figure 4 shows the size of the overall sample as well as the proportion of sub-categories. The use of quota sampling ensured that each sub-category contained a similar number of participants. A total of 124 participants completed the screening survey. However, only 80 participants agreed to complete the computer task. The final sample size was therefore 80, divided as follows: (a) 20 female video game players, (b) 19 female non-players, (c) 20 male video game players, and (d) 21 male non-players.

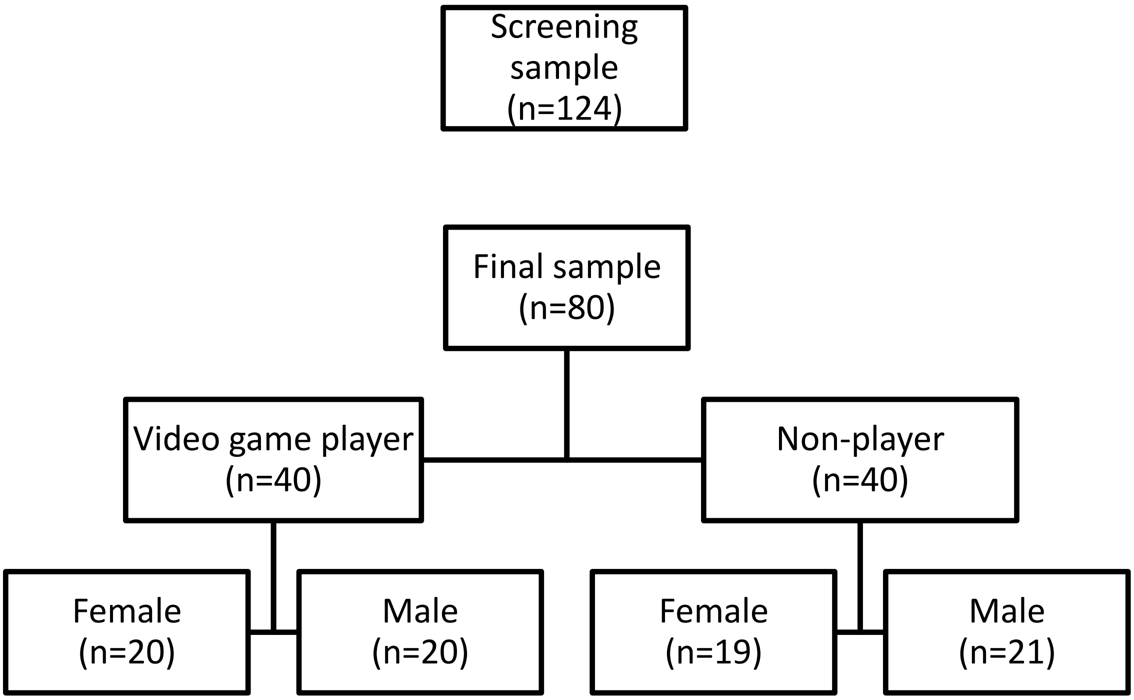

Figure 4. Size of the overall sample showing the proportion of sub-categories.

4.4 Data Collection Instruments

The data used in this study was obtained by means of two methods. Firstly, an online survey (Appendix A) was developed to collect demographic information from participants and to screen participants to categorise them into the experimental or control group. Secondly, a computerised version of the Stroop task was utilised to measure a participant's VSA. Both of these measures are discussed below.

4.4.1 Screening survey. To determine if participants were regular video game players, an electronic survey (Appendix A) was created on an online platform known as Qualtrics. Qualtrics is a widely-used survey platform that allows the user to capture and analyse data from customisable surveys (Qualtrics, 2016).

The survey was comprised of three sections. The first section gathered demographic information from participants, such as their age and level of education. The second section dealt with the individual's gaming habits, which included questions on the participants’ time spent playing video games and their preferred gaming platform. Finally, the third section requested that participants provide their contact details, as well as a name or pseudonym. Contact details were requested to allow the researcher to contact participants for further participation in the study.

An advantage of using Qualtrics to administer the survey was that various integrity checks could be implemented throughout the survey to ensure that participants did indeed meet the qualifying criteria. For example, if a participant entered their age and it did not fall within the 18 to 25 year range, Qualtrics terminated the survey session and no further data was collected from that respondent. Another advantage of the Qualtrics platform was that it allowed the researcher to customise the survey based on participants' responses. If participants did not classify themselves as video game players, they were not presented with the second section of the survey. Instead, they were presented with the final section, which requested their contact details. This is because the second section dealt with video game playing habits, which they as non-players did not need to answer. As a result, the data collection process was simplified for participants and the risk of incomplete or incorrect data that may result from participants who had misunderstood instructions was eliminated.

4.4.2 Stroop task.

According to Goldstein (2011), an individual's ability to ignore task-irrelevant stimuli is not only dependent on the difficulty of the task, but also on how powerful the task-irrelevant stimulus is. Furthermore, De Vito and Fenske (2015) showed that task-irrelevant stimuli that is easily held in visual working memory is easier to inhibit and is thus less likely to result in attentional interference. Both of these characteristics represent integral functions of VSA and are commonly tested using the Stroop task. The Stroop effect was first discovered by John Ridley Stroop (1935) and refers to the cognitive interference an individual experiences as a result of two simultaneously conflicting pieces of information. The Stroop task has since become a frequently used task in psychological evaluation and research (Baumstarck et al., 2013). Figure 5 shows an example of the Stroop task with congruent and incongruent stimuli.

Figure 5. Congruent and incongruent stimuli in the Stroop task (Lamers, Roelofs, & Rabeling-Keus, 2010).

In the Stroop task, an individual is asked to quickly respond to the colour of a printed word, while ignoring the spelling of the word itself. For example, the word "red" may be written in the colour red. The participant would then be required to state the colour of the ink that the word is written in, namely red (Lamers et al., 2010). In these "congruent" examples, the task is rather easy and participants have little difficulty responding quickly. However, the test also contains "incongruent" examples, where the colour that is spelled out is written in a different colour ink, for example, the word "red" written in blue ink. Due to the interference of task-irrelevant stimuli, the Stroop task demands more concentration and participants generally take longer to respond (Galotti, 2008). This delayed reaction time occurs because the spelling of the words causes a competing response with the colour that the words are written in (Goldstein, 2011). Furthermore, because the Stroop task presents participants with both congruent and incongruent stimuli in a random order, it is difficult for participants to anticipate the correct response for each upcoming trial, further taxing their attentional capacity (Galotti, 2008). The reason that task-irrelevant stimuli in the Stroop task are so distracting is because the reading of words is highly practised for literate individuals. Reading thus becomes such an automatic process that it is difficult for participants not to read the word (Wells & Matthews, 2014). Grégoire, Perruchet, and Poulin-Charronnat (2013) added that the two perceptual dimensions of the task—the spelling of the word and the colour of the word—are "embedded within each other in the strongest possible way. This [creates] an intensive conflict between the outcomes of the two processes involved in the processing of these two dimensions" (p. 2).

Effectively inhibiting task-irrelevant stimuli is a necessary feature of good VSA skills (Pilli et al., 2013). Therefore, individuals with good VSA skills complete the Stroop task faster than those with poorer VSA skills. The latter cannot inhibit task-irrelevant stimuli as effectively and hence take longer to respond (Pilli et al., 2013). For this reason, a participant's response time on the Stroop task may be used to determine their VSA, with faster reaction times indicating better VSA skills than those with slower reaction times (Macleod, 1991).

More recently, researchers have begun to make use of a computerised version of the Stroop task, as opposed to the traditional paper-based version (Davidson & Wright, 2002). This allows researchers to very accurately measure the respondent's reaction time, as the participant’s responses are recorded electronically rather than through manual means such as a stopwatch. Various studies have since made use of this computerised version in a variety of settings (Davidson & Wright, 2002; Duchek et al., 2013; Parsons, Courtney, & Dawson, 2013; Phelan et al., 2011; Pilli et al., 2013; Powell, Jones, Pampolini-Roberts, Rees, & Hindle, 2014). The Stroop task has even been employed using a virtual reality platform (Armstrong et al., 2013) and a smartphone application (Bajaj et al., 2013), both of which showed acceptable validity compared to traditional and computerised versions of the task.

To test a participant's VSA in the current study, a computerised version of the Stroop task was employed. Since its inception in 1935, the Stroop task has been refined with numerous variations having been proposed (Macleod, 1991). These variations include sorting as opposed to naming colours, using auditory stimuli rather than visual stimuli, and testing participants over a period of time rather than during a single test (Macleod, 1991). Each specific variation of the test has its own merits. However, in a comprehensive review by Macleod (1991), it was found that the original naming task administered in a single trial–as used in this study–was most effective at testing an individual's VSA. In the current study, the experiment was presented on a laptop computer using an open-source software package known as PsychoPy (Version 1.83; Peirce, 2015). PsychoPy is a computer program that allows for the presentation of stimuli and the collection of data specifically for use in neuroscience, psychophysics, and psychology (Peirce, 2007, 2009). The computerised Stroop task utilised in this study was created by Peirce (2015) using PsychoPy. Figure 6 shows a screen capture of the user interface of the Stroop task created in the PsychoPy program.

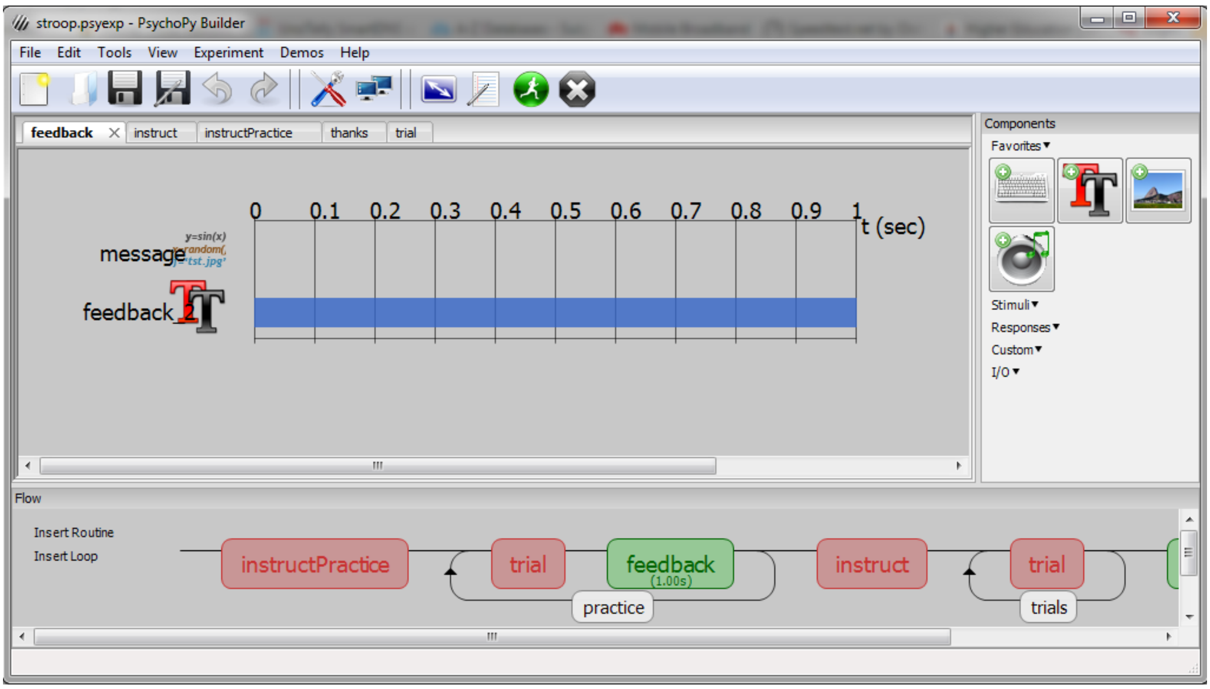

Figure 6. PsychoPy's user interface that is used to create and display the Stroop task

4.5 Data Collection Procedure

4.5.1 Screening survey. Once the survey (Appendix A) was created and uploaded onto Qualtrics (Qualtrics, 2016), participants were invited to participate in the research study via an announcement on ClickUP (Appendix B). The sample population, as described in section 4.3.2, was then able to view the announcement on ClickUP. The notification consisted of a short explanation of the study as well as a link to the survey. Once participants had clicked on the link, they were redirected to the Qualtrics platform where they could complete the survey. Before participants could begin completing the survey, they had to read a consent form (Appendix C). This not only made participants aware of their rights but also explained the selection criteria used in the study. Participants were informed that by continuing with the survey, they agreed to the terms discussed in the consent form. Ethical considerations are discussed in more detail in a later section of this chapter. Once participants had given their consent, the Qualtrics platform presented participants with the survey. A participant's responses were captured and stored by the Qualtrics platform. Using the contact details that participants had provided in the survey, the researcher then contacted participants via email and invited them to participate in the second phase of the study, namely the Stroop task.

4.5.2 Stroop task. After the researcher had received confirmation that a participant was willing to participate in the second phase of the research via email, a face-to-face session was arranged based on the participant's availability. During this session, participants were presented with the computerised Stroop task to test their VSA. Before the experiment commenced, participants were again asked to read the consent form (Appendix C) to remind them of their rights as research participants. Furthermore, the researcher clarified any questions or concerns that participants may have had regarding their participation.

The Stroop task was administered in the Humanities building at the Hatfield Campus of the University of Pretoria. To ensure standardisation, the task was conducted in the same room under similar conditions for each participant. Thus, the researcher ensured that participants were comfortable and that the research space was free of any distractions or loud noises. Each participant was then assigned a participant ID to ensure that his/her contribution remained confidential. This ID allowed the researcher to correlate a participant's survey responses with their results on the Stroop task without using any personal information, such as the participant’s name, to link the two corresponding data sets. The researcher then explained the instructions of the Stroop task, informing participants that one of three words would individually be flashed onto the screen in front of them, and that their task was to respond to the colour of the word while ignoring the meaning of the word. Participants were also asked to perform the task as quickly as possible. The researcher gave an example where the word "red" written in the colour blue might flash on the screen, and that the correct response in that instance is "blue". To ensure standardisation, that same example was used for each participant.

The researcher then explained that the experiment would consist of two parts. Firstly, a short practice session that would provide feedback as to whether participants had successfully completed each trial. Secondly, a longer session that would not provide feedback during which data collection would commence. The data used in this study constituted only the data that was gathered during the second part of the experiment. This brief practice session was included in the study to minimise the risk of slow response times due to participants’ unfamiliarity with the task's instructions. Participants were then positioned in front of the laptop computer and the experiment began. A list of instructions appeared on the screen which stated that participants should press the "left" arrow key for words written in red, the "down" arrow key for words written in green, and the "right" arrow key for words written in blue. Coloured labels were placed over the three keyboard keys that participants were required to press in order to complete the task. A red label was placed over the "left" arrow key, a green label was placed over the "down" arrow key, and a blue label was placed over the "right" arrow key. This colour coding was to ensure that participants easily remembered the correct response on the keyboard and would not need to rely on their ability to recall the instructions. This reduced the likelihood that a participant's memory might constitute a confounding variable in the study. Placing coloured labels over the corresponding keys when administering the Stroop task is a strategy employed by numerous authors (Afsaneh et al., 2012; Quero, Baños, & Botella, 2000). Figure 7 shows a screen capture of the list of instructions with which participants were presented during the practice session.

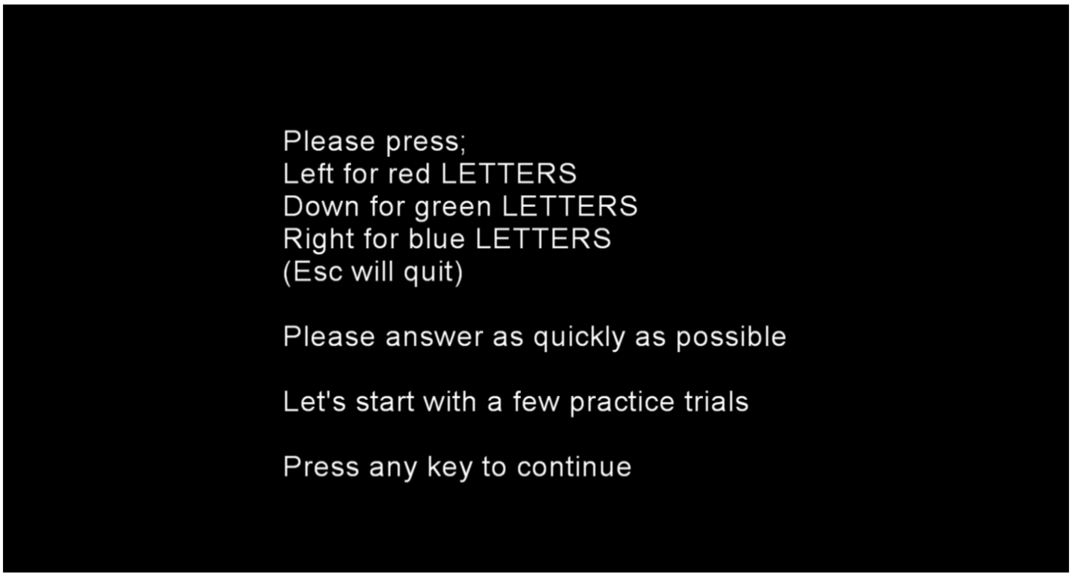

Figure 7. List of instructions presented to participants before the practice session.

Once participants were ready, they would press any key on the keyboard to start the practice session. After every response from the participant, the computer provided feedback, consisting of the participant's response time as well as feedback about the correctness of their selection. Figure 8 shows a screen capture of the feedback that participants were shown when they gave either an incorrect or a correct response.

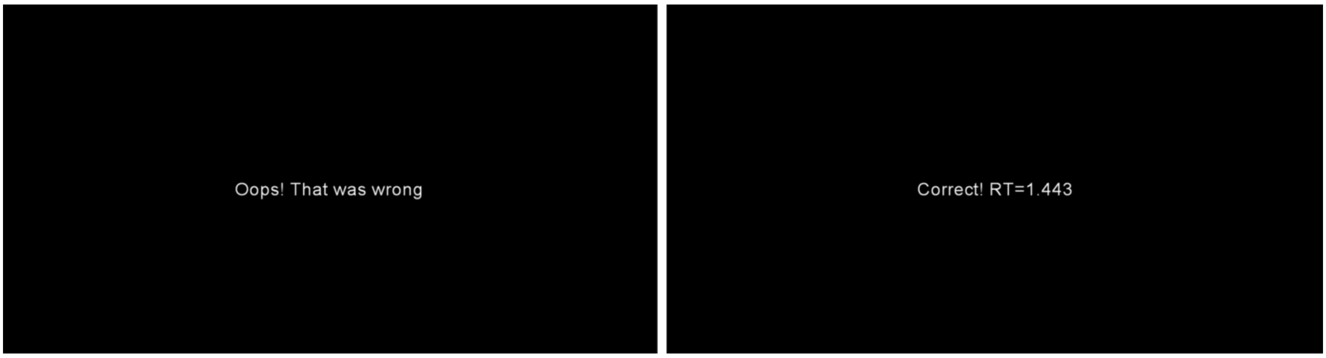

Figure 8. Feedback given to participants for incorrect (left) and correct (right) responses. Correct responses showed the participant's response time (RT).

The practice session consisted of 12 trials. Thereafter, another set of instructions appeared which informed participants that actual data collection would then commence and that they would not receive any feedback. The researcher clarified any final questions that participants might have had and then stepped out of the room to allow the participants to complete the experiment without interference. The data collection phase of the experiment consisted of 60 trials, which were presented in rapid succession until the experiment ended. Thus, a participant completed a total of 72 trials, including the practice trials. Macleod (1991) suggested that the total number of trials in the Stroop task should be greater than 50 to ensure that participants have sufficient opportunity to become acquainted with the task. On average, the task took approximately five minutes to complete, depending on the response speed of the participant. Once participants had finished the task, a debriefing session was held and the participants were given the opportunity to ask any questions they may have had. This debriefing session is discussed in section 4.9 of this chapter. The researcher then thanked the participant for their time and their participation.

4.6 Validity and Reliability of the Stroop Task

Considering that the Stroop task was first created in 1935, there are already a number of studies regarding the validity and reliability of the measure. The Stroop task can be considered to be highly reliable, as test-retest coefficients for the task tend to range between .71 and .88 (Strauss, Allen, Jorgensen, & Cramer, 2005). This finding was further supported by studies which showed that the Stroop task exhibited good reliability across a variety of situations (Jensen, 1965; Santos & Montgomery, 1962; Schubo & Hentschel, 1977, 1978; Uechi, 1972). Determining the validity of the Stroop task is more complicated, as different researchers often employ different variations of the task (Macleod, 1991). However, according to Macleod (1991), most of the variations of the traditional Stroop task still produce substantial interference effects as seen in the traditional task. This means that although variations of the task—such as the Emotional Stroop task, which is used to assess an individual's emotional state—may be used to test different constructs, the fundamental interference caused by the conflict between word colour and word spelling is present in most Stroop-like tasks. This result is evident in a number of studies (McCown & Arnoult, 1981; Peretti, 1971; Regan, 1978; Zajano, Hoyceanyls, & Ouellette, 1981) which examined the effect of different data collection procedures, instructions to participants, and the manner in which the task was completed by participants. Therefore, the Stroop task exhibits high validity in a variety of different contexts (Macleod, 1991).

This study made use of a computerised version of the traditional Stroop task. Administering the task electronically removed the possibility of human error during data collection while also allowing for fast and accurate data collection procedures. Considering that the manner in which the Stroop task is administered differs significantly between the traditional task and the computerised task, it is important to discuss the validity and reliability of the computerised Stroop task. The computerised Stroop task has been widely proven to exhibit acceptable reliability and validity across a variety of contexts compared to the traditional task (Armstrong et al., 2013; Bajaj et al., 2013; Davidson & Wright, 2002; Duchek et al., 2013; Parsons et al., 2013; Phelan et al., 2011; Pilli et al., 2013; Powell et al., 2014).

However, one major criticism regarding the validity of the Stroop task concerns the task's vulnerability to practice effects. Multiple exposures to the task by the same participant have been shown to result in improved reaction times compared to participants who attempted the task for the first time (Galotti, 2008; Macleod, 1991). Therefore, to avoid the confounding influence of practice effects in the current study, the task was administered during a single sitting. In conclusion, both the traditional Stroop task and the computerised Stroop task may be considered valid and reliable test instruments (Macleod, 1991).

4.7 Statistical Conclusion Validity

Considering that the quantitative research design relies heavily on the use of statistical tests (Given, 2008), the statistical conclusion validity (SCV) of this study will now be discussed. According to Garcia-Perez (2012), SCV is upheld when the conclusions of the research study are "founded on an adequate analysis of the data" (p. 1), meaning that the conclusions about the relationship between variables may be considered to be correct. According to Shadish et al. (2002), there are a number of threats to SCV, including low statistical power, violated assumptions of test statistics, unreliability of measures, and extraneous variance in the experimental setting. Statistical power refers to a measure's ability to detect relationships between variables (Lipsey, 1990). The power of a test is particularly influenced by the sample size of the study (Shadish et al., 2002). Considering the relatively small sample utilised in this study (n=80), this may have represented a threat to the study's SCV. Taking into account that the current study did not violate the assumptions of the statistical measure employed, as will be shown in section 5.3.2, it is reasonable to assume that the SCV of this study was not impacted by violated test assumptions. With regard to the unreliability of measures, as was shown in section 4.6, the Stroop task is considered to be a highly reliable measure that may be employed in a variety of contexts (Strauss et al., 2005).

This suggests that the SCV of this study was not impacted due to an unreliable data collection tool. Finally, Shadish et al. (2002) stated that it is nearly impossible for a research study to completely control for the presence and impact of extraneous variables. As a result, there exists a possibility that participants in the current study may have become distracted or influenced by external variables that may have affected the outcome of the study. As described in section 4.5, standardised experimental procedures were followed during the data collection process in an effort to minimise the possible impact of extraneous variables.

4.8 Data Analysis Techniques

To determine if video game playing and gender had an impact on a participant's VSA, a two-way between-groups analysis of variance (ANOVA) was conducted using version 24 of SPSS (IBM Corp, 2016). A two-way between-groups ANOVA is a technique that allows a researcher to search for the main and interaction effect of two independent variables on one dependent variable (Gravetter & Wallnau, 2012; Harris, 1994; Pallant, 2013). The two independent variables in this study were gender and video game playing, while the dependent variable was VSA. According to Pallant (2013), an advantage of using a two-way design is that it allows the researcher to test the main effect of each independent variable while also exploring the possibility of an interaction effect. An interaction effect occurs when an independent variable's impact on the dependent variable is affected by another independent variable (Runyon, Coleman & Pittenger, 2000; Tabachnick & Fidell, 2013). For example, in this study, it may be found that the influence of video game playing on VSA is different for males and females. The results of this analysis are presented in chapter five. The gender and video game playing status of participants were determined from their responses on the screening survey. Participants' VSA was determined from their response time on the computerised Stroop task. Using a participant's results from each of the 60 trials presented during the computerised Stroop task, a mean response time was calculated for each participant. This mean response time was used to indicate a participant's VSA.

4.9 Ethical Considerations

When conducting any form of research, it is vital that researchers consider certain ethical standards to protect participants from possible harm (Salkind, 2009). It is the duty of the researcher to ensure that a participant's psychological welfare and dignity remain uncompromised throughout the research process (Salkind, 2009). Willig (2009) highlighted numerous ethical issues that should be taken into account when conducting research in the social sciences. These include avoiding harm to participants, confidentiality, informed consent, and adequate debriefing at the conclusion of the research process (Willig, 2009). These ethical concerns and how they were applied in this study are discussed below.

Firstly, the two phases of data collection did not include potentially harmful or dangerous procedures. Furthermore, the experiment took place in a safe environment at the University of Pretoria. As a result, participation in this study did not subject participants to any immediate danger.

The issue of confidentiality was particularly pertinent in this study. This is because the researcher needed to obtain the contact information of participants to request further participation in the study. To uphold this ethical concern, the personal information of participants was handled with the strictest of confidence. The personal information of participants was only viewed by the researcher and was not viewed or given to a third party. To ensure that the personal information of participants remained secure, it was electronically stored on the researcher's computer, and protected by an access password. Once data collection had ended and the researcher no longer needed to contact participants, the contact details of all participants were erased. To comply with university regulations, the data used in this study will be stored in room 11/24 of the Department of Psychology at the University of Pretoria for 15 years.

Another manner in which this study ensured the confidentiality of participants was by giving participants the option of entering a pseudonym instead of their real name when providing their contact details. Although most participants provided their real names, some opted to provide a pseudonym. In this case, the researcher engaged with them using the pseudonym provided. To further protect a participant’s confidentiality, each participant was assigned a participant ID once they completed the screening survey. This participant ID was used, instead of the participant’s name, to link a participant's survey responses with their results on the Stroop task. For example, when a participant had completed the screening survey, they may have listed their name as "Karen". When the researcher met with Karen to complete the Stroop task, the researcher assigned a participant ID to Karen. This ID was entered into the computer when Karen conducted the computerised task and data collection commenced. Furthermore, the participant’s name/pseudonym was removed from their survey results, and was instead replaced with their participant ID. In this way, the participant's results were linked to their participant ID, and not their name/pseudonym. This method not only allowed the researcher to easily keep track of various participants' responses, but also ensured the confidentiality of all participants.

Before participating in the first phase of the study, participants were presented with a consent form (Appendix C) that described their rights as participants. During the second phase of the research study, which took place in person, participants were given the opportunity to ask any questions they may have had concerning their participation. Participants were reminded that their participation was completely voluntary. Participants were also reminded that they were allowed to terminate the session at any time and that such a decision would not result in any form of punishment or negative consequences.

Finally, once participants had completed the computer task, they were debriefed and given the opportunity to ask any questions they might have relating to their participation in the study. Debriefing involved a discussion on how the participants felt about their participation in the study as well as an explanation of why incongruent stimuli in the Stroop task might have caused them to feel frustrated due to slower response times. Furthermore, participants were reminded that the email addresses of both the researcher and the research supervisor were printed on the consent form and that any further concerns could be addressed through these channels. If participants requested feedback on their own performance on the Stroop task, the researcher shared these results with them during the debriefing session. Participants never saw the results of other participants or any other data, but were only provided with their own results. Once the researcher had showed a participant their results, the researcher explained to them that the results were not meant to diagnose and that the results were not indicative of any underlying attentional conditions. The researcher was also ready to refer any participants to a qualified counsellor at the University of Pretoria, should they experience any discomfort or anxiety as a result of their participation in this study. None of the participants in this study required counselling as a result of their participation in the research process.

4.10 Chapter Summary

The aim of this study was to investigate the effects of video game playing on VSA in early adulthood. To examine this issue, a quantitative design consisting of two separate phases was utilised. The first phase consisted of a survey research design, which allowed the researcher to gather demographic information from participants, while also assigning participants into a control or experimental group. The second phase of the research employed a quasi-experimental research design, where participants were asked to complete a computerised version of the Stroop task to test their VSA. Participants were sampled using non-probability quota sampling which resulted in a final sample size of 80. Data was collected using the Stroop task. During the Stroop task, an individual is tasked with responding to the colour of a printed word, while ignoring the meaning of the word (Lamers et al., 2010). Participants usually perform more poorly in the task when they are confronted with incongruent examples, where the colour of the word and the meaning of the word do not match (Goldstein, 2011). This occurs because task-irrelevant stimuli cause a delayed reaction time (Wells & Matthews, 2014). Therefore, an individual's reaction time in the Stroop task provides researchers with an indication of that participant's VSA abilities (Galotti, 2008). Both the traditional and the computerised version of the Stroop task have been shown to exhibit good validity and reliability across a variety of situations (Armstrong et al., 2013; Bajaj et al., 2013; Macleod, 1991). To analyse the data obtained in this study, a two-way between groups ANOVA was utilised. The advantage of using a two-way between groups ANOVA is that the researcher is able to test the main effect of each independent variable while also exploring the possibility of an interaction effect. To ensure the comfort and safety of participants during the research process, various ethical principles were upheld including informed consent, confidentiality, and avoiding harm to participants. The results of the study are described in the following chapter.

Chapter 5

Results

In this chapter, the results of the study are presented. This includes the demographic information as well as the video game playing habits of participants gathered during the screening survey. What follows is the results of a two-way between-groups ANOVA which tested for main and interaction effects with regard to video game playing and gender on an individual's VSA.

5.1 Demographic Characteristics

The demographic characteristics of participants are presented in the following sections. To obtain a description of the sample, participants were asked to provide their age, gender, level of education, and their video game playing status. This descriptive information was then used to explore the second research objective in the study, which related to the relationship between VSA, video game playing, and gender.

5.1.1 Age. This study examined the effects of video game playing on VSA in a sample of participants in early adulthood. The majority of participants were 21 years of age, representing 24% of participants in the sample. Participants aged 19 years made up the smallest age category, representing only 9% of the sample. The mean age of the sample was 21.3 years. The age of participants, expressed as a percentage of the total sample, is shown in figure 9 below.

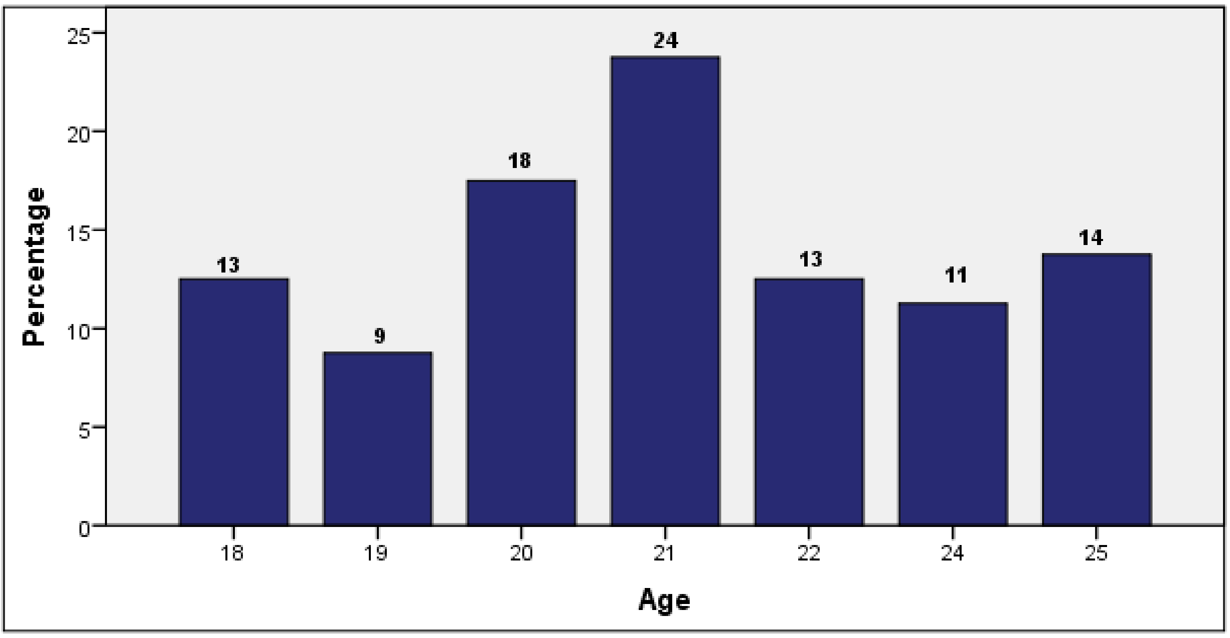

Figure 9. Age distribution of participants in the sample.

5.1.2 Gender. Due to the implementation of quota sampling, a similar number of males and females were included in the sample. In this study, 51% of participants were male, while 49% of participants were female. The gender of participants, expressed as a percentage of the total sample, is shown in figure 10 below.

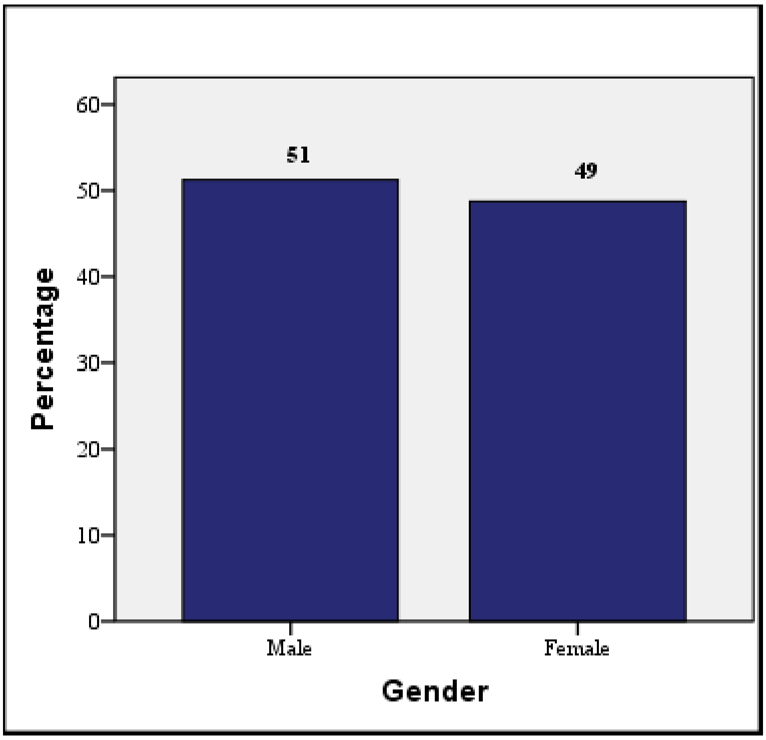

Figure 10. Percentage of male and female participants in the study.

5.1.3 Level of education. Participants were also questioned about their level of education. For most participants, their highest level of completed education was Matric, comprising 80% of the total sample. 10% of participants had completed a Bachelor's degree while the remaining 10% had completed an Honours degree. This finding is not surprising, considering that the sample consisted of university students. The level of education of participants in the sample, expressed as a percentage, is shown in figure 11.

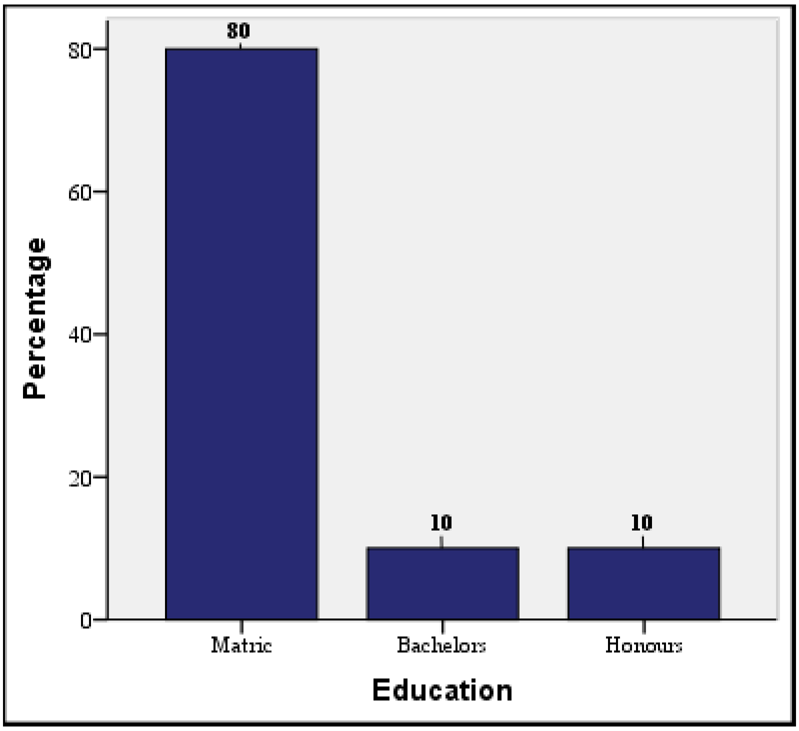

Figure 11. The highest level of education completed by participants in the sample

5.1.4 Video game playing. To examine the manner in which video game playing affects the player, an equal number of video game players and non-players were included in the sample using quota sampling. Therefore, the sample was divided between 50% video game players and 50% non-players.

5.2 Video Game Playing Habits

This section examines the video game playing habits of participants. The results below consist of data collected from half of the participants in the overall sample, namely those that had qualified as regular video game players. The total number of hours played per week, the number of years spent playing video games, the preferred video game platform, the preferred video game type, and the preferred video game genre of video game players in the sample are presented below.

5.2.1 Average number of hours played per week. Most video game players in the sample played on average between 6-15 hours a week. Of the sample, 35% played video games for 6-10 hours a week and 30% played video games for 11-15 hours a week. Only 8% of the sample stated that they only played an average of 5 hours a week. The average number of hours per week spent playing video games, expressed as a percentage, is shown in figure 12.

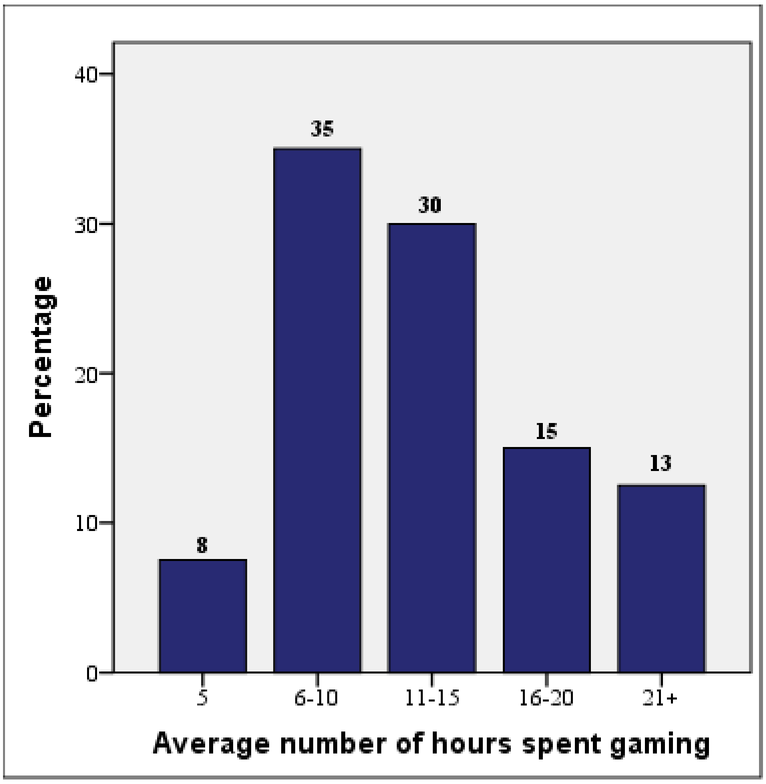

Figure 122. Number of hours per week spent playing video games.

5.2.2 Number of years played. Of the 40 video game players in the sample, the mean number of years spent playing video games was 9.6 years, ranging in years between 1 and 20 with a standard deviation of 5.24. This is shown in table 1 below.

Table 1: Number of years spent playing video games

	N	Minimum	Maximum	Mean	Std. Deviation
Years spent gaming	40	1	20	9.60	5.237

5.2.3 Preferred video game platform. Most video game players in the sample preferred playing on a desktop computer (PC). Of the sample, 62.5% of participants stated that a PC was their gaming platform of choice, while only 27.5% listed consoles, such as the Xbox or Playstation, as their gaming platform of choice. Handheld consoles, such as the PSP or Nintendo DS, and cellular devices were the least popular gaming platforms, as both were the preferred platform of only 5% of participants in the study. This is shown in figure 13.

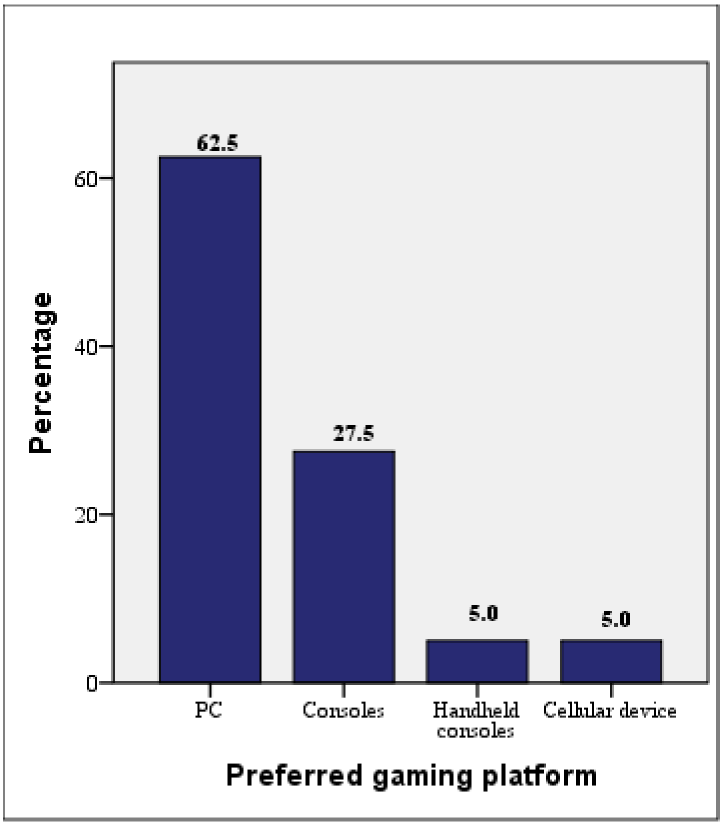

Figure 133. Preferred gaming platform of video game players in the sample.

5.2.4 Preferred video game type. A large majority of the video game players in the sample (85%) listed games that they considered to be "fast paced and exciting" as their preferred game type. The remaining 15% of participants opted for games that they considered to be "relaxed and casual". This is shown in figure 14 below.

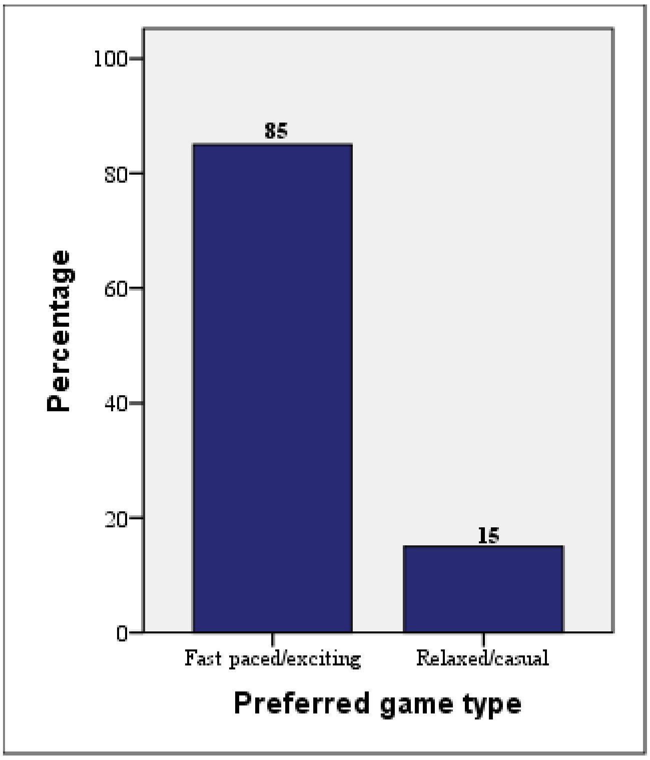

Figure 144. Preferred game type of video game players in the sample.

5.2.5 Preferred video game genre. Massively multiplayer online role-playing games (MMORPG) and first-person shooters (FPS) were the most popular video game genres, with both being the preferred genres of 25% of participants in the sample. This was followed by strategy and multiplayer online battle arena (MOBA) games which were the preferred genre of 20% and 15% of participants respectively. Other genres, which participants listed as "single player role-playing games" and "team racing games" were the preferred genre of 7.5% of participants. Simulation and sport games were the least popular video game genres, with only 2.5% of participants preferring simulation games and 5% of participants preferring sport games. These results are shown in figure 15.

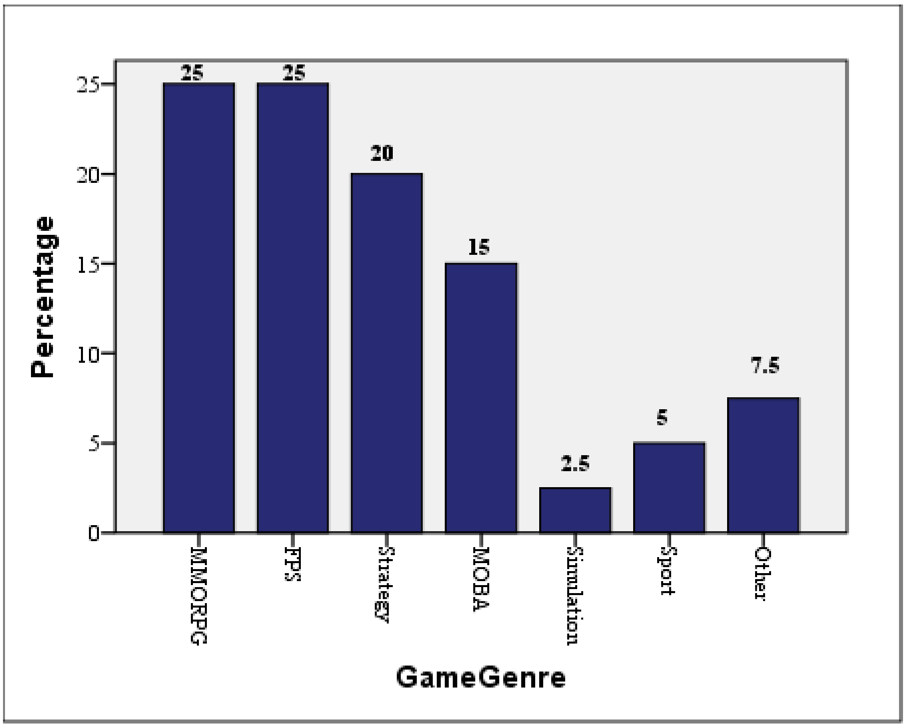

Figure 155. Preferred game genre of video game players in the sample.

5.3 VSA Scores

The data collected from participants using the computerised Stroop task is presented in this section. As discussed in section 4.6, the Stroop task is considered to be a valid and reliable measure. The mean VSA scores, measured by a participant's mean reaction time on the computerised Stroop task, is presented for the four sub-groups of participants. This is followed by the results of a two-way between-groups ANOVA which determined if significant differences existed between the video game players and non-players, while also testing for interaction effects.

5.3.1 Mean VSA scores by group. The first objective of this study was to measure the difference in VSA between video game players and non-players using the Stroop task. As discussed in section 4.4.2, individuals' response times on the Stroop task provide an indication of their VSA. The mean response times of video game players and non-players is shown in table 2. The mean response time of video game players was 637 milliseconds (ms), with values ranging from a minimum of 456 ms to a maximum of 1.043 seconds and a standard deviation of 125 ms. The mean reaction time of non-players was slower than that of video game players. Non-players had a mean reaction time of 778 ms, ranging from a minimum of 466 ms to a maximum of 1.094 seconds and a standard deviation of 133 ms. To determine if these results reached statistical significance, a two-way between groups ANOVA was conducted. The results of this test are shown in section 5.3.3.

Table 2: Mean response times of video game players and non-players in seconds

Video game playing status		N	Minimum	Maximum	Mean	Std. Deviation
1 Video game player	Response time average	40	.456	1.043	.63717	.124898
2 Non-player	Response time average	40	.466	1.094	.77758	.133121

The second objective of this study was to explore the relationship between VSA, video game playing and gender. With this in mind, figure 17 shows the mean response time of video game players and non-players differentiated by gender. As previously mentioned, video game players had a faster reaction time than non-players. Male and female video game players had a similar reaction time of 639 ms and 635 ms respectively. Interestingly, the differences between male and female non-players were more noticeable than male and female players, with males having a reaction time of 806 ms and females having a reaction time of 746 ms.

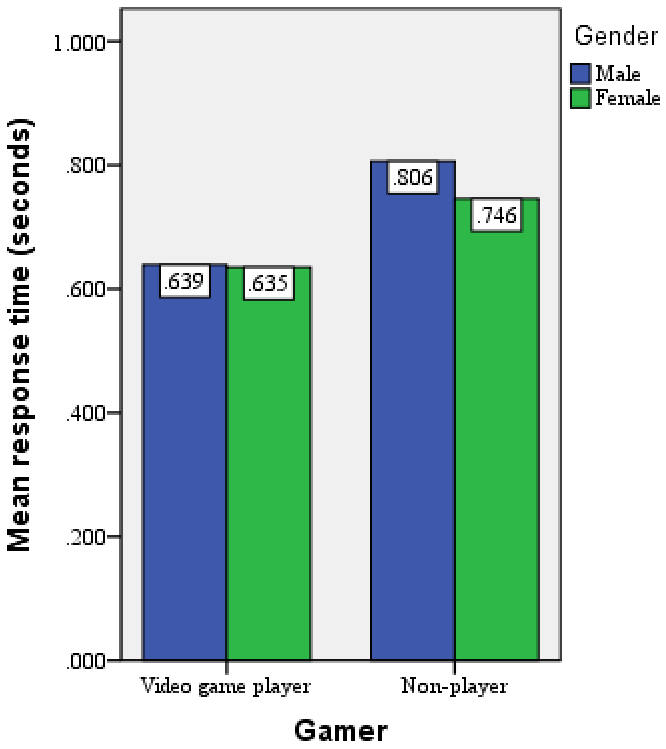

Figure 166. Mean response time in seconds of participants grouped by video game playing status and gender.

As shown in table 2 and figure 16, video game players had on average a faster reaction time, and thus, more advanced VSA abilities than non-players. A two-way between-groups ANOVA was conducted to determine if these observed differences reached statistical significance. The results of this analysis are shown in the following section.

5.3.2 Test assumptions. According to Pallant (2013), when conducting a two-way between-groups ANOVA, it is important to ensure that various test assumptions are adhered to. The first assumption refers to the fact that the data must be normally distributed. Secondly, the variability of scores for each group should be similar, referred to as homogeneity of variances. Statistical tests were conducted to determine if these two assumptions were adhered to in this study. The results of these tests are shown below.

5.3.2.1 Assumption 1: Normality of the data. To assess the normality of the data, a Kolmogorov-Smirnov test was conducted. The results of this test are shown in table 3. According to Pallant (2013), a non-significant result indicates that the data is normally distributed. In this study, the test was not significant (p = .20), indicating that the data was normally distributed.

Table 3: Kolmogorov-Smirnov normality test

	Kolmogorov-Smirnov		
	Statistic	df	Sig.
Response time average	.077	80	.200*

*. This is a lower bound of the true significance.

5.3.2.2 Assumption 2: Homogeneity of variances. To determine if the groups in this study had similar variances, Levene's test of equality of error variances was conducted. As with the Kolmogorov-Smirnov test, a non-significant result indicates that the homogeneity of variances assumption has not been violated (Gastwirth, Gel, & Miao, 2009). In this study, the test was not significant (p = .67), indicating that the assumption was not violated. This is shown in table 4.

Table 4: Levene's test of equality of error variances

Dependent Variable: Response time average

F	df1	df2	Sig.
.526	3	76	.666

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

5.3.3 Two-way between groups ANOVA. Considering that the assumptions of normality and homogeneity of variances were met, a two-way between-groups ANOVA (Table 5) was conducted to explore the impact of video game playing and gender on VSA, as measured by the Stroop task. According to Pallant (2013), when conducting a two-way between groups ANOVA, the main effects can only be interpreted if the test proves that there were no interaction effects between the variables included. In this study, it was found that the interaction effect between video game playing and gender, $F(1, 76) = .97$, $p = .33$, was not statistically significant. Therefore, in the current study, the variable of gender did not influence the manner in which video game playing affects an individual's VSA. The main effect for gender, $F(1, 76) = 1.25$, $p = .27$, also did not reach statistical significance, meaning that males and females did not report statistically significant differences in VSA. There was, however, a statistically significant main effect for video game playing, $F(1, 76) = 23.19$, $p < .001$, with a large effect size ($\eta^2_{partial} = .24$). This result shows that there was a statistically significant difference in the VSA of video game players and non-players. Video game players therefore exhibited more advanced VSA abilities compared to non-players. Furthermore, according to Cohen's (1988) criteria, the effect size of this result can be considered large, meaning that the actual differences in the VSA mean values between video game players and non-players were large. Refer to table 5 for the results of this analysis.

Table 5: Two-way between-groups ANOVA

Dependent Variable: Response time average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.431[a]	3	.144	8.645	.000	.254
Intercept	39.895	1	39.895	2401.008	.000	.969
Gender	.021	1	.021	1.246	.268	.016
Gamer	.385	1	.385	23.189	.000	.234
Gender * Gamer	.016	1	.016	.966	.329	.013
Error	1.263	76	.017			
Total	41.724	80				
Corrected Total	1.694	79				

a. R Squared = .254 (Adjusted R Squared = .225)

5.4 Chapter Summary

The results of the screening survey showed that all participants fell within the range of 18-25 years of age. Furthermore, half the sample consisted of video game players while the other half consisted of non-players. While there were slightly more males in the sample, both genders were equally represented. Finally, with regard to the sample's highest level of completed education, most participants had completed Grade 12. These results are in line with expectations as quota sampling was utilised to ensure that the sample equally represented the variables of gender and video game playing status. With regard to the video game players in the sample, the majority of video game players played an average of 6-15 hours a week. The mean number of years having played video games was 9.6 years. The preferred gaming platform was a desktop PC, followed by gaming consoles such as PlayStation or Xbox. Most video game players in the sample preferred games that they considered to be "fast-paced and exciting". Finally, the preferred video game genre was split between MMORPG and FPS games.

Once the researcher had ascertained that the assumptions underlying a two-way between-groups ANOVA had been met, the statistical test was carried out to investigate the effects of video game playing on VSA. Results indicated that a participant's video game playing status did prove to be statistically significant with a large effect size. This indicated that, in this study, video game players had more advanced VSA abilities than non-players. To investigate if gender acted as a moderating variable with regard to the impact of video game playing on VSA, the possibility of an interaction effect was examined. There was no statistically significant interaction between video game playing and gender. Furthermore, the variable of gender did not have a statistically significant main effect on a participant's VSA. These results are discussed in the following chapter.

Chapter 6

Discussion, Limitations and Recommendations

The final chapter of this dissertation discusses the results presented in chapter five. The broad aim of this study was to investigate the effects of video game playing on visual selective attention (VSA). To achieve this aim, two primary objectives were identified. Firstly, to measure the difference in VSA between video game players and non-players using the Stroop task. Secondly, to explore the relationship between VSA, video game playing and gender. The demographic characteristics of the sample are briefly discussed to contextualise the study. To investigate the first objective, the following results are discussed: (a) the mean VSA scores of video game players and non-players as measured by the Stroop task, (b) the statistical significance of the main effect between video game playing and VSA as determined by the results of the two-way between groups ANOVA, and (c) the influence of a participant's video game playing habits on their VSA performance. To investigate the second objective, the main and interaction effects between video game playing and gender, as determined by the two-way between groups ANOVA, are discussed. Finally, the various limitations of this study are presented while also offering recommendations for areas of research that require further investigation.

6.1 Demographic Characteristics of the Sample

The age, gender, level of education, and video game playing status of participants were directly influenced and controlled by means of quota sampling in this study. In line with this study's sample requirements, participants were required to be in early adulthood. Therefore, the age of participants ranged from 18 to 25 years. Within this margin, the mean age of participants in the sample was 21.3 years. Due to the age limitation, it is understandable that most participants in the sample had not yet completed a Bachelor's or

Honours degree. Furthermore, the age limitation is a possible explanation for the highest level of completed education of most participants (80%) being Grade 12.

6.2 The Effects of Video Game Playing on VSA

Participants' reaction time on the computerised Stroop task gave an indication of their VSA. Results showed that regular video game players had a faster reaction time—and thus, more advanced VSA skills—than individuals who did not regularly play video games. Video game players had a mean response time of 637 ms while non-players had a mean response time of 777 ms. This shows that video game players were on average 140 ms faster than non-players. When interpreting the results of reaction time experiments, Tønnessen, Haugen, and Shalfawi (2013) highlighted the significance of minor differences in reaction time scores: A reaction time that varies by 100 ms or even 10 ms may have a profound impact on the outcome of a task, in some instances determining success or failure. Therefore, according to Tønnessen et al. (2013), the response time difference of 140 ms observed in this study may be regarded as a notable difference.

The results of the two-way between groups ANOVA showed that participants' video game playing status had a statistically significant main effect ($p < .001$) on their VSA. This means that there were statistically significant differences between the VSA of video game players and non-players in early adulthood. Furthermore, according to guidelines proposed by Cohen (1988), the effect size ($\eta^2_{partial} = .24$) of this result was very large. This finding corresponds with a large number of previous studies that found that video game players tend to have superior cognitive abilities compared to non-players, specifically with regard to heightened attentional skills (Annetta et al., 2009; Bavelier et al., 2012; Cohen et al., 2007; Dye & Bavelier, 2010; Feng et al., 2007; Granic et al., 2014; Green & Bavelier, 2003, 2006a, 2006b; Spence et al., 2009; Tobias and Fletcher, 2011; West et al., 2008; Wilms et al., 2013).

As discussed in the second chapter, research on video gaming often focuses on the negative effects of game play. However, the results of this study, as well as a number of other studies (Ewoldsen et al., 2012; Gentile & Gentile, 2008; Gentile et al., 2009; Russoniello et al., 2009; Ryan et al., 2006), suggest that video game playing also has beneficial effects on the player, including faster reaction times and improved VSA abilities. Although it cannot be definitely stated due to the limitations of this study, the statistically significant difference in reaction time between video game players and non-players suggests that video game playing might play a role in improving VSA. This is in line with research by Green and Bavelier (2003) who found that video game play improves reaction times across a variety of cognitive tasks. Furthermore, according to Bavelier et al. (2012), video game players have increased VSA skills compared to non-players. The results of this study further support these findings, suggesting that video game playing results in improved VSA skills.

Interpreting these results in the context of the Theory of Visual Attention (TVA), the results of this study may be due to video game players having an advanced ability to select and encode relevant stimuli into visual short-term memory (VSTM). As discussed in section 4.4.2, to efficiently complete the Stroop task, participants are required to supress irrelevant and distracting stimuli. The finding that video game players had a faster reaction time compared to non-players therefore suggests that video game players were more skilled at supressing irrelevant stimuli than non-players. One possible explanation for this improved ability to supress distractors is that, as a result of their exposure to video games, video game players may have been better at assigning attentional weightings to the stimuli that was relevant to the task at hand. This suggests that video game players supress irrelevant information more efficiently than non-players, which results in faster reaction times for video game players.

6.2.1 Influence of video game playing habits on VSA. The influence of a participant's video game playing habits is discussed below. Most video game players (35%) in this sample played an average of six to ten hours of video games a week. Furthermore, 58% of video game players stated that they played between 11 and 21+ hours of video games a week. This is well above the criteria of an expert video game player, which Boot et al. (2008) defined as a minimum of 7 hours per week. The mean number of years spent playing video games was nearly 10 years. This is noteworthy because long-term, expert video game players have been shown to outperform non-players on various measures of attention, such as reaction time tasks and measures of selective attention (Boot et al., 2008). Furthermore, expert video game players have been shown to have significantly faster reaction times than non-players (Castel, Pratt, & Drummond, 2005). Considering that a large proportion (58%) of video game players in this study qualified as experts and were long-term players, this may explain why video game players had statistically significant better VSA skills than non-players.

The majority of video game players in the sample (85%) listed "fast-paced and exciting" games as their preferred game type. According to Green and Bavelier (2003), fast-paced, immersive video games have been shown to result in "marked improvements" (p. 534) in an individual's VSA. This improvement in VSA is because fast-paced and exciting games train the player to supress distracting and irrelevant stimuli (Bavelier et al., 2012). The fact that most (85%) participants in this study played games that were fast-paced and exciting may explain why video game players exhibited more advanced VSA abilities compared to non-players as measured by the Stroop task. Although this cannot be definitely stated due to the limitations of the study, the results of this study suggest that fast-paced and exciting games enhance the player’s ability to supress irrelevant stimuli, and in turn, improve VSA.

This finding aligns with previous research on the effects of fast-paced and exciting games (Bavelier et al., 2012; Green & Bavelier, 2003, 2006a, 2006b, 2007).

While the effect that different video game genres have on the player has been investigated, most of these studies tend to focus on violent video games and their apparent link to aggression (Anderson, & Bushman, 2001; Elliott, Golub, Ream, & Dunlap, 2012; Sherry, 2001). With regard to how video games affect the player's attention, these previous studies often focus primarily on action video games (Green & Bavelier, 2007). This is because, according to Achtman et al. (2008), action video games appear to be most effective in the development of visual cognition skills such as mental rotation and attention. The results of the current study showed that 60% of video game players preferred games that were not considered to be "action" video games as defined by Green and Bavelier (2006a), such as massively multiplayer online role-playing games (MMORPG), strategy games, simulation games, and sport games. The remaining 40% preferred games that could be considered "action" video games such as first-person shooters and multiplayer online battle arenas (MOBA). Despite the fact that most of the sample did not play games that are generally considered to be "action" games, video game players had statistically significant more advanced VSA skills than non-players. This finding may suggest that video games of various genres and not simply action video games, train and improve the player's VSA.

6.3 VSA Scores and Gender

When exploring the relationship between video game playing and gender, it appeared that there were differences between male and female non-players. Male non-players had a mean response time of 806 ms while female non-players had a mean response time of 746 ms. Considering that a lower response time indicates a faster reaction, female non-players were on average 60 ms faster than male non-players. The faster response times of female non-players over male non-players observed in this study contradicts findings by Merritt et al. (2007), who found that males showed an advantage in a variety of visual-spatial tasks. According to Merritt et al. (2007), males are less proficient at inhibiting an uncued stimulus, meaning that they tend to broadly search a visual field and expect to perceive a stimulus across a broader field of vision than females. While this lack of inhibition may increase distractibility, it also results in faster reaction times due to a sense of readiness that females do not demonstrate. As a result, males tend to outperform females in some tests of VSA (Merritt et al., 2007). The differences between male and female video game players were less pronounced, with male video game players having a mean response time of 639 ms and female video game players having a mean response time of 635 ms. Therefore, female video game players' responses were only 4 ms faster than male video game players' response time. Although female participants in this study—both video game players and non-players—had a faster mean reaction time than males, this difference did not reach statistical significance ($p = .27$).

The results of the two-way between groups ANOVA showed that there was no interaction effect ($p = .33$) between gender and video game playing on VSA. This means that, in this study, a participant's gender did not influence the manner in which video game playing affected their VSA. This result contradicts findings by Ferguson and Olson (2013) who argued that a participant's gender has a profound impact on how a person's cognition is affected by video game play and should therefore always be included in studies involving video game research. Furthermore, the results of this study are in stark contrast to the findings of Feng et al. (2007), who found that video game playing reduces gender differences with regard to attentional performance. Feng et al. (2007) stated that females responded most positively to video game training compared to males, with females showing greater attentional improvements after having had exposure to video games. In this study, there may also have been other moderating variables that gave rise to this result. For example, due to the fact that participants were invited to participate in the study, it may be that only individuals who were interested in video games—whether they played video games or not—were willing to participate. This would result in a sample that neglects those individuals who show little interest in video games or general technology. Furthermore, the research by Ferguson and Olson (2013) and Feng et al. (2007) listed above was conducted in developed countries, where access to video game playing is more widespread than in South Africa. These methodological differences may have had an influence on the results of the study and may be the reason for the results of this study not aligning with the previous research mentioned.

6.4 Conclusion

The primary objective of this study was to measure the difference in VSA between video game players and non-players. To achieve this, a quantitative design was implemented to test the effects of video game playing on an individual's VSA. Results showed that there was a statistically significant difference between the VSA of video game players and non-players. A secondary objective of this study was to investigate the effects of gender on an individual's VSA. The variable of gender did not have a statistically significant impact on a participant's VSA. Furthermore, there was no interaction effect between video game playing status and gender on a participant's VSA. This finding does not align with previous research. This study may provide insight into the manner in which video game playing affects adult players. As mentioned, many studies that investigate the effects of video game play utilise an adolescent sample, while the sample in this study consisted of participants in early adulthood. The results of this study suggest that video games improve the VSA of the player. However, this is an area that requires more research before definitive claims can be made. This is particularly significant in a context as diverse and multi-cultural as South Africa.

6.5 Limitations of the Current Study

The results of this study show that video game players have statistically significant more advanced VSA skills than non-players. However, there are various limitations to this study that should be acknowledged. The sample was drawn from students enrolled for psychology modules at the University of Pretoria. Furthermore, the sample was obtained using quota sampling. Therefore, the representativeness of the sample may have been compromised. As a result, it is difficult to generalise the results of this study to the greater South African context (Gravetter and Forzano, 2012).

Another limitation is that the current study did not account for the possibility of attentional or neurological disorders, such as attention-deficit/hyperactivity disorder (ADHD). The possibility exists that video game players with attentional or neurological disorders may respond differently to the effects of video games than individuals whose attentional abilities are not negatively influenced by these conditions, as suggested by Bioulac et al. (2008). Considering that participants were not screened for attentional or neurological disorders, these aspects may have had an influence on the outcome of the study.

The sample size of the study is another limitation. Each of the four sub-groups utilised in the study had a relatively small sample size. As mentioned by Shadish et al. (2002), the power of a statistical test is influenced by a small sample size. This may have resulted in low statistical power, which in turn, may have impacted the statistical conclusion validity of the study.

The final limitation to be discussed relates to the current study's reliance on self-reporting. During the first phase of the research, participants were screened for participation using a survey research design. As mentioned by Gravetter and Forzano (2012), the survey research design is particularly susceptible to self-reporting biases, where participants either distort or falsify their responses. For example, the survey asked participants if they preferred games that are “faced-paced and exciting” or “relaxed and casual”. Different participants may have had different perceptions of "fast-paced" games, making it difficult to define the nature of the games that each participant preferred to play.

6.6 Recommendations for Further Research

It is suggested that future studies investigating the effects of video game playing on VSA take the rich cultural context of South Africa into account, by placing greater emphasis on issues such as socio-economic status and access to infrastructure, such as the internet. This would not only broaden the scope of local research, but would also take the unique challenges and contexts of South Africans into account. Greater emphasis could also be placed on how the participants’ age and video game playing status affect their VSA. In this study, video game players in early adulthood had statistically significant more advanced VSA skills than non-players of the same age group. This aligns with prior research conducted on an adolescent sample (Dye et al., 2009). Researching this issue, while also incorporating different age groups, may provide interesting insights into how video game playing affects the VSA of individuals across different stages of their lives.

Considering that research has shown that different video game genres affect the cognitive abilities of players in different ways (Pearce, 2008; Nap, de Kort, & Isselsteijn, 2009; McKay & Maki, 2010), greater emphasis could be placed on how the player’s preferred game genre–action games compared to violent games, for example–affects the VSA of the player. With regard to the methodological aspects of the study, it is recommended that future studies should ideally make use of a random sampling strategy that incorporates individuals from a variety of settings. This would most likely minimise or eliminate the limitations that arose in this study due to the use of non-random sampling. Furthermore, a larger sample size should be utilised to increase statistical power and improve statistical conclusion validity.

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Appendix A: Hardcopy version of the electronic survey

Research study: The effects of video gaming on visual selective attention in early adulthood

PARTICIPANT SURVEY

For office use only
Participant I.D.: ____

This survey consists of various questions regarding your demographics and video gaming habits. If you play video games, please complete Section A, B, and C. If you do not play video games, please only complete Section A and C.

Please note that this is not an evaluation, and your responses will remain confidential. Please answer as truthfully as possible.

Section A

1. What is your age in years?

____

2. What is your gender?

- o Male
- o Female

3. What is the highest level of education which you have completed?

- o Matric (Grade 12; Standard 10)
- o Bachelor's Degree
- o Honours Degree
- o Masters Degree
- o PhD

4. Do you regularly play video games (at least five hours a week)?

- o Yes
- o No

If you answered "no" to question 4, kindly skip to Section C.

Section B

5. On average, how many hours a week do you spend playing video games?

- o 5
- o 6-10
- o 11-15
- o 16-20
- o 21+

6. For how many years have you been playing video games?

____

7. Which of these platforms do you most frequently game on (select only one)?

- o Desktop computer (PC)
- o Consoles (Xbox, Playstation, Wii etc.)
- o Handheld consoles (PSP, Nintendo DS etc.)
- o Cellular device
- o Other (please specify): ___________

8. Which of these options best describes the type of games you generally play?

- o Fast-paced and exciting
- o Relaxed and casual

9. Which game genre do you most enjoy playing (select only one)?

- o Massively multiplayer online role-playing game (MMORPG)
- o First-person shooter
- o Strategy
- o Multiplayer online battle arena (MOBA)
- o Simulation
- o Sport
- o Other (Please specify): _______

10. Please list the name(s) of the game(s) you most commonly play:

____

____

Section C

Thank you for completing this questionnaire. Please provide your contact details in the space below to allow the researcher to contact you for further participation in the study. This information will remain strictly confidential. Only the researcher will have access to this information and it will not be used for any purpose other than to contact you for further participation in this research study.

Name/pseudonym: ___________________

E-mail address: ___________________

Contact number: ___________________

Signature: ___________________

Thank you for your participation!

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Humanities
Department of Psychology

Appendix B: Announcement sent via ClickUP

Dear students

My name is Michael Matern and I am currently an MA Research Psychology student at the University of Pretoria. I am currently conducting research on the effects of video game playing on visual selective attention in early adulthood. I would therefore like to invite anyone between the ages of 18 and 25 to participate in my research. Both video game players and non-players are encouraged to participate. Participation includes the following:

- A short questionnaire that will examine your video game playing habits. You will be asked to provide your contact details to allow the researcher to contact you for further participation in the study. Please note that your details will not be shared with anyone and will only be seen by the researcher.
- A short computer task that will test your visual selective attention. The researcher will contact you to schedule a session. A session should not take longer than 10 minutes to complete.

Please find the link to the questionnaire below. The link is PC and mobile-friendly:

https://pretoria.eu.qualtrics.com/SE/?SID=SV_aVsbrkqD0n3serTIV

If you would like further information regarding this study, please click the link to view the consent form or contact Michael Matern at michaelfrankmatern@gmail.com

Thank you for your time.

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Appendix C: Informed consent form

INFORMED CONSENT FORM

RESEARCH STUDY:

The effects of video gaming on visual selective attention in early adulthood

Please read through this consent form carefully before committing to participate in this study.

By signing this consent form, I acknowledge and agree to the following:

- I understand that there are no risks involved in this study and that I am free to withdraw at any stage during the research.
- I agree to complete the questionnaire and participate in the computer task.
- I understand that the researcher may or may not contact me in order to complete the second phase of the research by participating in a computer task.
- I have willingly provided my contact details to the researcher.
- I understand that my personal information will be kept confidential and will only be used by the researcher to contact participants with regard to this particular study.
- I understand that my participation will remain confidential and that my personal information will in no way be included in the analysis of the data.
- I understand that the resulting data will be stored for 15 years at the Department of Psychology, and consent to the use of this data for further research.

Participant signature ____________ **Researcher signature** ____________

Date ____________ **Date** ____________

Thank you for your participation!

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