Psychophysiological and Affective Correlates of Video Games

Senior Research Thesis

Presented in partial fulfillment of the requirements for graduation with research distinction in Psychology in the undergraduate colleges of The Ohio State University

by

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November 2013

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Abstract

Recent research has examined how playing video games affects young adults, with some evidence that playing video games can have a positive effect on cognition. Mixed results have been shown with mood. The present study sought to further examine the effect of video game play, gender, and "gamer" status on physiological functioning, mood, and cognition. Participants were 82 undergraduate students (31 females, mean age 19 [*SD* = 1.9]) who played one of four video games (human violence, zombie violence, racing, non-violent) for 30 minutes. Blood pressure, heart rate, and mood were assessed before, during, and after game play. In addition, sustained attention was assessed after video game play. Results indicated that males responded to video game play more negatively than females, and "gamers" had less physiological reactivity to game play than non-gamers. Heart rate was higher among individuals playing human violence or racing games than non-violent games. Finally, males and "gamers" had better performance on a measure of sustained attention. The results of this study have implications for the use of video games in treatments for depression and social anxiety.

Video game consoles were invented by Ralph H. Baer, William T. Rusch and William L. Harrison, with the invention patented on April 25, 1972 ("Television gaming apparatus and method," *United States Patents*). It was invented for individuals to use the television as an active rather than passive instrument ("Television gaming apparatus and method," *United States Patents*). Video games have come a long way, from games like Pong, Space Invaders, Pac-Man and Tetris, to newer games like Call of Duty and God of War. Many of the newer video games have a much more violent element, as, for example, players are tasked with killing enemy soldiers or organizing an invasion. What effect do these violent images and scenarios have on young players? What effect do they have psychological and cognitive functioning? Does the type of game played matter? The present study seeks to examine the effects of playing violent and nonviolent video games on heart rate, blood pressure, mood, and attention. First, previous research that has investigated the effects of video games on these factors will be reviewed.

Video Games and Aggression

The effects of violent video games on aggression have been extensively studied. A review of multiple studies indicated that exposure to violent video games is positively correlated with heightened levels of aggression, as well as physiological arousal, in children and adults, both males and females (e.g., Anderson & Bushman, 2001; Anderson & Dill, 2000; Anderson, Shibuya, Ihori, Swing, Bushman, & Saleem, 2010; Carnagey & Anderson, 2005; Kirsch, Olczak, & Mounts, 2005). Exposure to violent video games is also negatively correlated with prosocial behavior (helping and feeling concern or empathy towards others; Anderson & Bushman, 2001). In addition, a study of EEG readings in male undergraduate students found that playing violent video games desensitizes individuals to violence and increases levels of aggression (Bartholow, Bushman, & Sestir, 2005). However, some studies have shown that individuals who play video games cooperatively show increases in prosocial behavior and other cooperative play (Ewoldsen, Eno, Okdie, Velez, Guadagno, & DeCoster, 2012; Greitemeyer & Osswald, 2009). In addition, playing cooperative online games can improve social skills in children (Freddolino & Blaschke, 2008).

There have also been studies suggesting violent video games do not cause an increase in aggressive mood or behavior, but instead an increase in aggressive thoughts (Greitemeyer, Osswald & Brauer, 2010). For example, in a study of 345 adults (average age 19) who played video games, participants were randomly assigned to one of four conditions (low realism with high controller naturalness; low realism with low controller naturalness; high realism with low controller naturalness; high realism with high controller naturalness) while playing either Wii Sports: Boxing or Don King's Showtime Boxing for a 10 minute tutorial followed by 15 minutes of gameplay. Results indicated that greater immersion in the game resulted in increased cognitive aggression (McGloin, Farrar, & Krcmar, 2013). In a separate study of 83 adults, ages 18-22 (21 females), who played either a violent (Mortal Kombat vs. DC Universe, Resident Evil 5, Killzone 2, F.E.A.R. 2: Project Origin, or Call of Duty: Modern Warfare 2) or a non-violent video game (MotorStorm, NCAA Basketball: 2009, Sid Meier's Civilization Revolution, Little Big Planet, or Ferrari Challenge) for 20 minutes, results indicated that acute exposure to violent video games (regardless of the type of game played) increased aggressive thoughts compared to those who played nonviolent games (Engelhardt, Batholow, & Saults, 2011). In addition, particular individuals—those that were high in trait anger—were more susceptible to these effects of violent video games (Engelhardt et al., 2011). Many studies only focus on violent versus non-violent video games with regard to how playing video games affects level of aggression. Different types of games should be looked at, as well as other effects of playing various types of video games. In addition, equal numbers of male and female participants should be utilized in studies to determine if gender plays a role in the relationship between video game play and outcome variables.

Video Games and Mood

There is relatively little research focused on how playing video games affects mood. In a study of 143 adults who played one of three video games (Bejeweled 2, Bookworm Adventures, or Peggle) for 20 minutes, it was found that mood significantly improved regardless of the type of video game played (Russoniello, O'Brian, & Parks, 2009). It should be noted that none of the games used in this study would be considered violent games. In a separate study of 103 adults, playing video games (Hitman: Blood Money, Call of Duty 2, or Madden 2007) for 45 minutes resulted in decreased feelings of hostility and depression in comparison to those in a no-game condition (completion of Paced Auditory Serial Addition Task, a measure of working memory capacity; Ferguson & Reuda, 2010). The games in this study could be classified as violent (Hitmen: Blood Money and Call of Duty 2) or sporting (Madden 2007). In a study of 13 male adults (ages 18-26) who completed a measure of state mood and played a violent video game (Tactical Ops: Assault on Terror) during five functional neuroimaging sessions, it was found that greater activity in the temporal lobe during failure events (i.e., losses during video game play) was linked with a reduced negative affect response to the game (Mathiak et al., 2011). In other words, losses in the video game environment were linked with real-world negative mood. There were no significant findings for positive affect. Still other studies have shown decreased longer-term outcomes (i.e., depression) following video game play (Weaver et al., 2009). The previous studies have very different findings, with some showing improved mood and others decreased mood. This conflicting finding may be due to the variety of video games used across studies, and points towards examining different types of video games in the same study.

Video Games and Cognition

Although some studies show deficits in cognitive abilities following video game play (Hastings, Karas, Winsler, Way, Madigan, & Tyler, 2009), most have shown improvements in cognitive abilities. In a 14-week longitudinal study of primarily female older adults (ages 65-78), those who played various games from Wii Sports showed significant benefits on executive control and processing speed tasks compared to a group of participants who completed two 1-hour exergame sessions every week for 12 weeks (Maillot, Perrot, & Hartley, 2012). Regardless of the type of game played, improvements due to video game play have been shown across various cognitive abilities including working memory, selective attention, visuospatial perception, and task switching (Barlett, Vowels, Shanteau, Crow, & Miller, 2009; Boot, Kramer, Simons, Fabiani, & Gratton, 2008; Cherney, 2008; Ferguson, 2007; Dye, Green, & Bavelier, 2009; Green & Bavelier, 2006). These changes can depend on "gamer" status—experts tend to have a baseline (i.e., prior to the study session) higher level of cognitive function than non-gamers (Boot, Kramer, Simons, Fabiani, & Gratton, 2008). Although there is relatively little research focusing on video games and cognition, findings suggest that video games could have a positive effect on cognition.

Video Games and Physiological Reactivity

Although some research has shown heart rate (HR) and blood pressure (BP) changes following violent video game play, results have been inconsistent. Some have found increased HR and BP after playing violent video games (Anderson & Dill, 2000; Ballard & Lineberger, 1999; Ballard & West, 1996; Carroll, Turner, & Rogers, 1987; Panee & Ballard, 2002), as well as increased skin conductance responses (Lim & Lee, 2009), all of which can indicate increased cardiovascular reactivity and/or aggression. Other researchers have found opposing results (Ballard, Hamby, Panee, & Nivens, 2006; Russoniello et al., 2009). In a study of primarily male adolescents (ages 12-18) who played one of three games (NBA Live, Resident Evil, or Mortal Kombat) over three weekly sessions of 15 minutes each, BP decreased over each gaming sessions while HR remained reactive to the game in-session (Ballard et al., 2006). These results indicate that there may be some desensitization to the violence in video games over repeated playing. A second study supported these results. College students were randomly assigned to play one of four violent (Carmageddon, Duke Nukem, Mortal Kombat, or Future Cop) or non-violent (Glider Pro, 3D Pinball, 3D Munch Man, or Tetra Madness) games for 20 minutes with HR and galvanic skin responses taken every five minutes (Carnagey, Anderson, & Bushman, 2007). Next, they were shown a video of real violence for 10 minutes. Results showed desensitization to real violence after playing violent video games. Other studies have shown that physiological reactivity differs depending on gender, with increased variability among boys than girls (Ivarsson, Anderson, Akerstedt, & Lindblad, 2008).

Another series of studies of adolescents assessed different ways that video games could affect physiological functioning. In the first study, adults between the ages of 21 and 48 played either a racing (Burnout) or a non-racing (Tetris) game for 30 minutes, after which arousal was measured. During a second testing session, participants completed a measure of risk-taking, with results indicating that those who played the racing game took more risks in road traffic situations than those who played the non-racing game (Fischer et al., 2009). In the second study, a separate sample of adults played one of two different racing (Need for Speed, Burnout) or non-racing (Tak, Tetris) games prior to measuring driving-related risk-taking. Results again indicated higher levels of risk-taking in the racing game condition, regardless of the game played. In addition, players of racing games were more likely to perceive themselves as reckless drivers than players of neutral games (Fischer et al., 2009). In the final two studies, also using adult participants, results indicated that players of street racing games were more inclined to take risks in simulated critical road traffic situations than players of F1 driving and neutral games. In addition, participants who played a racing game perceived themselves more as a reckless driver than observers of racing games, players of neutral games, and observers of neutral games (Fischer et al., 2009).

Other results show that playing video games can decrease heart rate and blood pressure (Ballard, Hamby, Panee, & Nivens, 2006); this may be because different games were used in the studies. This was a longitudinal study of mostly male adolescents. There were 3 weekly sessions and participants were assigned to play 1 of 3 video games (*NBA Live, Resident Evil Director's Cut, Mortal Kombat).* We may also be seeing these differences because the studies mostly consist of males, and it is important to look at males and females equally.

The Present Study

Although much research has been conducted into the effect of playing violent video games on aggressive behaviors and thoughts, comparatively little research has examined how playing different types of video games affects mood, physiological reactivity, and attention. In addition, the gender of participants varies significantly across studies, with some including only male participants and others including at least some female participants. Finally, the research to date has overwhelmingly compared "violent" video game play to "nonviolent" video game play. Are all violent and non-violent games equivalent? Does the violence seen in a game with human violence have the same effect on individuals as a game with non-human violence or even a racing game? It is important to consider these variables when researching video games as it could help clarify some of the conflicting results of previous studies. The present study seeks to examine how gender, knowledge of video games (i.e., video game expertise), and the type of game played affect outcomes.

Based on previous research several hypotheses were made. First, it was hypothesized that female participants would experience a greater level of physiological functioning and a lower level of mood during and following video game play than male participants. It was also hypothesized that individuals who self-identified as “gamers” (i.e., individuals with a high level of video game expertise) would show less of a physiological or affective response to video games than non-gamers. Finally, several hypotheses were made regarding the type of video game played. It was hypothesized that those playing human violence and aggressive racing games would experience higher physiological reactivity during game play compared to those playing a non-violent game. In addition, it was hypothesized that those playing a human violence game would experience a greater decrease in mood compared to those playing other video games. Lastly, it was hypothesized that there would be no difference in physiological reactivity or mood between those playing the human violence and non-human violence games.

Method

Participants

Participants were 82 undergraduate students (31 female, 73.3% Caucasian), ages 18 –31 (mean age = 19, *SD* = 1.9), enrolled in an Introduction to Psychology course in which credit is given for participation in psychology experiments. Students signed up for the study via an online sign-up system.

Measures

Heart Rate. The Finger Pulse Oximeter MD300C1 by Choicemed was used to measure heart rate. Participants placed the oximeter over the first finger of their dominant hand, and a reading was completed in less than 10 seconds. Accuracy is +/-2 beats per minute.

Blood Pressure. The Diagnostic EW3109 by Panasonic was used to measure systolic and diastolic blood pressure. Readings were taken by placing a blood pressure cuff over the arm, which then self-inflated to provide a blood pressure reading. Participants placed the blood pressure cuff on their dominant arm, and a reading was completed in less than 20 seconds.

Demographics Questionnaire. The demographics questionnaire (Appendix A) was created for the present study and asked questions including participants' gender, age, and ethnic background.

Video Game History Questionnaire. This study-specific questionnaire assessed participants' history with video games (Appendix B). Questions asked about previous use of particular types of video games, frequency played, and whether the individual self-identified as a "gamer."

Positive and Negative Affect Schedule (PANAS). The PANAS measures current (state) positive and negative mood (Appendix C; Watson, Clark, & Tellegen, 1988). The 10-item positive affect subscale measures feelings of enthusiasm, activeness, and alertness (Watson et al., 1988). The 10-item negative affect subscale measures feelings of distress, such as anger, contemptuousness, fear, and nervousness (Watson et al., 1988). In terms of reliability, test-retest reliability after an 8-week interval was moderate (positive affect α = .54-.68; negative affect α = .45-.71; Watson et al., 1988). Negative affect scores are positively correlated and positive affect scores negatively correlated with the Beck Depression Inventory-II (Watson et al., 1988).

Beck Depression Inventory-II (BDI-II). The BDI-II measures the severity of depression (Beck, Steer, & Brown, 1996). It contains 21 items, each measured on a 0 (rare) to 3 (nearly all the time) scale. Summed total scores are categorized as follows: 0-13 minimal, 14-19 mild, 20-28 moderate, and 29-63 severe. In terms of reliability, internal consistency is high at .92 (Beck et al., 1996). Test-retest reliability after one week was also high at .93 (Beck et al., 1996). This measure is valid because it correlated with other measures of depression and suicidal ideation (Beck et al., 1996).

Conner's Continuous Performance Task. The Conner's Continuous Performance Task (CPT) measures symptoms and behaviors associated with adult Attention-Deficit/Hyperactivity Disorder (ADHD; Conners, 2000). Confidence index values above 50% indicate a closer match to a clinical profile, and values below 50% indicate a closer match to a non-clinical profile. Values between 40% and 60% are inconclusive (Conners, 2000). In terms of reliability, split-half reliability is high (α =.66-.95; Conners, 2000). 3-month test-retest reliability was moderate (Conners, 2000). Individuals with ADHD scored higher than individuals without ADHD, with 87% specificity (Conners, 2000). There is a positive correlation between CPT scores and self-reported ADHD symptoms (Conners, 2000). Dependent variables included total performance (determined by likelihood of ADHD diagnosis) and detectability (accurate detection of the target stimulus in milliseconds).

Video Games. Several different types of video games were examined in the present study. <u>Dead Island</u> is a first-person shooter zombie game. It has a close-quarters melee focus in which zombies can attack the player from all directions. <u>Call of Duty: Modern Warfare 3</u> is also a first-person shooter in which American forces fight a Russian forces invasion. <u>LittleBigPlanet</u> is a non-violent game that allows the player to explore a world of sock-puppet creatures and interact with the environment. Need For Speed: Hot Pursuit is a high energy racing game that allows players to race high-performance vehicles against other racers, as well as earn points by evading and destroying pursuing police vehicles. For each game, all participants played the same levels/courses in the same order.

Procedure

Students enrolled in psychology courses that provided credit for research participation saw information about the study on an online sign-up system. They were provided with information about the potential use of violent video games in the study, and interested participants were able to sign-up for a session. Prior to the scheduled sessions, all participants were randomly assigned to play one of four video games: violent (Call of Duty: Modern Warfare 3), zombie violent (Dead Island), non-violent (Little Big Planet), or racing (Need for Speed: Hot Pursuit).

Upon arrival at the experimental session, all participants provided written informed consent. Baseline blood pressure (BP) and heart rate (HR) readings were taken. Next, participants completed a series of questionnaires, presented in a random order, including the video game history questionnaire, BDI-II, and PANAS. Participants were then given a tutorial on the assigned video game, including information regarding play controls and how to start/pause/stop the game. HR and BP were again measured prior to video game play. During video game play, a depiction of the game controller with the appropriate controls for the selected game was provided for each participant's reference, if needed. Each participant then played the assigned game for 30 minutes. BP and HR were monitored at five-minute intervals. After completion of video game play, participants completed a second administration of the PANAS, the CPT, and several additional tasks as part of a larger study. HR and BP were monitored every

15 minutes during the remainder of the study session. At the end of the session, participants were debriefed and given course credit for their participation.

Data Analysis

The hypotheses were tested as follows. To assess for gender differences in HR, BP, mood, and attention, a series of independent-samples *t*-tests were conducted. To assess for "gamer/non-gamer" (as determined by self-report) differences in these variables, a second set of independent-samples *t*-tests were conducted. To assess whether the type of game played mattered, a series of one-way ANOVAs were conducted, with type of game as the between-subjects variable. The dependent variables were as follows: HR (average of two measurements *before* video game play, average of six measurements *during* video game play, average of two to four measurements *after* video game play), BP (average of two measurements *before* video game play, average of six measurements *during* video game play, average of two to four measurements *after* video game play), mood (measured *before* and *after* video game play), and attention (total performance and detectability).

Results

Gender Results

More men (51) than women (31) completed the study. There were no differences between men and women in terms of depressive symptoms, $t(78) = 0.545$, $p = .587$; however, more men than women self-identified as "gamers," $t(79) = -3.646$, $p < .001$. In terms of HR, there were no significant findings prior to, $t(80) = 1.688$, $p = .095$; during, $t(80) = 0.167$, $p = .868$; or after, $t(77) = 0.577$, $p = .566$, video game play. Significant differences were found for BP (systolic): men had higher BP values than women before, $t(78) = -2.931$, $p = .004$; during, $t(78) = -3.789$, $p < .001$; and after, $t(74) = -2.890$, $p = .005$, video game play. No differences were found for BP (diastolic) at any of the time points (*p*s > .147). Prior to video game play, men were in a more positive mood than women, $t(80) = -2.495$, $p = .015$; however, there were no differences between genders in positive mood after video game play, $t(76) = -0.845$, $p = .401$. In terms of negative mood, there were no differences prior to video game play, $t(80) = -0.348$, $p = .729$; but men endorsed more negative mood following video game play than women, $t(76) = 2.550$, $p = .013$. On the CPT, there was no gender difference found in total performance, $t(58) = 0.182$, $p = .856$; but men had greater detectability (i.e., accuracy) than women, $t(58) = 2.006$, $p = .050$.

Gamer Results

All participants reported a history of playing video games, but only 70/84 indicated they currently play video games. 45/85 self-identified as a "gamer." There were no differences between self-identified gamers and non-gamers in terms of depression symptoms $t(78)=-0.217$, $p = .829$. There were also no differences prior to game play between self-identified gamers and non-gamers for positive, $t(81)= -1.754$, $p = .083$, or negative, $t(81) = -0.698$, $p = .487$, mood. In addition, no differences between games and non-gamers were found after game play for positive, $t(78) = -1.246$, $p = .217$, or negative, $t(78) = 0.675$, $p = .502$ mood. In terms of HR, non-gamers had higher HR prior to game play than gamers, $t(82) = 2.324$, $p = .023$. Non-gamers continued to show a higher HR during video game play as well, $t(82) = 2.272$, $p = .026$. No differences were seen in HR after game play, $t(79) = 1.107$, $p = .271$. No significant differences were found for BP (systolic) before, $t(80) = -1.355$, $p = .179$; during, $t(80) = -1.204$, $p =.232$; or after, $t(76) = -0.335$, $p = .739$ video game play. No significant differences were found for BP (diastolic) at any of the time points ($ps>.161$). On the CPT, non-gamers had worse overall performance than gamers, indicating a greater likelihood of impairment on the task, $t(60) = 2.095$, $p = .040$; but no significant differences were found for detectability, $t(60) = 0.430$, $p = .668$.

Type of Game Results

Due to the small sample size of the game type groups, the following analyses should be considered exploratory. Individuals in the Violent game group had higher BDI-II scores than individuals in the Racing game group, $F(4,76) = 2.949$, $p = .025$. No differences were seen between groups in positive [$F(4,79) = 0.570$, $p = .685$] or negative [$F(4,79) = 0.182$, $p = .947$] mood before the video game was played, nor in positive [$F(4,76) = 1.878$, $p = .123$] or negative [$F(4,76) = 1.963$, $p = .109$] mood after video game play. There were no significant differences between video game groups on average blood pressure before [systolic: $F(4,78) = 1.446$, $p = .227$; diastolic: $F(4,78) = 0.912$, $p = .461$], during [systolic: $F(4,78) = 0.864$, $p = .489$; diastolic: $F(4,78) = 0.368$, $p = .831$] or after [systolic: $F(4,74) = 0.289$, $p = .884$; diastolic: $F(4,74) = 1.535$, $p = .201$] game play. In terms of HR, there were no differences for the type of game played before [$F(4,80) = 1.193$, $p = .320$], during [$F(4,80) = 1.021$, $p = .402$], or after [$F(4,77) = 1.605$, $p = .182$]. On the CPT, no differences were found for the overall scores [$F(4,57) = 1.229$, $p = .309$] or detectability [$F(4,57) = 0.229$, $p = .921$].

Several specific hypotheses were tested about the type of video game played. There were no mood differences found before or after game play for those in the human violence condition compared to the other gaming conditions ($ps > .281$). There was, however, a significant difference in average BP before game play, $t(81) = 2.175$, $p = .033$, with those in the human violence and racing game conditions (combined) having higher BP (systolic) before game play. No significant differences were found for average BP (systolic) during game play, $t(81) = 0.779$, $p = .435$, or after game play, $t(77) = 0.572$, $p = .569$. In addition, there were no differences between the human violence and racing game combined group and the non-violent game group in terms of BP (diastolic) before ($p = .067$), during ($p = .333$), or after ($p = .966$) video game play. Finally, there was a marginally significant difference between the combined human violence/racing group and non-violent group in terms of HR after video game play, $t(80) = 1.927$, $p = .058$, with those in the combined group experiencing a higher HR than those in the non-violent group. When the human violence and zombie violence conditions were compared, no differences emerged in mood (ps > .382), BP (ps > .104), or HR (ps > .185).

Discussion

The present study sought to examine whether gender, gamer status, and the type of video game played affected heart rate, blood pressure, and mood. Several hypotheses were tested. First, it was hypothesized that females would show higher physiological reactivity and lower mood due to video game play than males. The results do not support this hypothesis. Instead, males had higher blood pressure than females across all three time points, a finding consistent with previous research showing males in general have higher BP readings than females (Ivarsson et al., 2008). In addition, the present results show that males endorsed greater negative mood than females following video game play, contrary to prediction. It is possible males could have taken the game (regardless of the specific game played) more seriously and more competitively, resulting in higher negative real-world mood from losses in the game environment. Thus, no support exists to show that females have a worse affective and physiological response to video game play than males.

Second, it was hypothesized that gamers would show less physiological and mood response than non-gamers. Our results partially support this hypothesis. Non-gamers showed higher HR than gamers before and during game play, but no differences were found after game play. In addition, no differences were found for BP before, during, or after game play, or in positive or negative mood between gamers and non-gamers. Comparing self-reported state mood between gamers and non-gamers has not been specifically addressed in the literature, which has instead focused on HR and BP (Anderson & Dill, 2000; Ballard & Lineberger, 1999; Ballard & West, 1996; Carroll, Turner, & Rogers, 1987; Panee & Ballard, 2002). Those who self-identified as a gamer could have shown lower HR before and during game play because they find playing games therapeutic and relaxing. Those who are non-gamers may be less familiar with the games and the game controls, resulting in feelings of nervousness and a stressful gaming experience. In addition, there may have not been any significant findings for gamers and non-gamers in relation to mood due to the small sample size. In the present study, we relied on self-reported status as a "gamer" or "non-gamer." It is possible that some individuals who play video games frequently, per standards set in previous studies (e.g., Weaver, Mays, Weaver, Kannenberg, Hopkins & Bernhardt, 2009), would qualify as a gamer but do not self-identify as such. The present results suggest that self-identified "gamers" do experience less physiological but not affective reactivity to video game play, indicating some physiological tolerance may occur over repeated playing.

Third, it was hypothesized that playing human violence and racing games would result in higher physiological reactivity than playing non-violent games. Our results suggest that HR was marginally increased following video game play for those in the human violence and racing game conditions compared to those in the non-violent game condition. It is possible that playing violent and aggressive games requires quick-thinking and movements in response to action, resulting in greater HR. In addition, there were no differences in BP across these game conditions. These findings are consistent with a previous study showing BP decreasing over each gaming sessions while HR remained reactive to the game in-session (Ballard, Hamby, Panee, & Nivens, 2006). Here, HR but not BP was reactive to the game in-session, further supporting these previous results.

Fourth, it was hypothesized that those playing the human violence game would experience a decrease in mood versus those playing other games. The results do not support this hypothesis. Previous research has suggested that exposure to violent games desensitizes individuals to violence (Bartholow et al., 2005), which could result in violence having no effect on mood. There may have not been any significant findings due to the small sample size and unequal number of male and female participants. Because of these factors, mixed models investigating the combined influence of gender, gamer status, and type of game played could not be conducted. Another possible reason for the lack of finding could be the types of games played. It is possible that the level of violence in each of the games negated any differences in the content between games. On the other hand, differences in how the games were played (i.e., first-person shooter with distant combat; first-person shooter with up-close combat; racing; side-to-side play) could have affected participant reactions.

Fifth, it was hypothesized that there would be a significant difference in mood and physiological reactivity when comparing human violence and zombie violence game conditions. The results do not support this hypothesis—there were no differences in mood or physiological reactivity between those playing the human violence game and those playing the zombie violence game. It is possible that we found no results here because the human violence and zombie violence are so similar. In both games, participants were tasked with killing enemy combatants, either human zombies or human enemies. Previous studies examining multiple violent games in the same study have not always examined equivalency in the games used (e.g., Fischer et al., 2009). The results of the present study indicate that the results are consistent for these violent games and lead towards the idea that the violence itself, rather than the context of the violence, is what affects performance.

For the CPT, our findings suggest that men were more accurate than women, and that gamers had better overall performance when compared to non-gamers. These two findings may be related since more men self-identified as gamers than did women. When looking at the type of game played and performance on the CPT, there were no significant findings. The present results are consistent with previous findings in which cognitive abilities, including working memory, selective attention, visuospatial perception, and task switching, improved regardless of the type of video game played (Barlett, Vowels, Shanteau, Crow, & Miller, 2009; Boot, Kramer, Simons, Fabiani, & Gratton, 2008; Cherney, 2008; Dye, Green, & Bavelier, 2009; Ferguson, 2007; Green & Bavelier, 2006). The results are also consistent with findings from another study where experts tended to have a baseline higher level of cognitive function than non-gamers (Boot et al., 2008). Taken together, the present findings suggest that playing video games can improve cognition.

Limitations

There were several limitations to this study. We did not have high quality HR and BP monitoring equipment. If we were to have better equipment we may have been better able to determine more subtle differences in physiological reactivity. One of our biggest limitations was the fact that we did not have an equal number of female gamers to male gamers as well as females to males in general. This could affect our gender and gamer analyses because we may not able to accurately compare the groups since we had such a higher number of males and the majority of gamers were male. With a larger sample size, these factors could have been more fully assessed. It is possible that the different video games used in the present study were not equivalent in terms of engagement and interest, in turn affecting how invested participants were in the game and its outcome.

In the beginning of data collection, participants were not able to complete all the study tasks due to time constraints. This may have affected our results because that lowers the amount of people for each task that were assigned for after game play. We also did not limit caffeine or nicotine use before the study. This could have affected our results because caffeine and nicotine use can increase physiological functioning, resulting in a higher HR and BP to begin with and that could have been why we did not have many significant findings for physiological functioning. Lastly we did not record the quality and amount of sleep for the night before the study. This could have affected our results because if participants did not sleep enough or very well, they could have performed poorly on cognitive and attention tasks, such as the CPT. Collectively, these potential limitations may have negatively affected our results.

Conclusions

Collectively, the present findings suggest improved cognition among self-identified gamers, worse mood among males following game play, and higher heart rate in non-gamers before and during game play. Many of these findings fit into the current literature as they confirm and extend previous results showing improved cognition due to video game play. However, the finding that only males experienced a decrease in mood is novel and warrants additional research to determine if this is due to the losses in the game or to some other factor. The present study has implications for students, as it shows that playing video games can help increase cognitive performance, and future research should examine whether video game play can improve or impair academic performance in general. Before video games are used as a treatment for depression, social anxiety, and other disorders, additional research is needed to determine why males may experience a negative reaction to game play. In addition, the use of multiple different violent and non-violent video games in the same study would allow for a more in-depth analysis of the effects of video game play, independent of the specific game used.

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Table 1.

Study variables presented as mean (standard deviation)

Variable	Males	Females	Gamer	Non-Gamer
N	51	31	45	39
BDI	8.22 (7.42)	9.10 (6.19)	8.74 (7.19)	8.41 (6.68)
Pre- measures:				
PANAS-P	3.18 (0.76)[b]	2.74 (0.80)	3.14 (0.73)	2.84 (0.86)
PANAS-N	1.57 (0.57)	1.53 (0.56)	1.59 (0.60)	1.50 (0.52)
BP-Top	128.21 (10.41)[a]	121.33 (9.48)	127.20 (11.38)	123.93 (10.21)
BP-Bottom	76.82 (8.53)	75.45 (7.08)	77.33 (6.52)	74.89 (9.12)
HR	71.80 (10.07)	75.98 (12.10)	70.68 (9.10)[c]	75.88 (11.41)
During measures:				
BP-Top	125.15 (8.80)[a]	117.44 (8.67)	123.63 (8.47)	121.08 (10.74)
BP-Bottom	78.50 (6.90)	76.06 (7.67)	78.35 (6.45)	76.53 (7.80)
HR	71.97 (9.04)	72.34 (10.58)	69.62 (8.05)[c]	74.13 (10.13)
Post- measures:				
PANAS-P	3.05 (0.86)	2.88 (0.94)	3.08 (0.82)	2.84 (0.94)
PANAS-N	1.41 (0.45)[b]	1.74 (0.71)	1.48 (0.50)	1.57 (0.66)
BP-Top	125.19 (11.16)[a]	117.38 (11.72)	122.29 (10.35)	121.35 (14.39)
BP-Bottom	78.16 (10.14)	76.26 (8.89)	75.95 (8.48)	78.93 (10.60)
HR	69.11 (10.77)	70.54 (10.74)	68.14 (10.10)	70.67 (10.44)
CPT Dx	68% Clinical	68% Clinical	55% Clinical[c]	80% Clinical
CPT Detect	55.69 (8.85)[b]	59.71 (5.48)	56.68 (8.56)	57.55 (7.11)

[a]Men > Women, $p < .01$; [b]Men > Women, $p < .05$.

[c]Gamer > Non-Gamer, $p < .05$.

Note: BDI = Beck Depression Inventory-II; PANAS = Positive and Negative Affect Schedule, Positive (P) and Negative (N); BP = blood pressure; HR = heart rate; CPT = Continuous Performance Task, Diagnosis (Dx) and Detectability (Detect).

Table 2.

Video game data presented as mean (standard deviation)

Variable	Violent	Zombie	Racing	Non-Violent
N	21	18	17	15
Gender (#F/#M)	7/21	6/18	7/10	4/10
BDI	12.10 (5.42)[a]	9.06 (7.76)	5.47 (4.45)	8.46 (6.67)
Pre- measures:				
PANAS-P	3.04 (0.60)	3.00 (0.67)	2.79 (1.05)	3.22 (0.94)
PANAS-N	1.61 (0.53)	1.51 (0.42)	1.59 (0.61)	1.49 (0.46)
BP-Top	127.85 (10.75)	123.00 (6.45)	130.18 (11.88)	125.67 (15.35)
BP-Bottom	77.85 (6.80)	75.11 (6.10)	78.62 (10.01)	74.23 (10.02)
HR	77.24 (10.36)	72.47 (11.73)	73.85 (10.67)	69.57 (10.24)
During measures:				
BP-Top	122.75 (9.37)	120.36 (7.27)	124.35 (11.08)	125.11 (9.35)
BP-Bottom	78.74 (7.66)	76.65 (5.91)	78.19 (7.97)	78.00 (7.75)
HR	74.88 (8.13)	71.37 (11.40)	72.00 (8.69)	68.49 (8.68)
Post- measures:				
PANAS-P	3.04 (0.70)	2.80 (0.95)	3.46 (0.94)	2.84 (0.90)
PANAS-N	1.64 (0.64)	1.49 (0.44)	1.72 (0.79)	1.20 (0.25)
BP-Top	122.76 (10.84)	123.00 (8.52)	123.06 (14.11)	121.25 (15.52)
BP-Bottom	75.86 (7.60)	81.11 (11.88)	79.06 (11.91)	73.67 (4.37)
HR	73.53 (11.03)	69.50 (11.40)	70.83 (9.24)	64.58 (9.29)
CPT Dx	53% Clinical	67% Clinical	73% Clinical	64% Clinical
CPT Detect	58.03 (8.29)	55.80 (7.72)	56.31 (10.38)	57.22 (6.69)

[a]Violent > Racing, $p < .05$.

Note: BDI = Beck Depression Inventory-II; PANAS = Positive and Negative Affect Schedule, Positive (P) and Negative (N); BP = blood pressure; HR = heart rate; CPT = Continuous Performance Task, Diagnosis (Dx) and Detectability (Detect).

Appendix A
Demographic and Background Information

1. Gender: Male _____ Female _____

2. Age: __________

3. Educational Level:

First year college	_____	Fourth year college	_____
Second year college	_____	Fifth year college	_____
Third year college	_____	Other: ___________________	

4. What is your approximate GPA?

Below 1.00	_____	2.50 – 2.99	_____
1.00 – 1.49	_____	3.00 – 3.49	_____
1.50 – 1.99	_____	3.50 or higher	_____
2.00 – 2.49	_____		

5. Which best describes your ethnic background (check as many as needed):

Caucasian	_____	Black/African-American	_____
Hispanic	_____	American Indian or Alaska Native	_____
Asian or Pacific Islander	_____	Other: _____________________	

6. Have you ever received a diagnosis of Attention-Deficit/Hyperactivity Disorder (ADHD) or Attention-Deficit Disorder (ADD)?

Yes __________
No __________

If Yes, subtype: Inattentive __________
Hyperactive __________
Combined __________

7. How old were you when you were diagnosed with ADHD or ADD? __________

8. What current medications are you taking to treat ADHD/ADD?

____

9. If you are currently receiving medication to treat ADHD/ADD, when did you last take your medication? __________

10. Have you ever received a diagnosis of a Learning Disorder (LD), such as a Reading Disorder, Writing Disorder, or Math Disorder?

Yes __________
No __________

11. How old were you when you were diagnosed with an LD? ___________

12. Have you ever received a psychiatric diagnosis, such as depression, anxiety, Bipolar Disorder, or Schizophrenia?

Yes ___________

Specify: ___________

No ___________

13. How old were you when you received a psychiatric diagnosis? ___________

14. Are you currently, or have you in the past, received treatment for a psychiatric disorder?

Yes, currently ___________

Yes, in the past ___________

Yes, currently and in the past ___________

No, never ___________

15. Have you ever been diagnosed with a Traumatic Brain Injury (TBI) or a head injury?

Yes ___________

How many? ___________

No ___________

16. Are you currently experiencing any cognitive (thinking) difficulties related to a head injury?

Yes ___________

How long ago was the injury? ___________

No ___________

17. Have you ever experienced a concussion, such as while playing sports?

Yes ___________

No ___________

18. How many concussions have you experienced in your lifetime? ___________

19. Do you drink caffeinated beverages, such as caffeinated soft drinks, coffee, and tea?

Yes, regularly ___________

Yes, every now and then ___________

No ___________

20. During the past 30 days, on how many did you drink a caffeinated beverage? ___________

21. How many caffeinated beverages do you drink per day, on average? ___________

22. Do you consider yourself a regular or social cigarette smoker?

    Social ___________
    Regular ___________
    Neither ___________

23. During the past 30 days, on how many did you smoke cigarettes? ___________

24. How many cigarettes do you smoke per day, on average? ___________

25. Have you ever tried to quit smoking cigarettes?

    Yes, and I do not smoke cigarettes now ___________
    Yes, but I returned to smoking cigarettes ___________
    Number of quit attempts: ________________
    No, I have never tried to quit smoking cigarettes ___________
    No, I have never smoked cigarettes ___________

26. During the past 30 days, on how many days did you use chewing tobacco or snuff? ___________

27. How old were you when you first starting using chewing tobacco? ___________

28. Do you currently drink alcohol?

    Yes, Regularly ___________
    Yes, Socially ___________
    No ___________

29. During the past 30 days, on how many days did you have at least one drink of alcohol? ___________

30. During the past 30 days, on how many days did you have 5 or more drinks of alcohol in a row (i.e., within a couple of hours)? ___________

31. Have you ever tried to quit drinking alcohol?

    Yes, and I do not drink alcohol now ___________
    Yes, but I returned to drinking alcohol ___________
    Number of quit attempts: ___________
    No, I have never tried to quit drinking alcohol ___________
    No, I have never drank alcohol regularly ___________

32. Do you consider yourself a regular or social user of marijuana?

    Social ___________
    Regular ___________
    Neither ___________

33. During the past 30 days, on how many days did you use marijuana? ___________

34. When you used marijuana in the past 30 days, how much would you use per day? ___________

35. Do you consider yourself a regular or social user of cocaine?

Social ___________
Regular ___________
Neither ___________

36. During the past 30 days, how many times did you use any form of cocaine? ___________

37. Do you currently use pain medications (such as codeine, Percocet, Oxycontin, morphine, etc.) without a doctor's prescription, OR do you take more of these medications than is prescribed?

Yes ___________
No ___________

38. During the past 30 days, on how many days did you use pain medications not following a doctor's prescription? ___________

39. How many times in the past 30 days did you use inhalants (sniffing glue, breathing contents of aerosol cans, inhaling paints/sprays)? ___________

40. How many times in the past 30 days did you use steroids without a doctor's prescription? ___________

41. How many times in the past 30 days did you use other illegal substances, such as LSD, PCP, ecstasy, mushrooms, speed, ice, or heroin? ___________

42. How many times in the past 30 days did you mix alcohol with other substances? ___________

Appendix B

Video Game History Questionnaire

1. Have you ever played video games or computer games?
   Yes ___________ No ___________

2. Would you consider yourself a "gamer?"
   Yes ___________ No ___________

3. Do you currently play video or computer games?
   Yes ___________ No ___________

4. When did you first start playing video or computer games?
   Age started ___________

5. When did you first start playing violent video or computer games?
   Age started ___________

6. What game system(s) do you use (choose all that apply):

Nintendo Wii	___________	Nintendo 3D or 3DS	___________
PlayStation	___________	PSP	___________
Xbox	___________	iPhone /iPad	___________
Gameboy	___________	Computer	___________

   Other (please specify): ___________

7. How long have you owned each gaming system?

Nintendo Wii	___________	Nintendo 3D or 3DS	___________
Playstation	___________	PSP	___________
Xbox	___________	iPhone /iPad	___________
Gameboy	___________	Computer	___________

   Other (please specify): ___________

8. How many games do you currently own for each gaming system?

Nintendo Wii	___________	Nintendo 3D or 3DS	___________
Playstation	___________	PSP	___________
Xbox	___________	iPhone /iPad	___________
Gameboy	___________	Computer	___________

   Other (please specify): ___________

9. How many hours per day, on average, do you play video games?
   Weekdays ___________
   Weekends ___________

10. How many hours per day, on average, do you play computer games?
    Weekdays ___________
    Weekends ___________

11. How many hours per day, on average, do you play **violent** video games?
    Weekdays ___________
    Weekends ___________

12. How many hours per day, on average, do you play **violent** computer games?
    Weekdays ___________
    Weekends ___________

13. How often do you play each of the following types of video/computer games?

	Days/week	Hours/day
Action/adventure	___________	___________
Arcade-like with violent themes (such as Asteroids)	___________	___________
Arcade-like without violence (such as Tetris)	___________	___________
Human violence	___________	___________
Non-human violence (such as Legend of Zelda)	___________	___________
Role playing	___________	___________
Sporting	___________	___________
Strategy	___________	___________

14. How often do you play each of the following types of video/computer games…
    With a partner in person

	Days/week	Hours/day
Action/adventure	___________	___________
Arcade-like with violent themes (such as Asteroids)	___________	___________
Arcade-like without violence (such as Tetris)	___________	___________
Human violence	___________	___________
Non-human violence (such as Legend of Zelda)	___________	___________
Role playing	___________	___________
Sporting	___________	___________
Strategy	___________	___________

<u>With a partner online</u>

	Days/week	Hours/day
Action/adventure	___________	___________
Arcade-like with violent themes (such as Asteroids)	___________	___________
Arcade-like without violence (such as Tetris)	___________	___________
Human violence	___________	___________
Non-human violence (such as Legend of Zelda)	___________	___________
Role playing	___________	___________
Sporting	___________	___________
Strategy	___________	___________

<u>Alone</u>

	Days/week	Hours/day
Action/adventure	___________	___________
Arcade-like with violent themes (such as Asteroids)	___________	___________
Arcade-like without violence (such as Tetris)	___________	___________
Human violence	___________	___________
Non-human violence (such as Legend of Zelda)	___________	___________
Role playing	___________	___________
Sporting	___________	___________
Strategy	___________	___________

15. What are the top 5 games that you currently play?
    Game 1 ____
    Game 2 ____
    Game 3 ____
    Game 4 ____
    Game 5 ____

16. What category of video games (see #13) would you place your responses to #15?
    Game 1 ____
    Game 2 ____
    Game 3 ____
    Game 4 ____
    Game 5 ____

17. How often do you play the games from #15?

	Days/week	Hours/day
Game 1	___________	___________
Game 2	___________	___________
Game 3	___________	___________
Game 4	___________	___________
Game 5	___________	___________

18. How violent are the content and graphics in the games from #15, using the following scale:

1 2 3 4 5 6 7

not at all violent moderately extremely violent

	Violent Content	Violent Graphics
Game 1	___________	___________
Game 2	___________	___________
Game 3	___________	___________
Game 4	___________	___________
Game 5	___________	___________

19. Do you live with someone who plays video or computer games?

Yes ___________ No ___________

20. How often, on average, do you watch someone play video or computer games?

Days per week ___________
Hours per day: weekday___________
Hours per day: weekend___________

21. Do you find video/computer games to be relaxing?

Yes ___________ No ___________

22. Do you find video/computer games to be stressful?

Yes ___________ No ___________

23. Do you find video/computer games to be calming?

Yes ___________ No ___________

24. Do you find that playing video/computer games makes you more worried?

Yes ___________ No ___________

25. Do you find that playing video/computer games makes you more alert?

Yes ___________ No ___________

26. Do you find that playing video/computer games makes you more irritated?

Yes ___________ No ___________

27. Do you ever play video/computer games instead of doing homework or studying?
Yes ___________ No ___________

28. Do you ever miss class or work in order to play video or computer games?
Yes ___________ No ___________

29. Do you ever lose sleep (i.e., stay up too late at night) in order to play video or computer games?
Yes ___________ No ___________

30. What is your handedness?
Right handed ___________
Left handed ___________
Ambidextrous ___________

Post Game Questionnaire

1. Have you played this game before?

Yes ___________ No ___________

2. How familiar are you with this game?

Extremely familiar ___________
Pretty familiar ___________
Moderately familiar ___________
A little familiar ___________
Not at all familiar ___________

3. Did you find this game difficult to play?

Yes ___________ No ___________

4. Did you find this game frustrating/stressful to play?

Yes ___________ No ___________

5. How enjoyable did you find playing the video game today?

1	2	3	4	5
Not at all				Extremely

6. How relaxing did you find playing the video game today?

1	2	3	4	5
Not at all				Extremely

7. How arousing did you find playing the video game today?

1	2	3	4	5
Not at all				Extremely

8. How frustrating did you find playing the video game today?

1	2	3	4	5
Not at all				Extremely

9. How violent would you rate the game you just played?

1	2	3	4	5
Not at all				Extremely

10. How well did you play in comparison to how well you wanted to play?

1	2	3	4	5
Not at all like I wanted to				Just like I wanted to

11. Did you deviate at all from the game instructions?

Yes ___________ (please explain: ____)
No ___________

Appendix C

PANAS

Directions: This scale consists of a number of words that describe different feelings and emotions. Read each item and then circle the appropriate answer next to the word. Indicate to what extent you feel this way **right now**.

	Very Slightly	A Little	Moderately	Quite a Bit	Extremely
1. Interested	1	2	3	4	5
2. Distressed	1	2	3	4	5
3. Excited	1	2	3	4	5
4. Upset	1	2	3	4	5
5. Strong	1	2	3	4	5
6. Guilty	1	2	3	4	5
7. Scared	1	2	3	4	5
8. Hostile	1	2	3	4	5
9. Enthusiastic	1	2	3	4	5
10. Proud	1	2	3	4	5
11. Irritable	1	2	3	4	5
12. Alert	1	2	3	4	5
13. Ashamed	1	2	3	4	5
14. Inspired	1	2	3	4	5
15. Nervous	1	2	3	4	5
16. Determined	1	2	3	4	5
17. Attentive	1	2	3	4	5
18. Jittery	1	2	3	4	5
19. Active	1	2	3	4	5
20. Afraid	1	2	3	4	5