2009

Autonomic response and behavioral performance of avid video game players on a decision-making task

Patrick Clinton Lingenfelter
Louisiana State University and Agricultural and Mechanical College, plinge1@tigers.lsu.edu

AUTONOMIC RESPONSE AND BEHAVIORAL PERFORMANCE OF AVID VIDEO GAME PLAYERS ON A DECISION-MAKING TASK

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Arts

in

The Department of Psychology

by

Patrick Lingenfelter
B.A., Nicholls State University, 2004
May, 2009

Table of Contents

Abstract

Avid video gaming is proposed as a term for individuals that play video games for prolonged periods of time. These individuals were predicted to show similar performance on a MineHunter, an analogue to the Iowa Gambling Task, comparable to the performance of pathological gamblers reported in the literature. Comparisons have been made between gamblers and video gamers based on similarities in the interaction level of the activity, as well as similarities in demographics and reported detriments in social and employment areas. The results of the study do not support a comparison. Avid gaming may be a hobby rather than a psychopathology like pathological gambling. The study does provide support for the use of MineHunter instrument. Advantages, limitations, and potential improvements for MineHunter are discussed.

Introduction

Video Game 'Addiction'

The concept of video game "addiction" was proposed as a diagnosis for individuals that play video games for long periods of time at the expense of financial, educational, and/or social responsibilities (Charlton, 2002; Griffiths & Davies, 2005; Soper & Miller, 1983). At present, detrimental video game play is not specifically classified in the DSM-IV (APA, 2000). Soper and Miller (1983) compared excessive video game playing to impulse control disorders such as pathological gambling. Video game play and gambling do share superficial qualities and a review of the literature lends support to the idea that those who play video games to their detriment may share qualities with problem gamblers. As pathological gambling is classified in the DSM-IV and has been researched more extensively, examining possible similarities may aid in properly classifying detrimental avid gaming. This in turn could aid in assessment and treatment of those individuals suffering negative consequences due to their video gaming habits.

Similarities between Video Gaming and Gambling

Studies have compared playing video games and gambling, especially slot machine gambling (Griffiths, 1991; Griffiths, 2005; Johansson & Gotestam, 2004). Both slot machines and video gaming involve a player physically interacting with the machine and provide visual and auditory stimuli. Although video games typically lack a potential financial reward for continued play, the accumulation of points or other achievements within a video game may be comparable to the accumulation of money in gambling activities (Griffiths, 1991, 2005). Griffiths (2005) theorized that the goal for both video games (specifically arcade games) and slot machines is maximizing the time spent playing while minimizing the financial cost. The money won in slot machines may be a way to continue playing rather than the goal of the player (Griffiths, 2005).

There are noted demographic similarities between the most common players of video games and slot machines, after accounting for legal restrictions on gambling. Because United States law prohibits gambling by minors, comparing the typical age range of video game players to that of gamblers is difficult. In the United Kingdom, where teenagers are legally allowed to play slot machines, teenage males make up the largest percentage of players of both video games and slot machines (Griffiths, 1991, 2005).

Video Gaming

Demographics of Video Game Players

Males are the most common video game players (Chiu, Lee, & Huang, 2004; Griffiths, 1991; McLure & Mears, 1984; Phillips, Rolls, Rouse, & Griffiths, 1995). Recent studies have reported an increasing proportion of players are post-adolescent with the majority of players found between the ages of 17 and 22 (Charlton & Danforth, 2007; Griffiths, Davies, & Chappell, 2004). These players reported playing in adolescence, indicating that for some gamers, video game play is a persistent behavior from youth into adulthood (Griffiths, Davies, & Chappell, 2004).

Although males were the most common gamers in studies, there was an increased number of female players in more recent studies (Charlton & Danforth, 2007; Griffiths, Davies, & Chappell, 2003; Ng & Weimar-Hastings, 2005). Researchers theorized that a growing number of games are successfully marketed toward females by focusing on less violent game objectives and more on social activities within games (Charlton & Danforth, 2007; Griffiths, Davies, & Chappell, 2003; Ng & Weimar-Hastings, 2005).

Game Type

While “video game” is used as a blanket term, there are different types of games (Apperley, 2006; Bailey & Barbato, 2007; Wood, Griffiths, Chappell, & Davies; 2004). While the sheer number of video games would make exhaustive definition unfeasible, broad categories have been used in published reports and popular media to differentiate games with different play styles (Apperley, 2006; Bailey & Barbato, 2007). Four broad categories were suggested by Apperley (2006). Simulation games imitate real-world activities such as sports, racing, driving, or managing a business or city. Games of the Strategy-type draw inspiration from board games and have the player working from a distant perspective and utilizing planning and tactics to achieve game objectives. Such games often have a military focus. Action games are fast-paced games in which a player maneuvers a single character around an environment, fighting enemies and passing obstacles. Role-playing games have characters that gain new game abilities as the game progresses. Role playing games typically allow players to make decisions about their character’s development. Individual games may blend elements of these genres and thus it can be difficult to properly classify a game into a single genre (Apperley, 2006). A game may be based around racing cars (Simulation) but also allow players to customize their car (Role playing game) or attack other cars (Action). Games may also vary in allowing only a single player or by allowing multiple players to either work together or compete against one another towards goals of the game. Like gambling tasks, there is a large variety of video game styles available to suit the preferences of the individual player.

One style of game that has received considerable attention is the massive multiplayer online role playing game. These are a relatively new type of video game, first appearing in the early 1990s (Bailey & Barbato, 2007). In such games, players typically pay a monthly fee in order to play in a game environment shared with many other players. Like other role playing games, player-controlled characters improve over the course of game play. Players can create one or more characters to represent themselves within the game world. Game worlds are persistent and individuals may join with other players to cooperate or compete in completion of game tasks. Players can communicate with one another through text using a keyboard or through voice using microphones (Bailey & Barbato, 2007).

Studies have compared massive multiplayer online role playing games to other types of video game (Charlton, 2002; Chiu, Lee, & Huang, 2004; Griffiths, Davies, & Chappel, 2003; Ng & Weimar-Hastings, 2005). Ng and Weimar-Hastings (2005) found that, on average, MMORPG players spent significantly more time playing than those that preferred to play other video games. Eleven percent of these players reported playing over 40 hours a week (the maximum amount recorded in the study) compared to only two percent of other players.

Autonomic Responses to Video Games

Because of the prevalence of video games, research has examined the effects of video games on players. Turner, Carroll, & Courtney (1983) studied cardiovascular reactions of participants playing a "Space Invaders" game design. This design, based on a common type of early video game, involves players maneuvering an icon representing a weapon and attempting to destroy a series of enemy icons as they descend the screen (Turner et al., 1983). The researchers found that this game evoked an increase in heart rate and respiration greater than the physical requirements of playing the game. The increases were not present when individuals performed similar physical actions but were unable to affect the game (Turner et al, 1983).

Physiological changes following in-game consequences vary between subjects (Griffiths & Dancaster, 1995). These responses correspond to self-reported measures of emotional state as well as positive and negative events within video games (Griffiths & Dancaster, 1995; van Reekum, Johnstone, Banse, Etter, Wehrle, & Scherer, 2004; Turner et al., 1983). Events can result in feelings of joy, sadness, and anger and accompanying physiological states (Griffiths, 1991; Grusser, Thaleman, & Griffiths, 2007; van Reekum, Johnstone, Banse, Etter, Wehrle, & Scherer, 2004; Turner et al., 1983).

Video Games and Aggression

Since video game play can affect emotional state, video game playing has been examined for a link to aggression (Griffiths, 1991; Grusser, Thaleman, & Griffiths, 2007). Video games often depict violent situations and sometimes require violent solutions and actions from the player in order to progress in the game. These qualities have been theorized to lead to real-world aggression and violence in players (Bailey & Barbato, 2007). The literature has not supported the connection (Griffiths, 1991; Grusser, Thaleman, & Griffiths, 2007; Williams & Skoric, 2005). Statistically removing other factors that lead to aggression eliminates any significant effect of video games alone on aggression (Griffiths, 1991; Grusser, Thaleman, & Griffiths, 2007). Playing video games was not significantly correlated with aggression or other psychopathology diagnoses (Griffiths, 1991).

Consequences of Avid Gaming

The majority of players do not experience significant negative consequences from playing video games (Charlton, 2002; Charlton & Danforth, 2007; Chiu, Lee, & Huang, 2004; etc). Video game playing does not have direct health effects comparable to substance-use or a risk of financial loss comparable to gambling but, excessive gaming can lead to problems for some individuals. While research has not demonstrated co-morbidity with other psychopathology, a minority of video game players do show qualities similar to those suffering from other impulse control disorders (Griffiths, 1991). Individuals may play to cope with real-life pressures and use lunch money to play (McClure & Mears, 1984), give up other leisure activities (Egli & Meyers, 1984), associate only with other gamers, and experience cognitive and physiological 'withdrawal' symptoms (Soper & Miller, 1983). While extremely rare, there have been documented cases of individuals playing video games to the point of suffering serious health complications or even death (BBC, 2005). However, different studies have not agreed on a consistent way to assess detrimental video game play among a general population.

Phillips and colleagues (1995) theorized that the increasingly detailed graphics along with the increased involvement required for success in games, create a significant risk of addiction among some players, particularly children. They hypothesized that the realism and investment of time and effort may lead to a potentially detrimental attachment to video games. The researchers examined the playing habits of children between 11 and 16 using a questionnaire asking about time spent playing as well as reasons for playing and consequences of playing. From their findings, the researchers estimated 5-7% of the sample met the qualifications for gaming dependence (Phillips et al., 1995). While many children reported that they sometimes played more than they intended, the majority also reported that they did not neglect responsibilities and that they played purely for enjoyment. Of those that neglected their responsibilities, the majority reported playing to avoid doing other activities rather than just for fun. For some players, video games may be more of an escape or dependence rather than just a pleasurable past-time (Phillips et al., 1995).

Engagement and Addiction

It is difficult to determine whether an individual has an impulse control disorder or simply enjoys playing video games. To differentiate compulsive behavior from playing for enjoyment, Charlton (2002) conducted a factor analysis of items from a computer gaming dependence scale. Charlton theorized that earlier measures of gaming dependence were overestimating the prevalence of the disorder by including individuals that were highly engaged but not addicted.

Charlton's analysis used Brown's theory of behavioral addiction (1991). Brown created six criteria defining addictions. Salience represents when an activity is a major part of a person's life. Tolerance is the need to engage in an activity more in order to gain the same enjoyment of earlier experiences with the activity. Euphoria is the positive affect experienced when performing an activity. Withdrawal is the negative affect and/or physiological state experienced when an individual is unable to perform the activity. Relapse is experienced when an individual resumes habits following a period of abstention. Finally, conflict represents fighting with others as a result of participating in the activity (Brown, 1991).

Charlton (2002) utilized a questionnaire based on Brown's theory and found that the questions loaded on two primary factors. Items were divided into those representing engagement with video games and those representing addiction. Engagement referred only to preference and included items such as "I feel happy at the thought of using a computer" and "When I see a computer I feel drawn to it" (Charlton, 2002). Addiction items included negative consequences such as "I am sometimes late for engagements because of my computer activities" and "Arguments have sometimes arisen at home because of the time I spend on computing activities"

(Charlton, 2002). Some items were noted to load on both factors but the majority was found to load primarily on a single factor.

The factors were then used by Charlton and Danforth (2007) to measure the levels of behavioral addiction among game players. Ten items chosen to represent addiction were used within a survey administered to players of an MMORPG with a cut-off point of five or more positive responses to the ten questions. With this criterion, the researchers found that video game dependence was present among 38.7% of the participants. This number is not necessarily comparable to the population at large as the sample was drawn exclusively from players of a MMORPG. Subjects were recruited through a webpage directly related to the game. Researchers theorized that visiting the webpage implied that the participants were more interested in the game than other players. The researchers used the criteria in a post-hoc analysis of a previous study with a more diverse sample taking the same survey and found 1.8% of respondents met the qualification of addiction when they excluded items related primarily to engagement (Charlton & Danforth, 2007). The results of the study suggest that while most players do not show significant signs of impulse control disorder, some individuals play to the point of experiencing detrimental consequences.

Griffiths (2005) grouped excessive video gaming with excessive slot machine playing, excessive use of the internet, and excessive television watching under the category of "technological addictions." In a broad sense, the technological addictions are similar to Brown's (1997) behavioral addictions but are limited exclusively to activities using technological devices. Griffiths (2005) created six criteria to define a technology-based behavior as an addiction: salience, mood modification, tolerance, withdrawal symptoms, conflict, and relapse (Griffiths, 2005). Griffiths defined salience, tolerance, conflict, relapse, and withdrawal in a similar manner to Brown (1991) but did not include euphoria. Mood modification included positive affect similar to euphoria but also includes other moods such as sadness or anger.

Different studies have reported very different levels of gaming “addiction” (Charlton & Danforth, 2007; Fisher, 1994; Griffiths & Hunt, 1995). Statistics ranged from 2% of video gamer players (Charlton & Danforth, 2007) to 20% of adolescents (Griffiths & Hunt, 1998) and 39% of massive multiplayer online role playing game players (Charlton & Danforth, 2007). It is difficult to be certain how prevalent video game “addiction” is among the population. Literature has found that time spent playing was significantly positively correlated with impulse control issues and detrimental consequences (Charlton & Danforth, 2007; Fisher, 1994; Griffiths & Hunt, 1995, etc.)

Classifying excessive video game play as an impulse control disorder requires that the behavior meet other criteria. As noted by Griffiths (1991, 2005), video game play shares qualities with gambling. Thus, it may be fruitful to examine video gaming for similarity to pathological gambling.

Pathological Gambling

Pathological gambling is the continuation of gambling behavior in spite of potentially damaging consequences and/or an individual’s desire to stop. The DSM-IV classifies pathological gambling as an impulse control disorder, requiring that the individual engage in gambling behavior while displaying one or more of the following criteria: preoccupation with gambling, tolerance in the positive emotional and physiological reaction following a win, withdrawal-like symptoms after stopping gambling behavior, gambling in order to escape real-life problems, chasing, lying about one’s gambling behavior, loss of control in gambling behavior, performing illegal acts to support the behavior, damage to relationships, and requiring financial assistance due to problems resulting from the behavior. Chasing, also known as "chasing losses" is a tendency among some gamblers to continue gambling following a loss in the belief that one will regain lost money (Breen & Zuckerman, 1999; Dickerson, Hinchy, & Fabre, 1987). Meeting five of the eight criteria is considered to be a diagnosis of pathological gambling (APA, 2000).

Potenza (2006) studied pathological gambling using criteria similar to those used for addictions. These criteria were similar to Brown's (1991) and Griffith's (2005) theories of behavioral addictions and included ideas of tolerance and withdrawal. Wray and Dickerson (1981) studied 'withdrawal' among pathological gamblers that had stopped gambling. A minority of those surveyed did report some irritation and/or agitation but no direct physiological assessment was used (Wray & Dickerson, 1981). Similar findings were found by Griffiths (2005) in his study of video gaming addiction. Video gaming and gambling are both able to provoke a variety of addiction-like experiences and behaviors in some individuals according to the literature. Considering these similarities, avid gamers may be expected to show qualities similar to pathological gamblers in other areas.

Somatic Markers

If pathological gamblers continue to perform behaviors with possible negative consequence despite recognizing the risk, they may be experiencing disruption of somatic responses. Damasio's (1996) somatic marker hypothesis explains decision-making through physiological responses to different stimuli. These are divided into primary inducers which are stimuli within the immediate environment and secondary inducers which result from thoughts or memories. Conflicts between these inducers determine decisions (Bechara, 2003). Somatic markers are attached to stimuli to aid in determining advantageous and disadvantageous conditions and anticipate results (Bechara & Damasio, 2002; Bechara, Dolan, & Hindes, 2002). When markers are not present, situations may not be properly assessed, disadvantageous decisions may be made, and damaging behaviors may persevere. Ventromedial prefrontal cortex is involved in this process. Damage to this area has been documented to result in poor decision making and a lack of sensitivity to consequences (Bechara, Damasio, Damasio, & Anderson, 1994; Bechara, Dolan, Denburg, Hindes, Anderson, & Nathan, 2001; Bechara, Dolan, & Hindes, 2002; Bechara, Damasio, Tranel, & Damasio, 2005).

The Iowa Gambling Task

Bechara & Damasio (2002) developed the Iowa Gambling Task in order to study persons with dysfunction of the ventromedial prefrontal cortex. In the Iowa Gambling Task, subjects are asked to draw a card from one of four decks of cards. Each draw usually results in a gain of money but occasionally results in an unpredictable loss of money. In two decks (advantageous), each card drawn from the deck is worth a relatively small amount of money while the loss is also small. In the other two decks (disadvantageous), each card is worth significantly more but the loss is significantly greater as well and occurs more frequently. Over repeated draws, the advantageous decks yield a net gain in money while the disadvantageous decks produce a net loss. The subjects are not told which conditions are advantageous or disadvantageous prior to beginning the task.

Most control subjects showed a preference for choices from the advantageous decks even before they were able to consciously explain their preference (Bechara & Damasio, 2002; Bechara, Dolan, & Hindes, 2002). However, this tendency was not found for all controls (Lehto & Elorinne, 2003). Typically, individuals with ventromedial prefrontal cortex damage damage continued to draw from the disadvantageous deck, even after they consciously stated which deck provides a better chance of overall gain. The Iowa Gambling Task was used to examine decision making deficits among a number of different disorders, including alcohol dependence, Tourette's syndrome, and others (Goudriaan, Oosterlaan, de Beurs, & Van der Brink, 2004, 2005, 2006). Researchers found similar results in individuals with those disorders and individuals with VM damage.

Iowa Gambling Task and Pathological Gambling

Studies of pathological gamblers using the Iowa Gambling Task have found that pathological gambling correlates with poorer performance compared to control groups and other gamblers without a pathological gambling diagnosis (Bechara, 2003; Cavedini, Riboldi, Keller, D' Annuci, & Bellodi, 2002; Goudrian et al., 2005, 2006; Linnet, Rojskaer, Nygaard, & Maher, 2006). Pathological gamblers draw more cards from disadvantageous decks than advantageous decks. These subjects have similar dysfunction in their ability to make correct decisions with regard to future consequences in their lives (Bechara, 2003; Cavedini et al., 2002).

Goudriaan and colleagues (2004, 2005, 2006) examined the performances of pathological gamblers on the Iowa Gambling Task. Initially the researchers compared pathological gamblers' performance to that of individuals dependent on alcohol, individuals with Tourette syndrome, and a control group. They found pathological gamblers performed significantly poorer on the task. The pathological gamblers' performance was comparable to that of alcohol dependents. The pathological gambler group made significantly fewer selections from the advantageous decks than the controls and showed slower learning of the advantageous decks. One noteworthy finding of the study was that slot machine gamblers showed poorer decision making trends than table gamers. Additionally, pathological gamblers took longer to correctly identify advantageous conditions (Goudriaan et al., 2004, 2005, 2006; Kalechstein, Fong, Rosenthal, Davis, Vanto, & Newton, 2007) compared to controls or were unable to identify the advantageous decks at all.

Excessive video game playing can lead to negative consequences in various areas of life (Charlton, 2002; Charlton & Danforth, 2007; Chiu, Lee, & Huang, 2004; Egli & Myers, 1984; etc). Individuals diagnosed as pathological gamblers display similar problems in properly managing gambling behavior (Breen & Zuckerman, 1999; Wray & Dickerson, 1981) and researchers using the Iowa Gambling Task have theorized these issues may represent an inability to assess future consequences (Bechara & Damasio, 2002). If avid gamers have a similar limitation, then subjects should display poorer performance on the Iowa Gambling Task and similar tasks. They are expected to choose disadvantageous conditions more often than control groups or casual gamers.

Hypothesis 1: Avid Gamers will select advantageous conditions less often than nongamers and casual gamers.

Hypothesis 2: Avid Gamers will take longer to learn the advantageous condition than casual gamers and non-gamers

Autonomic Responses

Both gambling and playing video games have been noted to produce autonomic arousal in participants including changes in heart rate, skin conductance, and respiration independent of the physical activity involved in playing (Anderson & Brown, 1984; Coventry & Constable, 1999; Coventry & Norman, 1997; Griffiths & Dancaster, 1995). The level of arousal produced can vary between individuals, especially based on preference for and experience with the activity. Gamblers, especially those diagnosed with pathological gambling, show physiological responses to stimuli related to gambling. Pathological gamblers exposed to pictures of gambling devices, sounds of slot machines, videos of gambling activity, and similar stimuli demonstrate increases in heart rate (Anderson & Brown, 1984; Coventry & Constable, 1999; Coventry & Norman, 1997). Avid gamers have shown similar reactions to game-related stimuli such as sounds and images from video games (Griffiths & Dancaster, 1995; Griffiths & Davies, 2005).

Psychophysiological responses are somatic markers. During the Iowa Gambling Task, participants showed changes in heart rate (HR) and skin conductance response (SCR) (Bechara & Damasio, 2002; Bechara, Dolan, & Hindes, 2002; Goudriaan et al, 2006; etc). Patients with damage to the ventromedial prefrontal cortex have demonstrated different responses during the Iowa Gambling Task compared to controls (Bechara & Damasio, 2002; Bechara, Dolan, & Hindes, 2002). Other groups with performance similar to ventromedial prefrontal cortx – damaged patients on the Iowa Gambling Task also have similar psychophysiological responses (Bechara & Damasio, 2002; Bechara, Dolan, & Hindes, 2002; Goudriaan et al, 2006; etc).

Anticipatory Skin Conductance Response

In the literature, control subjects showed changes in SCR prior to selecting a card from the disadvantageous decks of the IGT (Bechara & Damasio, 2002; Bechara, Dolan, & Hindes, 2002; Goudriaan et al., 2006; etc). This anticipatory SCR occurred before participants consciously identified the decks as poor choices (Bechara & Damasio, 2002; Bechara, Dolan, & Hindes, 2002). These responses were theorized to be conditioned stimuli that aid in decision-making (Bechara, 2003).

Goudriaan et al. (2006) measured the autonomic responses of pathological gamblers and control subjects while the groups completed the Iowa Gambling Task. The pathological gambling group had significantly poorer performance. Measurement of the anticipatory SCRs of the two groups prior to selecting from a disadvantageous deck revealed that the control group had an anticipatory increase in SCR while the pathological gambling group did not. These findings may indicate that the pathological gambling group had a lack of sensitivity to the conditions likely to result in a future negative consequence (Bechara et al., 2002; Goudriaan et al., 2006.) Similarly, alcohol dependent individuals, and other groups with poor task performance do not generate anticipatory SCRs before making a selection from disadvantageous decks (Bechara & Damasio, 2002; Bechara, Dolan, & Hindes, 2002; Goudriaan et al,2006; etc).

If avid gaming represents an impulse control disorder comparable to pathological gambling, avid gamers should also demonstrate less of an anticipatory SCR prior to selection from a disadvantageous condition. The somatic marker hypothesis would attribute this to a reduced ability to anticipate the negative consequence of selecting a disadvantageous condition.

Hypothesis 3: Avid Gamers will demonstrate less of an anticipatory SCR prior to selecting a disadvantageous condition than casual gamers and nongamers.

Heart Rate

In examining pathological gambling performance on the Iowa Gambling Task, Goudriaan, et al. (2006) found significant differences in heart rate between pathological gamblers and controls following a positive result (gaining money). Following a win, the control group had an increase in heart rate and pathological gamblers did not. Goudriaan and colleagues (2006) theorized that this lack of an increase indicated a decreased sensitivity to reward. Some PG subjects may be insensitive to future consequences and insensitive to reward.

Avid gamers may also be less sensitive to reward. Therefore, they may display differences in heart rate following a successful result compared to nongamers and casual gamers. If avid gamers require greater stimulation, this might explain the preference for fast-paced and realistic games among most gamers (Wood et al., 2004). Individuals that play video games often would be expected to have experienced more victories in their playing and might be desensitized to victory.

Hypothesis 4: The heart rate response of Avid Gamers following a win will be less than the response of casual gamers and nongamers.

Current Study

For the present study, video games were defined as any form of interactive entertainment using an electronic device such as a computer, cell phone, or video game console that does not present any chance for financial gain or loss as a result of game events. Slot machines, video poker devices, online gambling, and similar activities were not considered video games within the context of this study. Additionally, electronic entertainment primarily used for communication, such as instant messaging, chat rooms, and text messaging were not considered video games. Within this study, a video game was defined as a program intended primarily for entertainment purposes rather than communication, art, or productivity and must require continual input from the user (player).

Time spent playing was the primary factor used to separate participants into groups in the current study. For the study, gamers that spent a significant amount of time playing were classified as 'avid gamers' and differentiated from those that spent little time playing ('casual gamers') and those who did not play at all ('non-gamers'). Non-gamers were those that report playing less than an hour a week. Casual gamers played less than ten hours a week and spend an average of two or fewer hours a day playing. Avid gamers spent more than ten hours a week and/or more than two hours a day playing video games. These cutoffs are based on the average playing habits found in the literature (Charlton & Danforth, 2007; Fisher, 1994; Griffiths & Hunt, 1995; etc).

While studies have compared video game playing and gambling, these have focused on similarities in demographics, motivations, and consequences (Griffiths, 1991; Griffiths, 2005; Johansson & Gotestam, 2004). Psychophysiological research on video gaming has been limited to studies of arousal evoked by video games (van Reekum et al., 2004; Griffiths & Dancaster, 1995; Turner, Carroll, & Courtney, 1984). This study examined the autonomic responses of avid gamers, casual gamers, and non-gamers on an analogue of the IGT.

Method

Participants

The experiment was approved by the Human Subjects Institutional Review Board (IRB) of Louisiana State University. Individuals participating in the experiment completed a notice of written consent (Appendix 1).

Participants were male and female students at Louisiana State University aged 18 and over. Applicants were asked to complete a written survey (Appendix 2) in order to screen for individuals meeting the criteria of the three gaming groups. The form asked individuals the amount of time spent on a variety of leisure activities and what their preferred leisure activities were. Questions unrelated to video game activity were added to reduce potential bias. Gender and age were also reported by individuals.

Individuals were recruited through one of three methods: the PsycExperiment system of Louisiana State University, surveys administered to undergraduate Psychology courses, and direct recruitment. Participants enrolled in Louisiana State University Psychology classes were able to earn 1 credit point for completing the survey. Individuals received an additional 2 credit points for participating in the experiment itself. Seven participants were volunteers that did not receive compensation. Each participant completed the experiment individually.

A target of 20 subjects per group was set based on sample sizes reported in the literature. Kalechstein, Fong, Rosenthal, Davis, Vanyo, and Newton (2007) reported significant results using a sample size of 9 pathological gamblers and 25 control subjects. Similarly, Bechara et al. (1994) found significant results using 6 men and 2 women as the sample with ventromedial prefrontal cortex damage and 28 controls. Goudriaan and colleagues (2005, 2006) used a sample of 46 pathological gamblers and 47 controls in one study (Goudriaan et al., 2006) and 48 pathological gamblers, 46 alcohol dependents, and 49 control subjects in another study (Goudriaan et al., 2005). Power analysis using the performance data reported by Bechara et al. (1994) and Kalechstein et al. (2007) suggested a sample size of 5 individuals per group would produce a power of .96 with a reported effect size of 1.18. The effect size found in the Goudriaan et al. studies (2005, 2006) was 1.83 and power analysis predicted that a sample size of 5 per group would produce a power of 1.00 with this effect size. Physiological data reported in the Goudriaan et al. (2005, 2006) studies suggested a sample size of 10 per group to attain power of .90 from the effect size of .68. The target of 20 individuals per group was retained as a conservative measure.

MineHunter

The MineHunter software program was designed to assess implicit and explicit learning in a manner comparable to the Iowa Gambling Task. Participants were tasked with sending mining probes to planets in order to harvest minerals. Participants were given funding and then selected from two planets represented by simple pictures of the planet's terrain. The terrains had different values for the minerals as well as differences in the probability of a probe crash. When a probe landed and harvested minerals, the player received a monetary reward. A probe crash was used as an unpredictable punishment, resulting in the loss of money. As in the Iowa Gambling Task, the riskier condition had the potential for larger rewards but an accompanying greater risk of losing a probe, thus making it ultimately disadvantageous.

Participants were placed in front of a computer containing the MineHunter software. The concept of the program was explained after physiological monitoring equipment was attached. The experimenter gave a scripted explanation of the game as follows and pointed out the locations on the game screen and desk corresponding to instructions:

> “In this game, you will see sets of two screens. These will be randomly generated, with different backgrounds and terrain features. These represent different planets. Your job is to search these planets for minerals. You’ll do that by choosing one screen and clicking on the slider next to it and dragging it down. The further you drag it down, the more probes you’ll send to check that planet. Once you’ve done so, a launch button will appear at the bottom of the screen and you’ll click that to launch probes. If the probes find minerals, you’ll gain money and if they crash, you will lose money. The more probes you send, the greater the gain or loss. Something you want to look for is what feature or features seem to be the most profitable to look for when choosing a planet. Every ten trials, the mouse will turn off and that will be your cue to mark which feature or features you feel are the best to select on the sheet in front of you. The profitable feature or features will not reset every time you’re asked to mark the sheet. Once the game is finished, a button will appear saying, ‘Game Over,’ and that will be the end of the experiment. When you’re ready to begin, click on the instructions button to hear the instructions again and then click on Begin Game to start.”

The following instructions were then presented by the program visually and audibly via a sound file:

> “Welcome to the MineHunter program. Your job is to find rare Newtonite and Bubaru embedded under a planet's surface. Examples of the terrain you may encounter are displayed to your right. Your ship will locate two worlds, but you will only be able to send probes to analyze one world at a time. If your probe finds minerals, they will be sold on the open market for a profit. But be careful as some areas are harder for the probes to navigate, and they may crash. To launch probes, drag the slider and hit the launch button. The number of probes you are about to launch is displayed next to the slider. After ten trials, your trainer will disable control and ask you to mark which feature or features you feel mark the most profitable area to send probes too. You will mark this on the sheet in front of you then continue with the game. This will happen for each set of ten trials, for about thirty minutes, or until the simulation target is reached. If you have any questions, please direct them to the trainer now. Good hunting.”

Planet A, the advantageous condition, was present in all trials after the first trial. The first trial was a practice to familiarize players with the game environment and presented two identical screens. The game presented combinations of six topographic features: mountains, volcanoes, fields, trees, cacti, and rivers (Appendix 4). Planet A terrain always contained mountains while Planet B never did. The planet conditions were randomly placed on the top or bottom of the screen.

Planet A had Newtonite worth $50 while Planet B had Bubaru worth $100. These values were identical to the values of cards from one advantageous deck and one disadvantageous deck in the Iowa Gambling Task. Planet A had a relatively low probability of a probe crash (0.1) while Planet B had a higher probability (0.5). The cost of a probe crash was $250. Up to 5 probes could be launched at one time. Each player began with $2000. If a player did not experience a probe crash, he or she received a reward equal to the number of probes launched multiplied by the value of the mineral present. If the player experienced a crash, he or she lost money equal to the number of probes launched multiplied by $250. The game did not terminate if a player reached a negative balance of money.

Despite the greater potential reward for Planet B’s mineral, the planet was disadvantageous due to a greater number of crashes. Planet A had a lower reward per successful landing but resulted in a profit due to fewer total crashes. A completely random selection of Planets A and B resulted in a net loss.

Each subject completed a total of 201 trials. The first trial was an introduction and was not included in data analysis or used in the division of trial blocks. After each block of 10 trials, subjects were asked to mark on a test sheet which feature or features they felt were the most profitable (Appendix 3). Marking of the sheet was monitored via camera and participants were reminded to mark the sheet if they failed to do so. The sheet contained pictures of all topographic features above the blanks to be marked.

Data Acquisition

Each participant was signed in using his or her surname and last four digits of his or her student ID number. Physiological readings were processed and recorded via AcqKnowledge® software integrated with BioPac® equipment. An acquisition sample rate of 125.0 samples per second was used for the analog HR and SCR signals. Recording began 1 minute before MineHunter trials began and continued for a total of 45 minutes or until the participant completed all trials. During the initial 1 minute period, participants were presented with the instructions. The instructions were timed to take over a minute to present and the participant could not begin until the audio instructions were complete. This was used to provide a baseline reading of heart rate and SCR and to reduce effects of the novel situation of the game and monitoring equipment.

MineHunter sent digital signals to AcqKnowledge® for three events within the game: presentation of a new pair of worlds, the moment the player pressed the launch button, and a probe crash result. Each of these signals was sent via a separate channel. These events were presented visually within the AcqKnowledge® window and recorded by AcqKnowledge® and MineHunter.

Once the experiment was complete, data from MineHunter and AcqKnowledge® were exported to a trio of spreadsheets, one for each of the three recorded events and included windows 4s before and 10s after each event. The spreadsheets recorded the experiment date and the number of trials. Additionally, MineHunter data included the position (top or bottom) chosen for each trial, the number of probes launched in each trial, whether the advantageous condition was chosen, physiological measures, and time of event. The data were analyzed using SPSS® statistical software.

Dependent Variables

Total Number of Advantageous Selection

The number of advantageous selections for the task was recorded for each individual. Avid gamers were expected to make fewer advantageous selections than other groups.

Average Number of Probes Sent to Planet A

The number of probes sent to the selected condition, from one to five, was recorded for each trial. An average of the number of probes sent to the advantageous condition was calculated. A low average was believed to indicate less confidence that a given selection was correct, as greater numbers of probes would bring higher losses if the choice were incorrect. A high average of probes but low number of advantageous selections would indicate a greater willingness to gamble.

Percentage of Probes Sent to Planet A

The percentage of total probes sent to advantageous conditions was examined to distinguish between individuals sending a high number of probes to all conditions from those that sent the majority of their probes to advantageous conditions. A high percentage of probes and high average number of probes were believed to indicate confidence in selecting the advantageous condition, while low percentage but high average number was theorized to indicate low confidence but high risk-taking. Based on the literature, avid gamers were expected to have a low percentage relative to their average number.

Selection of Planet A at a Rate above Chance

Selection above chance was defined as the trial number after which individuals consistently selected advantageous conditions at a rate higher than 60% (i.e., 3 out of 5 consecutive trials) for the duration of the experiment. The variable was taken as the point at which individuals developed a covert knowledge of the advantageous condition. Avid gamers were theorized to take longer to covertly learn the advantageous condition.

Feature Awareness Score

Feature awareness was operationally defined as the number of features selected on the MineHunter test sheet (Appendix 3) that included mountains. A selection of mountains, and only mountains, would be a feature awareness of one. Selection of mountains and one additional feature would be feature awareness of two and so on. Selection of any number of features that did not include mountains was feature awareness of six as was selecting "Don't Know". Feature awareness was believed to represent the degree to which individuals recognized that the mountain feature was the sole indicator of the advantageous condition. Feature awareness was expected to decrease as the game went on. Feature awareness was expected to be negatively correlated with the number of advantageous selections within each set of ten trials. This would indicate that as individuals made more advantageous selections, their feature awareness decreased as they narrowed down their selections to the single correct terrain feature.

Continuous Selection of Only Mountains

Selection of only mountains was operationally defined as the number on the trial sheet (Appendix 3), out of 20 blocks of 10 trials, in which an individual: had a feature awareness of one, maintained that feature awareness for the rest of the experiment, and for at least three continuous blocks. The range of potential scores was 1, representing selection of only mountains in the 1st trial and all subsequent trials on the test sheet, to 18, representing selection of only mountains on the 18th trial and all subsequent trials. Achieving a feature awareness of one only on the 19th or 20th block would not provide a sufficient number of blocks to meet the third component of the operational definition of selection of only mountains. Selection of only mountains was considered to be the point at which an individual had overtly learned the advantageous condition. A lower trial number indicated that the participant identified the advantageous condition earlier in the experiment. Avid gamers were expected to require more time to develop explicit knowledge of the advantageous condition.

Skin Conductance Response

Skin response was measured via TSD203 Ag-Cl electrodes inside molded housings. The housings were filled with Gel 101 electrode paste and attached to the middle and index fingers of the participant's left hand and secured via Velcro® strap. SCR was measured using BioPac® MP 150 equipment and a SCR100C electrodermal activity amplifier module. Gain was set to 5 micro-mhos/volt with a low pass filter of 1.0 Hz.

Average SCR in a 4 s window prior to probe launch was calculated. This window was chosen based on two factors. In the literature, recording times of 3s, 4s, and 5s have been employed (Bechara & Damasio, 2002; Bechara, Dolan, & Hindes, 2002; Goudriaan et al., 2006). Additionally, the SCR recordings from the current experiment were analyzed to determine the interval in which the largest increases in SCR (peaks) were observed prior to probe launch, using a random sample of five individuals from each of the three gamer groups. The observed intervals for these individuals, across all trials, ranged from 1s to 4s. An ANOVA was conducted using time period (1s, 2s, 3s, 4s) as the IV and the percentage of the total peaks observed for the individual in each interval as the DV. There was a significant difference between time periods [$F(3, 56) = 43.09$; $p<.05$] and a post-hoc Newman-Keuls test found that the 4s (40%) windows was significantly different from the 1s (17%) and 3s (8%) windows [$p<.05$], but not from the 2s (36%) window [$p=.28$]. The 4s window was selected to match with the literature. The SCR at the moment the participant launched probes was subtracted from average SCR during the 4s window prior to launch. A positive result indicated an increase in SCR. Increases were expected among casual gamers and non-gamers prior to making a disadvantageous selection.

Heart Rate

Heart rate was measured via electrocardiogram (ECG) electrodes processed through a BioPac® MP 150 system and an ECG100C amplifier module. The electrodes were attached to the shoulders and below the lowermost left rib of each participant. Detection equipment was set to a gain of 500 millivolts, a 35 Hz low pass filter and a .05 Hz high pass filter.

As with SCR, the data from the current experiment were analyzed to determine the best period in which to compare change in HR, using a random sample of five individuals from each gamer group. The time periods in which the highest HR increase (peaks) occurred following each win/loss event were noted for each individual and across all trials. The number of peaks that occurred within four distinct time intervals (1s, 2s, 3s, 4s) was examined using a one-way ANOVA. There were significant differences between intervals [F (3, 56) =221.79; $p<.05$] and a post-hoc Newman-Keuls test found that the 2s interval accounted for significantly more (62%) of the peaks than the 1s (9%), 3s (10%), and 4s (19%) windows [$p<.005$]. HR in the 2s immediately prior to individuals being shown a win or loss was subtracted from average HR in the 2s window after the win or loss was displayed to find change in HR. A positive result indicated a HR increase while a negative result indicated a decrease in HR. Increases were expected following a win.

Statistical Analysis

Age and gender were tested using one-way ANOVAs to determine if groups significantly differed on these demographic variables. A one-way ANOVA was conducted to determine if group had a significant effect on the trial in which individuals began to consistently select planet A at a rate above chance. A separate one-way ANOVA was conducted to determine if groups were significantly different on the trial in which they began selecting only mountains for the rest of the experiment. A one-way MANOVA was conducted using feature awareness, percentage of probes, average number of probes, number of advantageous selections, SCR, and HR as DVs. Group was the IV. Any significant differences were examined using post-hoc Newman-Keuls tests. Correlations were conducted to examine possible relationships between variables.

Post-Hoc Examination

Alternate Time Periods to Examine Physiological Measures

A set of post-hoc ANOVAs were performed to determine if physiological measures were significantly different at different times during the experiment. The ANOVAs were used to look for differences between the first 50 trials and the last 50 trials, between the first 1/3 of trials, the second 1/3, and the last 1/3, and between physiological responses prior to the player selecting planet A at a rate above chance and after doing so.

Alternative Definitions for Gaming Groups

While group assignment was based on the distribution of hours spent gaming, using cutoff values reported in the literature, it is possible that the participants used in this experiment were not equivalent. The distribution of hours per week was examined to determine if groups properly represented the distribution of average hours spent playing video games by individuals.

Somatic Marker Groups

To assess the presence and effect of somatic markers, groups were also created based on the presence or absence of HR increase following a win and SCR increase prior to making a disadvantageous selection. Based on the literature, individuals demonstrating somatic markers were predicted to have better scores on performance measures compared to individuals that did not demonstrate somatic markers.

Results

Demographics

A total of 623 surveys were completed. Of the total survey population, 508 met the criteria for non-gamers, 32 individuals met the criteria for avid gaming, and 83 met the criteria for casual gaming. In an attempt to create more equal sample sizes for the three groups, individuals were selectively recruited based on their video game activity. All survey participants meeting the avid gaming criteria were invited to participate in the experiment. Sample sizes for each group completing the experiment were 17 avid gamers, 26 casual gamers, and 23 non-gamers; providing a total of 66 participants.

Gender

There were 13 female and 53 male participants (Figure 1). Among female participants, 2 females were avid gamers, 4 were casual gamers, and 7 were non-gamers. Among males, 15 were avid gamers, 22 were casual gamers, and 16 were non-gamers. A chi square analysis found that gender did not significantly differ between groups [chi square = 3.03, p=.20].

Age

Fifty-five individuals fell between the ages of 18 and 23 with the maximum age of participants being 30 (Figure 2). Among avid gamers, 14 individuals fell between 18 and 23 with two inidividuals being 27 and one being 26. Among casual gamers, 23 fell between 18 and 23 with the remaining three individuals being 24, 26, and 30 years of age respectively. Twenty-one non-gamers fell between 18 and 23, with the remaining three being 25 and 27. A one-way MANOVA using age as the DV and group as the IV did not find significant differences in age among the three groups [$F(2, 63)=.48$; $p= .62$]

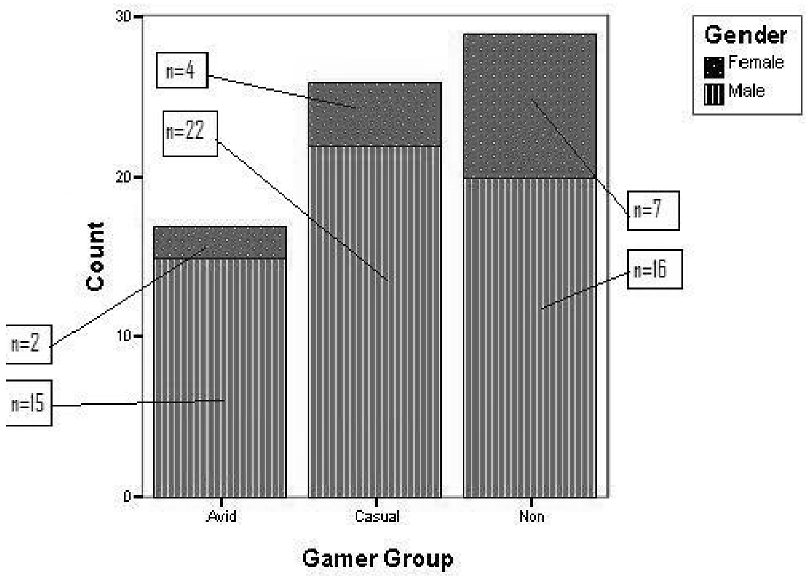


Figure 1: Gender among gamer groups

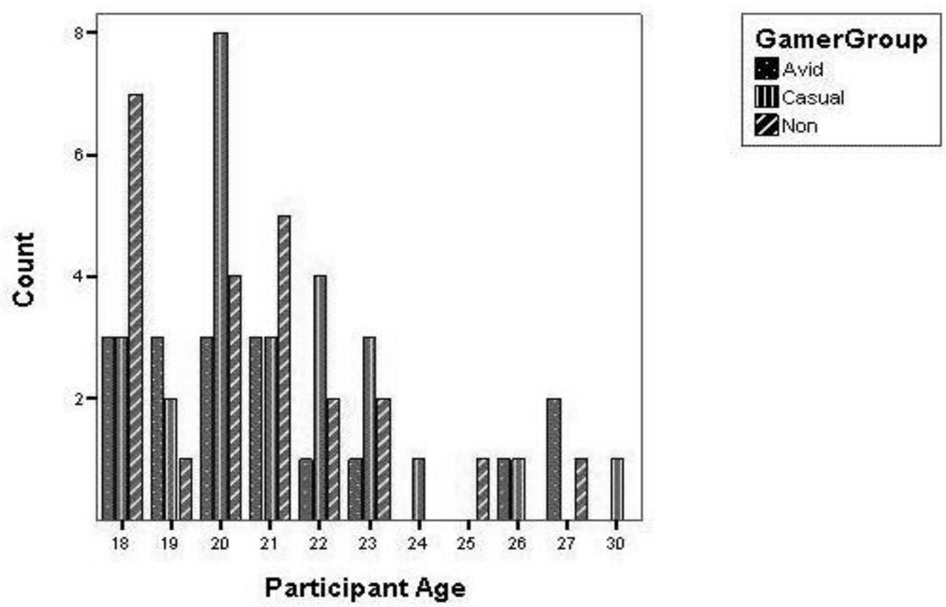


Figure 2: Age among gamer groups

Dependent Variables

Selection of Planet A at a Rate above Chance

There were 37 participants that achieved a selection rate above chance: 7 avid gamers, 15 casual gamers, and 15 non-gamers. Avid gamers had a mean of 107 trials, casual gamers had a mean of 95 trials, and non-gamers had a mean of 96 trials. A one-way ANOVA found that groups did not differ significantly [$F(2, 34) = .12; p=.89$].

Consistent Selection of Only Mountains

Of the 66 participants, only nine completed the experiment with a feature awareness of one, meaning they consistently marked mountains, and only mountains, as the advantageous terrain feature. One was an avid gamer, four were casual gamers, and four were non-gamers. The avid gamer required 70 trials to select only mountains, casual gamers had a mean of 90 trials, and non-gamers had a mean of 85 trials. A one-way ANOVA found that groups did not differ significantly [$F(2, 6) = .03, p=.97$].

Other Dependent Variables

A one-way MANOVA was conducted using the remaining six DVs and found that the groups did not significantly differ on any DV [$F(12, 114) = .87; p=.74$]. Avid gamers had a mean feature awareness score of 4.82, casual gamers had a mean of 4.35, and non-gamers had a mean of 3.91. The average number of probes for all selections of Planet A was 3.12 for avid gamers, 3.19 for casual gamers, and 3.18 for non-gamers. The mean percentage of probes sent to Planet A was 65% for avid gamers, 65% for casual gamers, and 67% for non-gamers. Avid gamers had an average of 131 selections of Planet A compared to 126 for casual gamers and 144 for non-gamers. The average change in SCR before a disadvantageous selection was 3.71 mV for avid gamers, 3.86 mV for casual gamers, and 2.10 mV for non-gamers. Change in HR following a win had an average of -.87 BPM for avid gamers, -.59 BPM for casual gamers, and -.70 BPM for non-gamers.

Correlations Between Dependent Variables

Total Number of Advantageous Selections during the Experiment and Average Number of Probes Sent to Planet A

There was not a significant correlation between the number of advantageous selections and the average number of probes sent [r= -.04; p=.73] across all participants. There were also no significant correlations between number of advantageous selections and average number of probes among avid gamers [r=.02; p=.94], casual gamers [r = -.03; p=.87], or non-gamers [r= -.10; p=.63]. The average number of probes sent to Planet A, the advantageous condition, was not predictive of the total number of advantageous selections, out of 200, made during the experiment.

Total Number of Advantageous Selections during the Experiment and Percentage of Probes Sent to Planet A

There was a significant positive correlation between number of advantageous selections and percentage of probes sent [r=.76; p<05] across all participants. There were also significant correlations between these variables within groups among avid gamers [r=.76; p<.05], casual gamers [r=.78; p=.05], and non-gamers [r=.79; p<.05]. The percentage of probes sent to Planet A, out of all probes sent to either planet, was predictive of the total number of selections of Planet A, out of 200, made during the experiment.

Number of Probes Sent and Percentage of Probes Sent

There was not a significant correlation between average number of probes sent to Planet A and the percentage of Probes sent to Planet A across all groups [r=.02, p=.87]. There were also not significant correlations between these variables within avid gamers [r= -.01, p=.99], casual gamers[r= -.11; p=.58], or non-gamers [r=.19; p=.38]. The average number of probes sent to Planet A was not significantly predictive of percentage of probes sent to Planet A.

Feature Awareness and the Number of Selections of Planet A within Blocks of 10 Trials

There was a significant negative correlation between the number of advantageous selections made within blocks of ten trials and the feature awareness for those blocks [r= -.24; p<.05]. As individuals narrowed down the range of possible terrain features that could indicate the advantageous planet, their number of selections of the advantageous planet increased.

Feature Awareness and Consistent Selection of Planet A at a Rate above Chance

There was a significant positive correlation between the trial in which individuals began to consistently select Planet A at a rate above chance and feature awareness in the final trial [r=.43; p<.05]. The earlier individuals were able to achieve and maintain a selection rate above chance, the more they were able to narrow the range of potential advantageous features to the sole correct feature (mountains).

Selection at a Rate above Chance and Selection of Only Mountains

There was a significant, positive correlation between the trial in which individuals began selecting Planet A at a rate above chance and the trial in which individuals attained and maintained a feature awareness of one [r =.68; p<.05]. The earlier individuals were able to achieve and maintain a selection rate above chance, the sooner they were able to continually select mountains and only mountains as the advantageous condition.

Potential Alternate Groups and Time Periods

Alternate Time Periods to Examine Physiological Measures

A one-way ANOVA did not find significant differences between the first 50 trials and the last 50 trials for skin conductance prior to a disadvantageous selection [$F(1, 68) = 2.06$, $p = .16$] or heart rate following a win [$F(1, 78) = 1.67$, $p = .24$]. Likewise, a one-way ANOVA did not find significant differences between the first, second, and last thirds of the experiment for SCR [$F(2, 104) = 1.61$, $p = .20$] or HR [$F(2, 132) = .98$, $p = .34$]. Finally, there were no significant differences found in the period before players selected Planet A at a rate above chance and the period after for SCR [$F(1, 73) = 1.31$, $p = .26$] or HR [$F(1, 102) = 1.02$, $p = .31$].

Alternative Definitions for Gaming Groups

The distribution of hours spent playing during a week had four distinct peaks (Figure 3), with those at 0 and 10 being the most pronounced. Based on this, group assignment was re-examined and new groups were created. Hypotheses were tested again with avid gamers defined as those playing for 7 or more hours a week, casual gamers being those that played 1 or more hours a week but less than 7 hours a week and non-gamers being those that played less than 1 hour a week. These criteria for avid gamers and non-gamers are similar to those used by Boot et al. (2008) for expert and non-gamers. This increased the casual gaming group size to 30, the avid gaming group size to 18, and decreased the non-gamer group size to 18. Repeating the MANOVA described above with the new groups did not find significant differences in the DVs of FAS, NP, PP, AS, SCR, or HR [$F(12, 116) = .83$; $p = .63$].

Somatic Markers

Individuals were broken into four groups based on the presence (average positive result) or absence (average negative result) of SCR increase prior to selecting the disadvantageous planet and HR increase following a win.   These groups were: individuals with a negative HR and negative SCR (n=13), those with a negative SCR but positive HR (n=3), those with a positive SCR and a negative HR (n=44), and those with a positive SCR and positive HR (n=6).

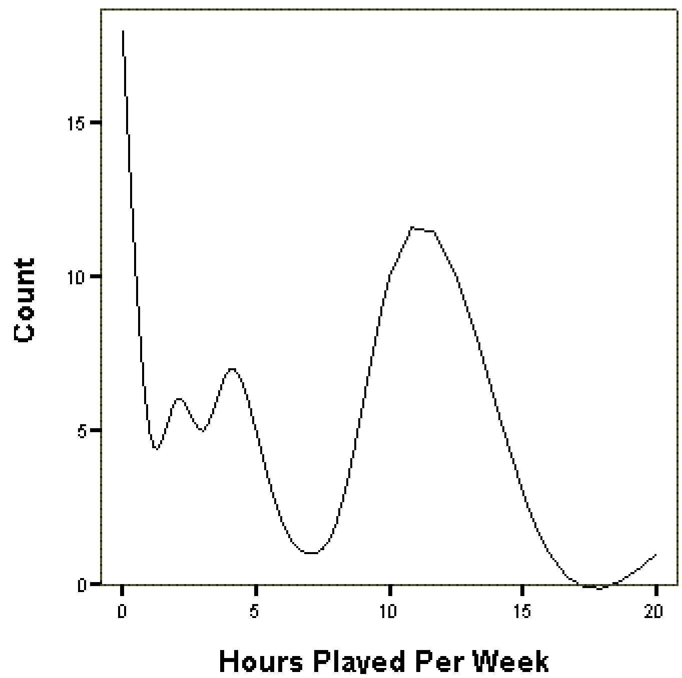


Figure 3: Total hours played per week by participants

This group assignment was used in a one-way MANOVA with feature awareness, average number of probes sent to Planet A, percentage of total probes sent to Planet A, and total number of advantageous selections as the DVs. The results approached not significant [F (12, 156) = 1.71; p=.07]. When limited to those with negative SCR and HR and those with positive SCR and positive HR, there was no significant difference between groups [F (4, 14) = .48; p=.75].

Discussion

Hypotheses

Hypothesis 1

Hypothesis 1 stated that avid gamers would select the advantageous condition, Planet A, less often than non-gamers and casual gamers. Three variables represented this hypothesis: the total number of advantageous selections out of the total 200 trials in the experiment, the average number of probes sent to Planet A, and the percentage of total probes sent to Planet A. There were no significant differences between groups on these three variables. Therefore, hypothesis 1 is not supported.

Hypothesis 2

Hypothesis 2 said that avid gamers would take longer to learn the advantageous condition than casual gamers. Learning the advantageous condition consisted of two processes. The first was selection of Planet A rather than Planet B. Selection above chance was operationally defined as the selection of Planet A in at least 3 of 5 consecutive trials and maintaining this rate for the rest of the experiment. The first trial in which an individual achieved this selection rate was used to rate their covert learning.

The second process was overt learning. The identification of mountains as the sole advantageous terrain feature in a given block on the MineHunter test sheet was used as the operational definition for overt learning. Selection of only mountains was defined as the block on which individuals were able to identify this feature and continued to state that only mountains were the advantageous feature for all subsequent trial blocks. Feature awareness was used to assess the degree to which individuals were aware that only mountains were advantageous, with a score of 1 indicating that individuals were completely aware of this and each score above this indicating that individuals believed the correct answer was an increasing combination of mountains and some other terrain features.

Based on these variables, hypothesis 2 would be supported if individuals took longer to select Planet A at a rate greater than chance and took longer to identify mountains as the sole advantageous terrain feature. The results did not support this hypothesis.

Hypothesis 3

Based on hypothesis 3, avid gamers were expected to have a lower anticipatory SCR increase, on average, prior to selecting Planet B, the disadvantageous condition, than casual gamers and non-gamers. The results did not support this hypothesis. There were no significant differences between groups in average SCR prior to disadvantageous selections.

Hypothesis 4

Hypothesis 4 stated that avid gamers would have a lower heart rate response following a win than casual gamers and non-gamers. The results did not support this. However, it should be noted that the majority of individuals (57 out of 66), did not experience an increase in HR following a win, regardless of group.

Comparisons to Prior Literature

Avid Gaming and Pathological Gambling

The results of the current study were contrary to the literature. As discussed, excessive video game playing has been connected to numerous deficiencies in social, educational, and vocational functioning (Charlton, 2002; Griffiths & Davies, 2005; Soper & Miller, 1983, etc). Individuals fulfilling PG criteria have similar deficiencies (Breen & Zuckerman, 1999; Dickerson, Hinchy, & Fabre, 1987, etc). Similarities between gambling and video gaming were reported in the literature in demographics, psychological characteristics, and impulse control issues (Griffiths, 1991, 2005; Johansson & Gotestam, 2004). Based on that prior research, avid gamers were expected to have deficient performance on a task similar to the Iowa Gambling Task.

However, there are also some differences between video gaming and gambling noted in the literature as well as some discrepancies in how gambling and gaming were compared. Griffiths (1991) noted that video games lack many of the financial aspects of gambling and motivations may be different, although he theorized that slot machine gamblers are using money as a way to play rather than a reason to play. However, Griffiths (1991) primarily examined slot machine gambling and arcade video game play, both of which require the player to deposit money in order to play. While playing a video game at home requires the player to purchase or otherwise acquire the game, from that point on there is no direct financial requirement for continued play. This is in contrast to all forms of gambling, which tend to require a financial investment for subsequent play, or at least, success at winning money equal to the amount spent. Thus, there is a possible difference in motivation and a potential limiting effect of money on the time an individual may gamble but not on the amount of time an individual may play video games.

Additionally, success in a video game is determined by a degree of skill on the part of the player, rather than being dependent on random chance. As with any skill, video game playing abilities may improve with continuous, regular gaming activity. These skills may even be useful non-gaming activities. A pair of recent studies (Boot, Kramer, Simons, Fabiani, and Gratton, 2008; Castel, Pratt, & Drummond, 2005) found that video game play was positively correlated with improved cognitive performance, particularly among those that played regularly. Boot and colleagues (2008) divided their participants into expert gamers and non-gamers based on their time spent playing per week, with expert players being those that played more than 7 hours per week and non-gamers being those that played less than 1 hour per week. The researchers found that expert gamers had significantly greater cognitive performance in object tracking, object rotation, task alteration, working memory, and attention tasks than non-gamers (Boot et al., 2008). Additionally, focused, intensive video game play led to further improvements in task performance among expert gamers but not among non-gamers. Castel, Pratt, and Drummond (2005) found similar differences between players and non-players with players demonstrating significantly quicker reaction time during visual search tasks. A small number of video game players have even become professional players, living entirely off the winnings from video game tournaments (Caplan & Coates, 2007).

Based on those findings, it is possible that, with regard to MineHunter, time spent playing video games is not detrimental and may even be beneficial. Gamers may have experience in learning what decisions will benefit them in a simulation and this experience could be helpful in MineHunter. The results do not indicate that video game experience makes an individual better at MineHunter than a control subject, but the lack of significantly poorer performance could indicate that avid gamers do not have the same deficiencies in learning the advantageous condition that pathological gamblers do. A measurement of actual capability with different game-related skills might provide a deeper understanding of the potential effects of game play on MineHunter performance.

Individuals would be expected to have decreased sensitivity to rewards within the game due to repeated prior exposure to in-game rewards. The results do not support this idea. One possible explanation is that novelty might be a rewarding experience for avid gamers. The MineHunter game might have been sufficiently different from the typical experience for avid gamers and thus rewards in the game were processed differently from the rewards an avid gamer might experience while playing a favored game many times. Alternatively, the overall lack of increased HR for most participants in all three groups following a win may indicate that the game was not particularly arousing to anyone.

Demographics

The majority of individuals in the survey population were non-gamers and only 5% of all surveyed individuals met the criteria for avid gaming. This is lower than the 11.9% of college-aged (18-25) individuals reported by Grusser et al. (2007). However, this may be due in part to the sampled population being made up of primarily females. The literature notes that video game play is less common among females.

In the present study, 28% of those who reported playing more than one hour per week met the criteria for avid gaming. This is higher than the 2% of gamers reported by Charlton & Danforth (2007) and lower than the 39% of massive multiplayer role playing game players found by Charlton & Danforth (2007). However, Charlton and Danforth (2007) used additional criteria to define gaming addiction, used primarily male participants, and their participants had a much higher mean (18.64) number of hours spent gaming per week. With that in mind, it seems possible that the sample used in the current study is representative of gamers amongst the population at large, at least those of similar age.

Avid Gaming Criteria

Another consideration is that the criteria for avid gaming employed in the present study may not have been sufficient. In much of the literature, avid gamers were defined as those who played video games so much that they experienced problems in their daily lives. In the current study, all participants were undergraduate students or graduate student volunteers. By the nature of the population, all individuals are known to have successfully completed High School or an equivalent and performed adequately well academically to be accepted to Louisiana State University. Therefore, video game playing behavior was not so detrimental for any individual that they could not meet those educational requirements. Assessments of school performance or self-report measures of problems in work, social, and other situations might provide a more comprehensive measure of problem video gaming. The use of a diagnostic instrument such as Brown's criteria (1991) or Carlton's (2002) questionnaire might also provide a more accurate assessment of problem video gaming than a simple time report.

Sample Size

A possible limitation of the statistical analysis is the small sample sizes. An increased sample size is therefore recommended for future study. Because no prior studies have examined the performance of avid gamers on the Iowa Gambling Task, sample sizes for avid gamer performance were based on power analysis using the effect sizes reported in the literature on pathological gamblers (Goudriaan et al., 2005, 2006; Kalechstein et al., 2006). The results indicated the power was much lower for the current study than in the previous literature, with an observed power of .54.

Somatic Markers

The somatic marker hypothesis (Bechara & Damasio, 2002; Bechara et al., 2002; Damasio, 1996) holds that individuals develop physiological responses to conditions based on prior experience and that these somatic markers assist them in making advantageous decisions. In the IGT, these markers are displayed by the SCR responses shown by individuals prior to making disadvantageous selections (Bechara & Damasio, 2002). These markers may be formed and strengthened by experiences with rewards and punishments associated with different conditions (Bechara et al., 2002). In the current study, 50 individuals displayed SCR increases prior to selecting disadvantageous conditions and 9 displayed an average increase in HR following a win. Six individuals displayed both anticipatory SCRs and HR increases following a win. When groups were created based on the presence or absence of somatic markers, the differences between groups on performance variables approached significance when all groups were included, but were not significant when only those that displayed both and those that displayed neither were included.

The findings do support the basic idea that some individuals display SCR increases prior to selecting disadvantageous conditions. The results also indicated that winning was correlated with an increase in HR for some individuals. However, the presence of such responses was not significant for performance.

Physiological Measures

An inspection using a random sample from each of the three groups found windows in which significantly more heart rate and SCR increases occurred. The number of HR increases noted within the first 2s after a win or loss was significantly greater than the number observed within 1s, 3s, or 4s windows. This conforms to some degree with much of the literature (Bechara et al., 1994; Goudriaan et al., 2006), in which HR change was observed between the 1st and 3rd interbeat intervals. Based on the average human heart rate of 70 BPM, this would be a period from .86 seconds to 2.58 seconds. This is similar to the 2s used in the current study.

Additionally, there were significantly more increases in SCR during 2s and 4s windows. In the literature, researchers measured SCR in windows ranging from 3s to 5s (Bechara & Damasio, 2002; Bechara, Dolan, & Hindes, 2002; Goudriaan et al., 2006). Based on this, the 4s window was selected to average SCR as it was similar to the literature and because it included the 2s window in the averaged period. Average SCR in the 4s window was subtracted from SCR at the moment the participant made a decision.

MineHunter

Reliability and Validity

The current study examined MineHunter as a test of covert learning and decision-making comparable to the Iowa Gambling Task. This is the first documented study using the MineHunter instrument. There are three findings that support the reliability and validity of MineHunter as such a measure. First, some individuals achieved and maintained a selection rate above chance and demonstrated overt knowledge of the advantageous condition while others did not, just as in the IGT. Secondly, all individuals that demonstrated both covert and overt learning demonstrated covert learning first. Finally, the linear relationship between the frequency of selection of Planet A and the number of terrain features believed to be advantageous indicates that the MineHunter Test Sheet (Appendix 3) is a useful tool for determining the degree of overt learning for an individual. These findings could be further strengthened through a test-retest method using those individuals that never identified the correct terrain feature and never selected Planet A at a rate above chance.

Advantages

MineHunter has some potential advantages over the Iowa Gambling Task, although not all of these design elements were utilized in the current study. First, the experimenter may alter the probability of the advantageous planet being present in the two screens presented to individuals. Reducing the probability increases the complexity of the design as individuals are no longer guaranteed to see mountains on one of the screens. If individuals are told that the correct condition may be any combination of features, there are 1236 possible combinations of features. In the current study, individuals were not told that they were to find which specific single feature was most advantageous, so this level of complexity may have been present for many individuals and may have slowed the rate of overt learning. However, the presence of mountains on one of the two planets in every trial may have also mitigated these effects. Creating a design in which all terrain features have the same probability of appearance could allow for study of covert and overt learning for a larger number of trials as participants require more time to identify the advantageous feature and planet. Reducing this complexity could allow the experimenter to use a smaller number of trials.

A second advantage of MineHunter is that it allows the experimenter to create a situation in which individuals can have three possible results for a given decision: locating minerals, not locating minerals, and probe crash. If minerals are not present 100% of the time on a given world, there may be times in which individuals either make neither profit nor loss (if probes are free) or have a different degree of loss than a probe crash. This allows for greater complexity than the four deck system of reward-punishment used in the IGT.

A third potential advantage of MineHunter, as indicated by the results of the current study, is that it does not appear to produce much physiological arousal. The majority of individuals did not have an average increase in HR following a win, potentially because a win was not exciting enough to evoke a noticeable reaction. While this is problematic for the study of physiological responses using MineHunter, it may also provide some benefits. Individuals participating in the IGT may be primed by the card task and view the associated wins and losses as more "real" than similar results within MineHunter. While the card task has a real world equivalent, MineHunter simulates a fantasy situation: searching other planets for minerals. This activity is obviously not like any activity which individuals will have ever performed in real life.

This lack of arousal may be useful in studying covert learning, as somatic markers might be slower to provide helpful information to individuals. This lack of arousal might be mitigated by providing a more exciting or salient quality to MineHunter, such as improved graphics and sound, a more direct interface such as a touch screen, or through the potential for real world rewards (such as money or additional credit) for high performance.

Overt/Covert Learning

The current study provided some support for MineHunter as a test of overt and covert learning, similar to the Iowa Gambling Task. There were individuals that were able to correctly identify mountains as the only correct terrain feature and individuals that selected Planet A at a rate above chance. Individual that correctly identified the correct feature did so after their selection of Planet A occurred at a rate above chance, indicating that they learned covertly before they demonstrated full overt learning. Feature awareness was proposed as a measure of overt learning for a given block of ten trials. This measure was significantly correlated with the number of selections of Planet A made within the same block of ten trials. This indicated that as individuals narrowed down the possible terrain features to the single correct feature, the frequency of selections of the correct planet also increased.

Based on these findings, the process of individual learning within MineHunter could be envisioned as a progression from complete ambiguity, to covert learning, then finally, overt learning. Covert learning is assessed through performance; specifically, the consistent selection of Planet A before individuals are able to consciously state what the sole correct terrain feature is. This process occurs without the individual's conscious awareness and serves as a precursor to overt learning. When they have covert knowledge of the advantageous planet, they refine their identification of the advantageous terrain feature from the range of possible features until they have consciously learned the advantageous feature. If the experiment concludes prior to the individual identifying the sole advantageous feature, feature awareness may still be a valid means to assess their degree of learning.

Beyond identifying this process, feature awareness may be useful in planning the number of trials to be used in an experiment. If the experimenter wishes to limit the experiment to the time before individuals have full overt knowledge, feature awareness might be used to gauge how far along an individual has progressed in their overt learning. A feature awareness cut-off could be set to determine a period in which individuals had somewhat narrowed down the possible advantageous features but had not fully identified the correct feature. In this way, one might focus research solely on performance in the time between covert learning and overt learning.

Confidence

The percentage of total probes sent to Planet A was proposed as a potential measure of confidence in selecting Planet A. While there was no significant difference between groups on this variable, there was a strong positive correlation between the percentage of probes sent and the total number of advantageous selections. While this is expected as the number of advantageous selections plays a role in the total percentage, it confirms that individuals were not gambling by sending many probes to the riskier Planet B while selecting Planet A more often in total.

This is in contrast to the average number of probes sent to the advantageous condition, which was not significantly correlated with the number of advantageous selections or the percentage of probes. This indicates that the average number of probes was irrelevant to the number of selections made and, therefore, individuals may not have had the confidence to maximize their risk and potential reward. Based on probability, an individual that always sent five probes to Planet A would make more money than one that always sent three probes. However, the greater potential loss may have motivated individuals to play it safe and not send the maximum and risk a higher loss.

Potential Areas for Improvement

There are some limitations of the MineHunter design. Advantageous conditions can't be associated with any terrain feature but mountains and, therefore, an individual that recognizes the advantageous planet and the associated terrain feature in one set of trials will be aware of the advantageous planet in all further trials, making it difficult to use a test-retest method with him or her. While the conditions could be set to make mountains a disadvantageous condition, the task would then become a matter of avoiding mountains rather than selecting them. Program alterations allowing for the advantageous terrain feature to be altered could solve this problem and reduce potential learning effects.

A second potential improvement would be separating the presentation of win or loss from the presentation of the next set of planets. Doing so would provide a better separation between physiological responses to results and physiological responses based on decision-making. A more salient result screen might also improve the physiological response evoked by results. A longer red flash, for example, might provide greater arousal than the short red flash and red writing used to indicate a loss in the current design. A win result might be displayed by flashing lights and sounds similar to a win on a slot machine.

The method used in the current experiment required individuals to momentarily stop playing MineHunter after each set of ten trials and use a pen to mark which feature or features they felt were most advantageous. The addition of a response box to MineHunter itself would allow individuals to mark their choice for the advantageous condition without being interrupted by the experimenter or removing their hand from the mouse. A response box within the program would allow the participant to remain focused on the program without having to shift from using the computer to filling out a sheet of paper.

Finally, the addition of competition or specific goal to MineHunter might provide greater motivation for individuals to seek the most profitable strategy. The concept of a referent other has been examined in studies of work motivation (Bolino & Turnley, 2008; Bretz & Thomas, 1992; Lerner, 2003). The referent other, which may be a real person or an imagined ideal, is used in comparison with an individual's current output and the corresponding outcomes. Individuals may adjust their output to match the desired outcome if possible (Bolino & Turnley, 2008; Bretz & Thomas, 1992; Lerner, 2003). This concept could be adapted to MineHunter by giving players an explicit referent other and thus give them an idea of how their own performance compares. Adding a referent other would be expected to increase motivation for players to do well within the game. Players could be told by the experimenter or MineHunter itself that the average score for players is some particular amount and thus players would know whether their performance was above or below average. A more complex method might be to have a 'competitor' whose profits and losses vary as the experiment proceeds or even adjust in skill as the player's performance changes. Such a method could be associated with a salient reward such as extra credit points or a small monetary prize if the player exceeds their competitor.

Conclusion

The current study did not support the idea that avid gamers have different autonomic responses and poorer behavioral performance on a decision-making task than casual gamers and non-gamers. However, the study does provide support for MineHunter as a learning task comparable to the IGT. There were individuals that were able to maintain a selection rate above chance and those that could not, indicating that the task was neither impossible nor overly simple. Additionally, there were some individuals able to consciously identify the advantageous condition, although the relatively low proportion of individuals able to do so indicates that the overt learning task may have been overly complicated. In all individuals able to demonstrate full overt and covert learning, covert learning was a prerequisite of full overt learning. Finally, there is support for feature awareness as a measure of the degree of overt learning for an individual. These results provide some justification to use MineHunter as a supplement to the Iowa Gambling Task in situations where a card-based task may be undesirable. Future studies should examine MineHunter performance of individuals known to have poorer performance on the Iowa Gambling Task, such as pathological gamblers and those with ventromedial prefrontal cortex damage.

References

American Psychiatric Association (2000). Diagnostic and statistical manual of mental disorders (4th ed., Text revision). Washington, DC: American Psychiatric Association.

Apperley, T. (2006). Genre and game studies: Toward a critical approach to video game genres. Simulation and Gaming, 37, 6-23.

Bagby, R. M., Vachon, D. D., Bulmash, E. L., Toneatto, T., Quilty, L. C., & Costa, P. T. (2007). Pathological gambling and five-factor model of personality. Personality and Individual Differences, 43, 873-880.

Bailey, F. (Executive Producer), & Barbato, R. (Executive Producer). (2007). Rise of the Video Game. [Television Series] Silver Spring, MD: The Discovery Channel

BBC News (2005, October 8). S Korean dies after games session. BBC News. Retrieved December 08, 2007 from http://news.bbc.co.uk/1/hi/technology/4137782.stm

Bechara, A. (2003). Risky business: emotion, decision-making, and addiction. Journal of Gambling Studies, 19, 23-51.

Bechara, A., & Damasio, H. (2002). Decision-making and addiction (part I): impaired activation of somatic states in substance dependent individuals when pondering decisions with negative future consequences. Neuropsychologia, 40, 1675-1690.

Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. Cognition, 50, 7-15.

Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (2005). The Iowa Gambling Task and the somatic marker hypothesis: some questions and answers. Trends in Cognitive Sciences, 9, 159-162.

Bechara, A., Dolan, S., Denburg, N., Hindes, A., Anderson, S. W., & Nathan, P. E. (2001). Decision-making deficits, linked to dysfunctional ventromedial prefrontal cortex, revealed in alcohol and stimulant abusers. Neuropsychologia, 39,376-389.

Bechara, A., Dolan, S., & Hindes, A. (2002). Decision-making and addiction (part II): myopia for the future or hypersensitivity to reward? Neuropsychologia, 40, 1690-1705.

Bolino, M. C. & Turnley, W. H. (2008). Old faces, new places: Equity theory in cross-cultural contexts. Journal of Organizational Behavior, 29, 29-50.

Boot, W. R., Kramer, A. F., Simons, D. J., Fabiani, M., & Onion, G. (2008). The effects of video game playing on attention, memory, and executive control. Acta Psycholigca, 129, 387-398.

Brand, M., Kalbe, E., Labudda, K., Fujiwara, E., Kessler, J., & Markowitsch, H. J. (2005). Decision-making impairments in patients with pathological gambling. Psychiatry Research, 133, 91-99.

Breen, H. & Zuckerman, M. (1999). “Chasing” in gambling behavior: personality and cognitive determinants. Personality & Individual Differences, 27, 1097-1111.

Bretz, R. D. Thomas, S. L. (1992) Perceived equity, motivation, and final-offer arbitration in major league baseball. Journal of Applied Psychology, 77, 280-287.

Brown, R. I. F. (1993). Some contributions of the study of gambling to the study of other addictions. In W. R. Eadington J. A. Cornelius (Eds.), Gambling behavior and problem gambling (pp. 241-272). Reno, NV: University of Nevada.

Caplan, J. & Coates, T. P. (2007). Tiger, Jordan, Hawk, Wendel? Professional video gamer Jonathan Wendel compares himself to professional athletes Tiger Woods, Michael Jordan, Tony Hawk. Time, 169, 60.

Castel, A. D., Pratt, J., & Drummond, E. (2005). The effects of action video game experience on the time course of inhibition of return and the efficiency of visual search. Acta Psychologica, 119, 217-230.

Cavedini, P., Riboldi, G., Keller, R., D’ Annucci, A, & Bellodi, L. (2002). Frontal lobe dysfunction in pathological gambling patients. Biological Psychiatry, 51, 334-341.

Charlton, J. P. (2002). A factor-analytic investigation of computer ‘addiction’ and engagement. British Journal of Psychology, 93, 329-344.

Charlton, J. P., & Danforth, I. D. W. (2007). Distinguishing addiction and high engagement in the context of online game playing. Computers in Human Behavior, 23, 1531-1548.

Chiu, S.C., Lee, J.L., & Huang, D. (2004). Video game addiction in children and teenagers in Taiwan. CyberPsychology and Behavior, 7, 571-581.

Coventry, K. R. & Constable, B. (1999). Physiological arousal and sensation-seeking in female fruit machine gamblers. Addiction, 94, 435-430.

Coventry, K. R. & Norman, A. C. (1997). Arousal, sensation seeking and frequency of gambling in off-course horse racing bettors. British Journal of Psychology, 88, 671-681.

Damasio, A. R. (1996). The somatic marker hypothesis and the possible functions of the prefrontal cortex. Philosophical Transactions of the Royal Society of London (Biology), 351, 1413-1420.

Dickerson, M., Hinchy, J. & Fabre, J. (1987). Chasing, arousal and sensation seeking in off-course gamblers. British Journal of Addiction, 82, 673-680.

Egli, E. A. & Meyers, L. S. (1984). The role of video game playing in adolescent life: Is there a reason to be concerned? Bulletin of the Psychonomic Society, 22, 309-312.

Fisher, Sue. (1994) “Identifying Video Game Addiction in Children and Adolescents.” Addictive Behaviors, 19, 545-553.

Goudriaan, A.E., Oosterlaan, de Beurs, E., & Van der Brink, W. (2004). Pathological gambling: A comprehensive review of biobehavioral findings. Neuroscience and Biobehavioral Reviews, 28,123-141.

Goudriaan, A.E., Oosterlaan, J., de Beurs, E., & van der Brink, W. (2005). Decision making in pathological gambling: A comparison between pathological gamblers, alcohol dependents, persons with Tourette syndrome, and normal controls. Cognitive Brain Research, 23,137-151.

Goudriaan, A.E., Oosterlaan, J., de Beurs, E., & van der Brink, W. (2006). Psychophysiological determinants and concomitants of deficient decision making in pathological gamblers. Drug and Alcohol Dependence, 84, 231-239.

Griffiths, M.D. (1991). Amusement machine playing in childhood and adolescence: A comparative analysis of video games and fruit machines. Journal of Adolescence, 14, 53-73.

Griffiths, M.D. (2005). Relationship between gambling and video-game playing: A response to Johansson and Gotestam. Psychological Reports, 95, 644-646.

Griffiths, M.D., & Dancaster, I. (1995). The effect of type A personality on physiological arousal while playing computer games. Addictive Behaviors, 20, 543-548.

Griffiths, M. D. & Davies, M. N. O. (2005). Does video game addiction exist? Handbook of Computer Game Studies (pp.359-368). Cambridge, MA. MIT Press.

Griffiths, M.D., Davies, M.N.O., & Chappell, D. (2003). Breaking the stereotype: The case of online gaming. CyberPsychology and Behavior, 6, 81-91.

Griffiths, M.D., Davies, M.N.O, & Chappell, D. (2004). Online computer gaming: A comparison of adolescent and adult gamers. Journal of Adolescence, 27, 87-96.

Griffiths, M.D., & Hunt, N. (1995). Computer game playing in adolescence: Prevalence and demographic indicators. Journal of Community and Applied Social Psychology, 5, 189-193.

Griffiths, M.D., & Hunt, N. (1998). Dependence on computer games by adolescents. Psychological Reports, 82, 475-480.

Grusser, S.M., Thaleman, R., & Griffiths, M.D. (2007). Excessive computer game playing: Evidence for addiction and aggression? CyberPsychology and Behavior, 10, 290-292.

Johansson, A. & Gotestam, K. G. (2004). Problems with computer games without monetary reward: similarity to pathological gambling. Psychological Reports, 95, 641-650.

Kalechstein, A. D., Fong, T., Rosenthal, R. J., Davis, A., Vanyo, H., & Newton, T. F. (2007). Pathological gamblers demonstrate frontal lobe impairment consistent with that of methamphetamine-dependent individuals. The Journal of Neuropsychiatry and Clinical Neurosciences, 19, 298-303.

Lehto, J.E., & Elorinne, E. (2003). Gambling as an executive function task. Applied Neuropsychology, 10, 234-238.

Lerner, M. J. (2003). The Justice Motive: Where Social Psychologists found it, how they lost it, and why they may not find it again. Personality and Social Psychology Review, 7, 388-399.

Linnet, J., Rojskaer, L. J, Nygaard, J., & Maher, B. A. (2006). Episodic chasing in pathological gamblers using the Iowa gambling task. Personality and Social Sciences, 47, 43-49.

McClure, R.F., & Mears, F.G. (1984). Video game players: Personality characteristics and demographic variables. Psychological Reports, 55, 271-276.

Ng, B. D., & Weimar-Hastings, P. (2005). Addiction to the Internet and Online Gaming. CyberPsychology and Behavior, 8,110-113.

Phillips, C. A., Rolls, S., Rouse, A., & Griffiths, M. D. (1995). Home video game playing in schoolchildren: A study of incidence and patterns of play. Journal of Adolescence, 18, 687-691.

Potenza, M.N. (2006). Should addictive disorders include non-substance-related conditions? Addiction, 101,142-151.

van Reekum, C.M., Johnstone, T., Banse, R., Etter, A., Wehrle, T., & Scherer, K.R. (2004). Psychophysiological responses to appraisal dimension in a computer game. Cognition and Emotion, 18,663-688.

Soper, W. B. & Miller, M. J. (1983). Junk time junkies: an emerging addiction among students. School Counselor, 31, 40-43.

Turner, J. R., Carroll, D., & Courtney, H. (1983). Cardiac and metabolic responses to “Space Invaders”: An instance of metabolically-exaggerated cardiac adjustment. Psychophysiology, 20, 544-549.

Williams, D. & Skoric, M. (2005). Internet fantasy violence: A test of aggression in an online game. Communication Monographs, 72, 217-233.

Wood, R.T.A., Griffiths, M.D., Chappell, D., & Davies, M.N.O. (2004). The structural characteristics of video games: A psycho-structural analysis. CyberPsychology and Behavior, 7, 1-10

Wray, I. & Dickerson, M. (1981). Cessation of high frequency gambling and ‘withdrawal’ symptoms. British Journal of Addiction, 76, 401-405.

Young, K.S. (1996). Internet addiction: The emergence of a new clinical disorder. Cyberpsychology and Behavior, 1, 237-244.

A. Written Confirmation of Informed Consent

Study Title: Physiological characteristics and performance of avid video game players on a decision-making task with comparison to pathological gamblers.

Performance Site: Room 201, Audobon Hall, Louisiana State University

Researchers: Patrick Lingenfelter Dr. Mike Hawkins

Procedure: The purpose of this study is to examine the performance of different video game players and non-gamers on MineHunter, a learning video game program. Psychophysiological (heart rate and skin conductance) data will be collected to examine different reactions to game events. These will be recorded using electrodes placed on the shoulders, stomach, and on the middle and ring fingers of the left hand. These are not invasive. All information will remain anonymous. All participants should be over 18 years of age. There is no risk associated with this experiment.

Please read the following and sign below:

I have been fully briefed on the experiment prior to my participation in it. I understand that my participation is entirely voluntary and I am free to withdraw at any time without penalty or loss of benefits I would be entitled to.

SIGNATURE____________________________________ **Date_____________**

B. Demographic Questionaire and Leisure Survey

Last Four Digits of Student ID: ___________________

Gender: M F **Age: ______________**

Contact Email Address: _______________________________________

Contact Phone Number (optional): (_____) ______-_________

Please answer the following questions regarding your leisure activities as honestly as possible. All personal information will be kept strictly confidential. You may be contacted to participate in a second experiment and have the chance to receive additional course credit for Psychology. You are not obligated to participate and may withdraw at any time. If you have any questions, please ask the experimenter.

1) In an average week, how many hours do you spend doing each of the following?

Watching television	___________	Playing video games	___________
Reading:	____________	Using the internet	___________
Exercise/ Sports	____________	Going to clubs/bars	___________
Theater/ Cinema	____________	Other leisure activities	___________

2) Please rank the following in order of preference from 1-8:

Watching television	___________	Playing video games	___________
Reading:	____________	Using the internet	___________
Exercise/ Sports	____________	Going to clubs/bars	___________
Theater/ Cinema	____________	Other leisure activities	___________

3) How many hours do you spend doing each of the following on a typical day?

Watching television	___________	Playing video games	___________
Reading:	____________	Using the internet	___________
Exercise/ Sports	____________	Going to clubs/bars	___________
Theater/ Cinema	____________	Other leisure activities	___________

4) What do you watch most often when you watch TV? (circle one)

a) Comedy b) Talk Shows c) Drama d) Sci-Fi/Fantasy

e) News f) Educational g) Other h) Don’t watch TV

5) What is your favorite type of video game? (circle one)

a) Simulation (Flying; Driving; Music; “Sim”) b) Action (Shooting; Fighting)

c) Strategy (War; Management; Puzzle) d) Role-Playing Game e) Don’t play

6) What is your favorite type of book? (circle one)

a) Non-fiction b) Romance c)Sci-Fi/Fantasy d) Mystery e) Other

7) What is your favorite type of movie? (circle one)

a) Documentary b) Action c) Thriller/Horror d) Romance e) Comedy

f) Classic g) Musical h)Mystery i)Other h) Don’t watch movies

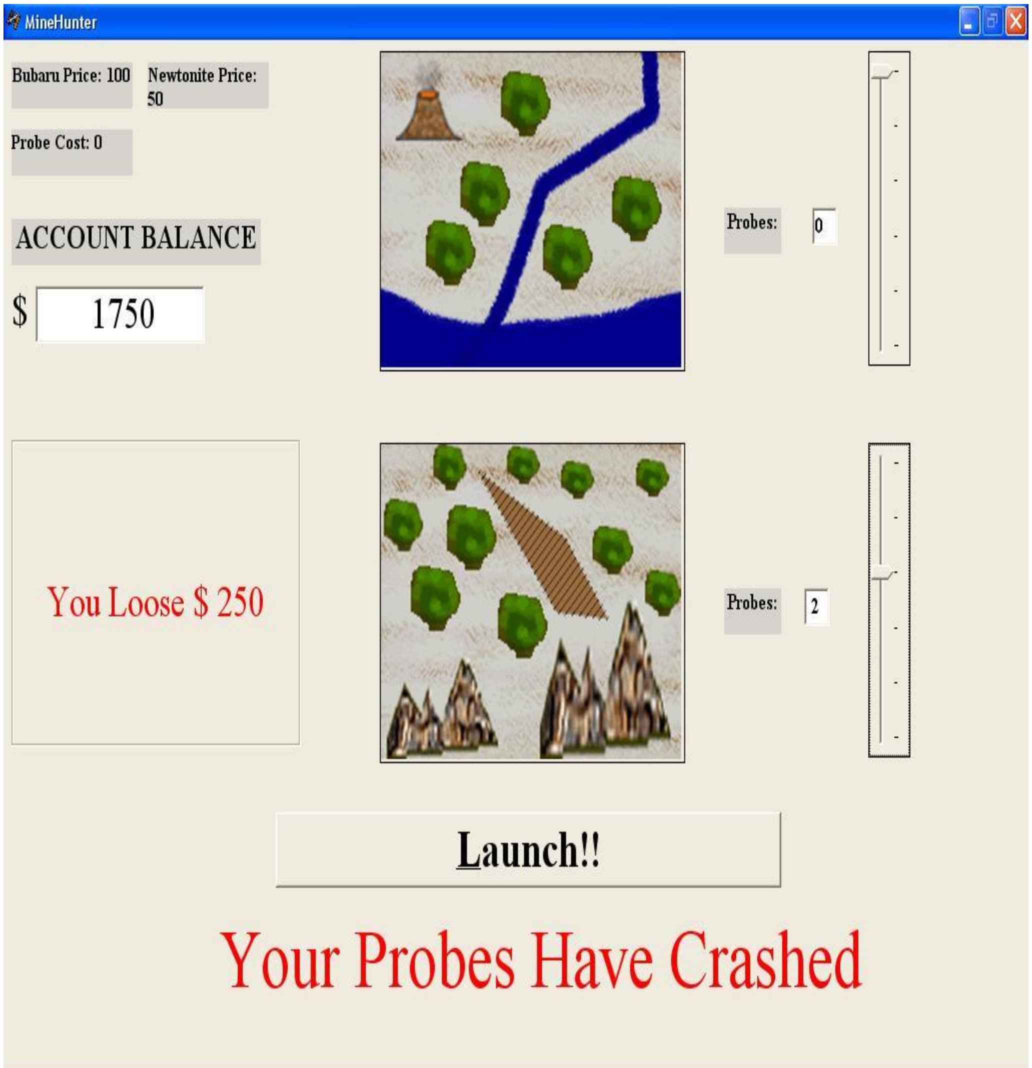
8) Who do you prefer to spend leisure time with? (circle one)

a) I prefer to be alone b) A few close friends c) The more the merrier

C. MineHunter Test Sheet

	X						
Number	Don’t Know	Field	Mountain	Tree	Cactus	Volcano	River
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

D. MineHunter Screen Capture



Vita

Patrick Lingenfelter is a third year graduate student in the doctoral program of Louisiana State University's (LSU) Department of Psychology. He completed his Bachelor of Arts degree at Nicholls State University in psychology with a minor at marine biology. He graduated Cum Laude and while at the university, was recognized by Who's Who Among American Colleges and Universities and was involved in the University Honors Program. After completing his undergraduate degree, he worked at Peltier-Lawless Developmental Center as an individual program coordinator. In this position, he planned and organized treatment programs for individuals with mental retardation and psychological disorders. He began his graduate training at LSU in 2006, pursuing a Doctor of Philosophy in psychology. He will complete the requirements for a Master of Arts in psychology in May of 2009. While at LSU, he served as a teaching assistant to Assistant Professor Beck for 'Sensation and Perception', Assistant Professor Rizzuto for 'Tests and Measures', and Associate Professor Hawkins for 'History of Psychology' and 'Psychophysiology'. Duties as a teaching assistant included reviewing and updating reading material, proctoring and grading examinations, organizing online discussion groups, and meeting with students on request.