STRESS-INDUCED ANALGESIA THROUGH VIDEO GAME PLAY

A Thesis
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FOREWORD

This thesis is written in accordance with the style of the *Publication Manual of the American Psychological Association (6th Edition)* as required by the Department of Psychology at Appalachian State University

I would like to thank my thesis chair, Mary E. Ballard, for her patience and guidance throughout this thesis process. Additional thanks are warranted to my dedicated thesis committee, Dr. McElroy and Dr. Zrull, and the undergraduate research assistants serving in the research lab including Mary Burton, Mary Cantrell, Trevor Dennie, Kelly Liner, James Mills, Russell Patton, Scott Rusk, and Wes Taylor. Finally, I wish to dedicate this thesis to my parents, Gregg and Nancy Jocoy. Their love and support has made my graduate school experience possible.

Running head: SIA THROUGH VIDEO GAMES

Stress-Induced Analgesia Through Video Game Play

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Abstract

Research on the positive effects of video game play suggests that video games provide an analgesic effect. The majority of research examining the analgesic properties of video games has suggested that cognitive distraction is the primary mechanism that drives this phenomenon. Playing video games also results in an increase in blood pressure, particularly diastolic blood pressure. This increase in blood pressure may also be responsible for the analgesic effects of video games through the process of stress-induced analgesia (SIA) and is often not examined in studies of video game distraction. The current study aimed to determine if the analgesia from video games is related to the changes in blood pressure via SIA. To test this, participants played one of three video games with varying levels of stress or were assigned to a drawing control. All were subjected to pain using a cold pressor. I expected that participants who played the most stressful game (Cold Fear) would exhibit greater reported levels of stress, larger increases in blood pressure, longer pain thresholds, and higher pain tolerances than those in the less stressful conditions (Soul Calibur 3, Snowboard Supercross 3, and Drawing). While gaming condition was related to perceived stress and frustration, there was no effect of gaming condition on any measure of pain perception or blood pressure. Diastolic blood pressure was most related to pain perception; however the effect was not significant. Because the game did not elicit the desired physiological reactivity, I could not determine the role of blood pressure in analgesia through video games. These results suggest that while the gaming conditions effectively induced stress, they did not bring about the desired effects of SIA.

Stress-Induced Analgesia Through Video Game Play

The perception of pain is highly influenced by situational factors, such as distraction (Kolko & Rickard-Figueroa, 1985; Vasterling, Jenkins, Tope, & Burish, 1993), anger (Greenwood, Thurston, Rumble, Waters, & Keefe, 2003), and stress (Beecher, 1959). Stress-induced analgesia (SIA) is a phenomenon in which the presence of stress reduces one's ability to perceive pain; it was first documented in wounded soldiers during World War II (Beecher, 1959; Ford & Finn, 2008; Kurrikoff, Inno, Matsui, & Vasar, 2008). The objective of this study was to examine if action video games have the potential to artificially evoke SIA. Artificially inducing this phenomenon in patients who are about to undergo painful medical procedures could prove to be an effective pain reliever without, or in conjunction with, the use of other exogenous pain relievers (Bloom, Dewey, Harris, & Brosius, 1977; Ford & Finn, 2008). However, this method of potential pain management would only be effective for short periods of time.

SIA was initially studied in rodent populations using tests of nociception. Nociception is the neuronal process of withdrawal from noxious stimuli (Kurrikoff et al., 2008). It differs from pain perception because it provides no information about the subjective experience of the pain; however, it is moderately correlated with pain perception in humans (Willer, Dehen, & Cambier, 1981). The majority of the initial research on SIA utilized a tail-flick test in which the researchers altered the level of painful electrical stimulation administered to rats or mice until the tail flicked, indicating that nociception had occurred (Hohmann & Suplita, 2006; Kurrikoff et al., 2008; Suplita, Eisenstein, Neely, Moise, & Hohmann, 2008).

This process revealed that rodents exposed to stress (i.e., forced swim, forced run) prior to the painful stimulation exhibited longer latencies before flicking their tails than those with no situational stressors. The difference in latencies suggests that the presence of stress increases the amount of time required to alert the body to injury. However, while nociception is related to the painful experience, it is only moderately correlated with subjective measures of pain (Willer et al., 1981). A recent study has found that while nociceptive responses remain stable, pain ratings can fluctuate with excitatory external stimuli and cognitive activity (Edwards et al., 2006). As a result, measures of nociception are not an appropriate proxy for pain when the participant is in a state of arousal. Therefore, studies examining SIA in humans often rely solely on subjective pain reports or a combination of self-report and nociception to provide a richer understanding of the painful experience (Ford & Finn, 2008; Suplita et al., 2008; Willer et al., 1981).

The mechanisms that control SIA are not fully understood. But certain factors appear to be strongly linked to SIA. Heightened blood pressure always precedes SIA in animal studies (Ditto, France, & France, 1997) and is typical in humans (Guasti et al., 1995). Chemical studies have shown that endogenous opioids and endocannabinoids contribute to the phenomenon of SIA and heightened blood pressure (Suplita et al., 2008). The chemical components of SIA have only been examined in animals, but it is logical to assume they are also involved in humans.

Hypertension-induced (artificially provoked) hypoalgesia is a well-studied effect in which increases in blood pressure result in decreases in pain perception (Ditto et al., 1997; Edwards et al., 2007). Similarly, hypertensive individuals consistently rate noxious stimuli as less painful than ratings of the same stimuli from normotensives. Hypertension-induced hypoalgesia differs from SIA, however, because SIA does not require an increase in blood pressure to operate, though it is typically accompanied by such an increase (see Ford & Finn, 2008 for a review).

A study by Guasti et al. (1995) examined the relationship between blood pressure and pain perception. Using twenty-four hour blood pressure monitoring of 30-50 year-old males, the researchers found that pain threshold and tolerance were higher in the group of participants identified as hypertensive than those in the normotensive group. Pain was induced using a dental pulpar test in which electrical stimulation was applied to the incisors of the upper jaw. The researchers took measures of pain threshold (when the stimulation was first noticed) and pain tolerance (when the participant asked for stimulation to end). Both pain threshold and tolerance were related to ambulatory blood pressure (Guasti et al., 1995). Hypertensive individuals were able to withstand more stimulation prior to the onset of pain and to tolerate the pain for longer when compared to normotensive individuals. This study did not include hypotensive individuals, but more recent studies have examined this population.

Recently, Duschek, Schwarzkopf, and Schandry (2008) observed a hypotensive population. The researchers examined the pain threshold and tolerance of hypotensive and normotensive women. The study did not include hypertensive women. Hypotensive women felt the pain sooner and could not withstand it as long as normotensive women. Their results suggest that pain perception as related to blood pressure is a linear function, with hypotensive individuals experiencing an increased sensitivity to pain compared to both hypertensive and normotensive groups.

How blood pressure mediates pain, though, is unclear. Artificial increases in blood pressure through administration of phenylephrine in rats (Randich & Hartunian, 1983) and norfenefrin in humans resulted in a reduced sensitivity to pain in normotensives (Larbig, Elbert, Rockstroh, Lutzenberger, & Birbaumer, 1985) while artificially decreasing blood pressure (through antihypertensive medications) did not result in the expected increase in pain sensitivity (Ghione, Rosa, Mezzasalma, & Panattoni, 1988). Together, these findings suggest that artificially heightened blood pressure may decrease pain sensitivity in normotensive and hypotensive individuals, but not hypertensive populations.

While the relationship between blood pressure and pain perception remains unclear, certain endogenous chemicals are known to be involved in SIA. Endogenous opioids and endocannabinoids are released in the brain when an individual is introduced to a stressful situation. These chemicals attenuate pain through different chemical pathways. Endocannabinoids are more effective at relieving neuronal pain (Hohmann & Suplita, 2006) while endogenous opioids relieve strong or inescapable pain (Willer et al., 1981). However, the current study will not examine the chemical components of SIA, as it is aimed at the manipulation of SIA per se.

Certain factors are known to reduce the efficacy of SIA. Smoking, for example, produces an analgesic effect similar to that of stress. One study found that smokers exhibited a reduced perception of pain when compared to nonsmokers. Smokers however, failed to exhibit SIA (Girdler et al., 2005). The researchers suggested that the lack of SIA in smokers indicated that the smoking related analgesia and SIA operate using similar pathways.

Another factor known to blunt the effects of SIA is the experience of hostility-guilt. Hostility-guilt is experienced when an individual feels that his or her aggressive actions are not morally justified. Proponents of the hostility-guilt hypothesis suggest that this process is a self-punishment mechanism to relieve guilty feelings and prevent further violent actions (Mosher, O'Grady, & Katz, 1980). While researchers have not proposed a mechanism by which this phenomenon might operate, they have found support for the construct (Ruma & Mosher, 1967). For example, Mosher et al. (1980) examined pain perception in participants who were rated either high or low on hostility-guilt after verbally aggressing against a confederate. Participants high in hostility-guilt exhibited a greater pain response than those low in hostility-guilt. Video game aggression is different from real-life forms of aggression in that there is no victim, and so I expect guilt over this form of aggression to be low, thus minimizing the ability of hostility-guilt to interfere with potential SIA.

Both physical (blood pressure) and chemical (endogenous opioids and endocannabinoids) factors contribute to the effects of stress on the experience of pain. The current study examined the manipulation of SIA through video games. Studies have shown that even brief sessions of video game play result in an increase in blood pressure (particularly diastolic blood pressure) and heart rate (Anderson, 2003; Ballard, Hamby, Panee, & Nivens, 2006; Ballard & Weist, 1996). One study found that the physiological arousal elicited by playing "Ms. Pac Man" was comparable to that of mild exercise (Segal & Dietz, 1991). Other studies have shown that physiological responding is reduced when exposure is increased (Anderson & Bushman, 2001; Ballard et al., 2006).

Both diastolic and systolic blood pressure readings are highly correlated with pain ratings and nociception (Bruehl, Burns, & McCubbin, 1998; McIntyre, Edwards, Ring, Parvin, & Carroll, 2006). Depending on the circumstances, one may be more predictive than another. For example, systolic blood pressure is strongly related to nociceptive responding and less related to the affective dimension of pain (McIntyre et al., 2006). Diastolic blood pressure is more predictive in the chronic pain community literature, as well as the stress literature (Bruehl et al., 1998; Bruehl, Chung, Diedrich, Diedrich, & Robertson, 2007). In the current study, diastolic blood pressure was expected to be the most predictive of subjective pain ratings.

A few studies suggest that violent video games tend to result in a larger average increase in physiological responding when compared to nonviolent video games (Anderson, 2003; Anderson & Carnagey, 2009). Violent video games are often more engaging and energetic. They often contain fast-paced music. Recent studies have found that energetic music increases stress and cortisol levels (Burns et al., 2002; McCraty, Barrios-Choplin, Atkinson, & Tomasino, 1998). One study proposed that the music built into the games adds an additional level of stress (Hébert, Béland, Dionne-Fournell, Crête, & Lupien, 2005). They found that participants in the music condition had more salivary cortisol compared to the silent control. In addition to the stress of violence and fear, the intense music found mostly in violent video games may be a contributing factor to the increases in physiological arousal and stress responding (Hébert et al., 2005).

While not examining arousal or stress, a few recent studies have examined the role of video games in pain attenuation during medical procedures via distraction. In one study, the researchers had two burn victims play a virtual reality game while their wounds were being treated. Subjective ratings of pain were much lower on days when the patients played the virtual reality game than on days that they did not play. For one patient, virtual reality therapy was more effective than opiates (Hoffman, Doctor, Patterson, Carrougher, & Furness, 2000).

Video game distraction may also relieve anticipatory symptoms of chemotherapy. Playing video games effectively reduced nausea prior to the therapy and decreased systolic blood pressure after the therapy (Kolko & Rickard-Figueroa, 1985; Vasterling et al., 1993). This effect is believed to have been caused by cognitive distraction, not the result of SIA.

Another study examined antinociception during video game play. Measuring the nocicieptive flexion reflex (NFR) during the game and during rest revealed that NFR thresholds were lower and pain was reduced during game play (Edwards et al., 2007). The NFR is a reflex in which the sural nerve withdraws from the noxious stimuli and is often used as a substitute for measures of pain perception. The sural nerve was stimulated until it withdrew. The initial moment of withdrawal is known as the NFR threshold. While participants were playing the video game, their NFR thresholds were higher than when they were not playing video games. Activation of the limbic system during play is hypothesized to be the reason for this difference (Edwards et al., 2007).

The few studies which examine pain relief via gameplay (Edwards et al., 2007; Kolko & Rickard-Figueroa, 1985; Vasterling et al., 1993) posit that the analgesia experienced is the result of distraction; the participant plays during the painful experience. The current study is the first to examine how video game play influences pain perception after the game play has ended.

In the current study, participants played a horror-survival video game, a violent video game or a nonviolent video game. A nonviolent control condition (drawing) was also used. Blood pressure and heart rate were monitored throughout the session at predetermined intervals. After game play, participants performed the cold pressor pain task and indicated the level of pain they experienced using a visual analog scale anchored at no pain at all and worst imaginable pain (See Appendix A).

Studies that have altered blood pressure through administering phenylephrine in rats (Randlich & Hartunian, 1983) and administering norfenefrin in humans (Larbig et al., 1985) have found reduced pain responses in the treated participants. These findings suggest that the alteration of blood pressure is a key component of SIA.

I hypothesized that there would be a main effect of condition such that those who play the horror video game would exhibit the highest increases in blood pressure and result in the highest pain threshold and tolerance among the groups. Because I expected the nonviolent control to elicit the lowest physiological reactivity and stress, I also expected that condition to display the lowest pain threshold and tolerance.

Research suggests that increased exposure to video games decreases the physiological arousal exhibited by gamers (Anderson & Bushman, 2001; Ballard et al., 2006). Therefore, I hypothesized that participants with more gaming experience will not be influenced as strongly by the stress of the video games. In other words, SIA through video games may be diminished for experienced gamers due to reduced physiological arousal (Ballard et al., 2006). To examine this issue, I asked each participant to report the amount of time he spends playing video games each week, and analyzed the effects of gaming experience on pain perception.

If the hypotheses were supported, the results from this study could have proven beneficial to the medical community. Distraction during a medical procedure is challenging for both the patient and the medical community, as means of distraction need to be placed directly in front of the patient. SIA, when properly evoked, may reduce the need for distraction during medical procedures as the effects remain for a brief period after the stressful event has occurred.

Method

Approval for this study was obtained by the Institutional Review Board on August 21, 2009. Approval can be found in Appendix B.

Participants

Due to gender differences in the perception of pain (Ditto et al., 1997; Girdler et al., 2005; Guasti et al., 1995) and the rate of exposure to video games (Anderson, 2003; Anderson & Bushman, 2001), only males were included in this study. A total of 77 males were recruited for participation in this study. The sample was young (M = 19.99, SD = 2.02, n = 77), mostly right-handed (84.8%) and mostly Caucasian (78.5%). Twelve participants were African American, two were Hispanic, and one was Asian. Students who played video games played an average of 7.01 hours per week (SD = 6.27). A small percent of participants smoked (7.8%) or consumed caffeine (23.4%) prior to the session.

Tobacco is known to inhibit the effects of stress induced analgesia (Girdler et al., 2005), and smokers are typically removed from studies of SIA (Ford & Finn, 2008; Willer et al., 1981). For these reasons, smokers were excluded from the analyses.

Participants were randomly assigned to one of four conditions: horror video game, violent video game, nonviolent video game, nonviolent control task. All participants were recruited through the Appalachian State University online psychology subject pool and were offered course credit for their participation. Participants completed the study individually.

To be considered for participation, participants could not have a chronic pain disorder, Reynaud's disease, or hypertension. Reynaud's disease is a vascular disorder which affects blood flow to the extremities during extreme temperature changes (Allen & Brown, 1932). Because the cold pressor has the ability to evoke symptoms related to Reynaud's disease, participants with a personal or family history of Reynaud's disease were not allowed to participate. None of the participants had a family or personal history of Reynaud's disease. Participants were also asked to refrain from caffeine consumption, exercise, and tobacco use for three hours prior to participation.

Demographic Questionnaire

Participants filled out a brief demographic questionnaire before participation. The questionnaire asked questions about age, race, and frequency of exposure to the three video game types. Questions which relate to the various exclusion criteria (smoking, Reynauds, hypertension, etc.) were also included. Only participants with Reynaud's disease were asked to leave.

Conditions

Participants were randomly assigned to one of four conditions.

Horror Video Game. In this condition, participants played Cold Fear on the PlayStation 2 for ten minutes. In Cold Fear, you play as Tom Hansen, a Coast Guard member who is exploring a derelict boat, only to find the crew slaughtered and taken over by a parasite known as exocels. It is a classic survival horror game which uses many tactics (swaying lights, quickly moving enemies, and slow lead-character movement) to frighten the gamer (Cold Fear, 2005). This game was selected because of its ability to induce stress in the participant.

Violent Video Game. In this condition, participants played Soulcalibur 3 on the PlayStation 2 for ten minutes. Soulcalibur 3 is a fast-paced fighting game set in 1591. As a sword-based game, the game play is quick and violent (Soul Calibur 3, 2005). This game should increase the stress experienced by the participant through quick movement and strategy.

Nonviolent Video Game. In this condition, participants played Snowboard Supercross 3 (SSX 3) on the PlayStation 2 for ten minutes. In SSX 3, the participant played the "race" section of the game. In this section, participants raced against the computer to the bottom of the mountain (Snowboard Supercross 3, 2003). There were three main runs which were combined into one 13 minute long race. Participants did not complete the race as the game play lasted ten minutes. This game was selected because of its nonviolent nature and comparable quality ratings on popular gaming sites (suggesting equal engagement levels in all games). It should only elicit minimal stress, as the participant was not playing against a real competitor and the race was relatively simple and relaxing.

Nonviolent Control Task. The nonviolent control task required the participant to draw pictures from a provided list for ten minutes. This method is comparable to that used by Ditto et al. (1997). Participants were informed that the drawings had no bearing on their performance in the study and that they could take them home if they like. Only one participant requested that he take his drawing home. Both colored pencils and crayons were available to participants. Participants were not observed during the drawing, as research assistants were instructed to read on the computer while participants drew. Drawings were only examined briefly to ensure that participants drew from the assigned list; however, no information was recorded about the participants' drawings, as it was only a control task designed to elicit similar mental and physical involvement in the task as the video games provided.

Procedure

Participants were recruited through the school's "psychology experiments" web page. Students in psychology classes can sign up for research credit, but have other options available to obtain the credit, such as papers and additional assignments. Participants were randomly assigned to one of the four conditions listed above prior to arrival in the lab. Once in the lab, informed consent was obtained. After informed consent was obtained, any relevant questions were answered, and the demographic questionnaire was administered. Please see Appendix C for the Informed Consent.

Two blood pressure readings taken three minutes apart provided information about the participant's resting blood pressure and heart rate. After baseline blood pressure was established, the game play procedure was explained. Then participants engaged in the experimental task (horror video game, violent video game, nonviolent video game, or nonviolent control task) for 10 minutes. Immediately following video game play, blood pressure was measured. After the third blood pressure reading, participants engaged in the cold pressor pain task (described in greater detail below). After the pain task, participants indicated the level of pain just experienced using a 7cm visual analog scale anchored at no pain and unbearable pain. See Appendix A. Then, a final blood pressure reading was taken. Lastly, the participant was debriefed and probed for suspected hypotheses. Any remaining questions were also answered at this point.

Cold Pressor

The cold pressor task provides measures of both pain threshold and pain tolerance. The task required the participant to place his hand in a one gallon bucket containing water maintained at 0-2°C. An insulating layer of ice kept the water cool. The water was circulated by an aquarium pump to prevent any warming around the participant's hand. The water temperature was monitored using an infrared thermometer. Temperature readings were taken before the participant placed his hand in the water.

The temperature of the hand or environment can affect the ratings of pain reported. This effect is known as the Lewis-wave effect. To avoid the Lewis-wave effect (Blasco & Bayés, 1988), the participant prepared for the cold pressor by placing his non-dominant hand in a bath of room temperature water (about 20 degrees centigrade) for 60 seconds. The temperature of the hand was also measured before and after the warm water bath using an infrared thermometer. The participant then placed his non-dominant hand in the cold pressor, ensuring that the water came up to the wrist. He was instructed not to move his hand. He was also told to report the first moment pain was experienced and to remove his hand from the water once the pain became unbearable. Time spent in the water was defined as the moment the hand became fully emerged to the moment the participant began to withdraw his hand. Pain threshold was operationalized as the first moment the participant experienced pain. Pain tolerance was defined as the total amount of time spent in water minus the pain threshold.

Unbeknownst to the participant, a time limit of 4 minutes was imposed to prevent skin damage. Halfway through the data collection, it came to my attention that one or more of the research assistants were telling the participants about the time limit. This factor may have increased the number of participants who made it to the time limit. Of the 77 participants, 15 reached the time limit. Of those 15, it is unknown how many of them were told about the time limit. These participants were equally distributed across conditions. After the cold pressor, the hand temperature was measured again and participants were permitted to place their hand back into the room temperature water bath for as long as they wished.

As a manipulation check, I asked the participant about his affective experience during gameplay. The participant completed a questionnaire using seven affective dimensions (i.e. how enjoyable did you find the game, how frustrating did you find the game, how stressful did you find the game, how relaxing did you find the game, how exciting did you find the game, how boring did you find the game, and how much experience have you had playing the game you played today?). All responses were on a scale from 1 (*not at all*) to 5 (*extremely*). See Appendix D for the full questionnaire. Because the conditions were selected to evoke various levels of stress, I was primarily interested in examining that affective dimension. I expected participants to report the least amount of stress in the drawing condition and the most amount of stress in the Cold Fear condition.

Analyses

A between participants design was utilized. Four conditions with increasing levels of stress were used to examine the relationship between video game play and analgesia. The four conditions, in order of expected stress level were (a) very low stress drawing condition, (b) low stress video game (SSX3,), (c) moderate stress video game (Soul Calibur 3), and (d) high stress video game (Cold Fear).

The dependent variables examined were change in blood pressure, pain threshold (the first moment pain is identified), pain tolerance (total time in the cold pressor minus the pain threshold), and subjective pain ratings (using a visual analog scale anchored from no pain at all to unbearable pain).

A one-way ANCOVA was utilized to examine the affect of stressful video game play on each dependent measure of pain perception. Because resting blood pressure has an effect on pain perception, blood pressure was used as a covariate. I hypothesized that participants in the more stressful conditions would experience a rise in blood pressure and a reduction of the pain response. Specifically, I expected that those in the Cold Fear (highest stress) condition would exhibit the highest pain threshold (time to notice pain) and tolerance (total time minus time to notice pain). Those in the drawing condition (very low stress) were expected to yield the lowest pain tolerance and threshold, while those in the low and moderate stress conditions (SSX 3 and Soul Calibur 3 respectively) were expected to yield low and moderate pain responses respectively.

The affect of video games on pain perception may change depending on the participants' level of gaming experience. I expected that those with experience playing video games may not produce as strong of an effect due to reduced physiological responding. To test this, gaming experience was operationalized as the number of hours spent playing video games weekly. A correlation was used to see if gaming experience was related to pain perception.

Results

Hypertension is known to impact the perception of pain (Bruehl et al., 2007; Duschek et al., 2008; Guasti et al., 1995). To ensure that family history did not influence pain perception, a one-way between participants ANOVA was used to compare those with a positive family history of hypertension to those without such history. While those with a positive family history of hypertension did have a significantly higher initial systolic, $F(1, 64) = 18.48$, $p = .0001$, and diastolic, $F(1, 64) = 3.88$, $p = .05$ blood pressure, this effect was reduced when the first two blood pressure readings were averaged. Means and standard deviations can be found in Table 1. Additionally, many other researchers frequently average the initial blood pressure readings to get a resting blood pressure reading (Bruehl et al., 2007; Ditto et al., 1997; Duschek et al., 2008). Therefore, the average of the first two blood pressure readings (henceforth known as resting blood pressure) was used for all further analyses of blood pressure. There were also no significant differences in the measures of pain perception between participants with a family history of hypertension and those without.

To determine if the conditions elicited the desired level of stress, a one-way ANOVA with game condition as the between-subjects factor was run on the participants' perceived level of stress. All other affective dimensions were examined in the same fashion. As expected, the Cold Fear condition was significantly more frustrating, $F(3, 46) = 6.38$, $p = .0001$, and stressful, $F(3, 46) = 5.41$, $p = .003$, than the other three conditions. The Cold Fear condition was also identified as less enjoyable, $F(3, 46) = 3.92$, $p = .014$, than the other conditions.

Contrary to my expectations, the drawing condition did not have the lowest reported stress level; it had the second lowest stress level. The Cold Fear condition had the highest reported stress level (M=1.92, SD=1.08), followed by Soul Calibur 3 ($M = 1.23$, $SD = .44$), Drawing ($M = 1.15$, $SD = .38$), and SSX3 ($M = 1.00$, $SD = .00$). SSX3 was by far the least stressful condition as each participant in that condition rated it as *not at all stressful*. See Table 2 for means and standard deviations of all affective dimensions.

I also examined cardiovascular reactivity. Using a one-way ANOVA with game condition as the between-subjects factor, I examined systolic and diastolic blood pressure and heart rate as dependent variables. There was no significant difference in the change in blood pressure due to the game played. There was also no difference in heart rate by condition. There was a trend toward higher diastolic blood pressure in the high stress Cold Fear condition, however this effect was not significant, $F(3, 70) = 2.07$, $p = .11$. See Table 3 for means and standard deviations.

A one-way ANCOVA with condition as the between-subjects factor and resting blood pressure as the covariate was used to examine the relationship between condition and pain perception. I treated resting blood pressure as a covariate due to its inverse relationship with pain perception (Duschek et al., 2008; Guasti et al., 1995). My analyses revealed that condition was unrelated to pain threshold, $F(3, 68) = 1.05$, $p = .38$; pain tolerance, $F(3, 62) = 1.56$, $p = .21$; and subjective pain ratings, $F(3, 71) = .11$, $p = .95$. See Table 4 for means and standard deviations. The amount of time spent playing video games per week was only significantly correlated with pain tolerance. Correlations were obtained with a two-tailed bivariate analysis and can be found in Table 5.

Discussion

This study examined the possibility of eliciting SIA using video gameplay. There were six main hypotheses. First, I expected participants to rate the high stress condition, Cold Fear, as most stressful. This hypothesis was supported; however the other three conditions were not rated as expected. Specifically, the *low stress* condition of drawing was perceived as more stressful than the nonviolent video game, SSX 3. This finding was unexpected; however, I believe it may have been the result of evaluation apprehension (Minor, 1970). Despite being told that the drawings held no bearing on their performance, I believe that the mere act of being observed while performing a task outside of their usual activities may have resulted in the observed level of stress.

An increase in blood pressure and heart rate is typical after video game play (Anderson, 2003; Anderson & Bushman, 2001; Ballard & Wiest, 1996), particularly violent video games (Anderson & Carnagey, 2009). My second hypothesis was that those in the Cold Fear condition would yield the highest increases in blood pressure. There was no significant difference in either systolic or diastolic blood pressure between the conditions. Cold Fear had the smallest change in systolic blood pressure and only a small increase in diastolic blood pressure and so this hypothesis was not supported. I also expected that of the two blood pressure measures, diastolic blood pressure would be most related to the measures of pain perception. I found moderate support for this; however, the effect was not significant.

My third through fifth hypotheses were concerned with pain perception. I expected that participants in the high stress condition would take longer to notice the pain, be able to withstand the pain for longer periods, and report the sensation as less painful when compared to the other conditions. There was no support for any of these three hypotheses.

My sixth and final hypothesis was that participants with gaming experience would not experience as much SIA through video gameplay due to desensitization and reduced cardiovascular responding (Anderson & Bushman, 2001; Ballard et al., 2006). However, only the measure of pain tolerance was correlated with gaming experience, such that those with higher levels of weekly play were able to withstand the pain for longer. This is interesting because gaming experience was not correlated with either measure of blood pressure.

The findings of this study suggest that video games may not be effective at evoking SIA. It is not clear why the video games were not effective; however, further examination of the affective dimensions of gameplay may explain why the game was ineffective. There were many other affective dimensions, such as fear and anger, which were not measured that may have contributed to my findings. While no participants displayed visible fear, some participants appeared angry while playing the Cold Fear condition.

Some studies have found that negative affect increases pain perception. This appears to be true for all negative emotional states except for stress (Weich & Tracey, 2009) and fear (Fanselow, 1986). These researchers believe that the negative emotional states are highly influenced by the level of arousal. Without sufficient arousal or threat, the individual actually experiences an increased perception of pain. They argue that inducing negative affect in low threat situations affect pain in a few different ways. First, negative affect decreases one's expectancy of relief and feelings of perceived control (Rainville, Bao, & Chrétien, 2005). Negative affect also influences muscle tension. When negative affect, anger in particular, is provoked, there are increases in lower paraspinal tension. This increased tension results in higher levels of reported pain and lower pain thresholds and tolerances (Burns, 1997; Greenwood et al., 2003). Since anger was not directly measured, I cannot be certain of its influence. I did find that the Cold Fear condition had overall higher levels of negative affect however, and behavioral notes indicated that participants may have also been angered by the condition. Future studies should examine this possibility and find a game which induces stress without inducing other negative affect.

It is also possible that the increased frustration from playing the game Cold Fear may have dampened any effect the stress had on participant's pain perception. Participants rated Cold Fear as significantly more frustrating than the other games, and as more frustrating than stressful. In other words, the game was better at eliciting frustration than stress. Current literature suggests that experiencing frustration in conjunction with pain leads to a greater experience of pain (Wade, Prince, Hamer, Schwartz, & Hart, 1990). I believe that the lack of two features, intuitive controls and gamer immersion, lead to the increased frustration with Cold Fear.

If the gamer lacks a feeling of autonomy and competence, he will be less motivated to play and more frustrated during gameplay (Ryan, Rigby, & Przybylski, 2006). The gamer's sense of competence is heavily influenced by intuitive controls. If the controls do not make sense or are not responsive, then they are not intuitive, and the gamer feels like he has little control over the game (Pryzybylski, Rigby, & Ryan, 2010). Reviews of Cold Fear at popular gaming sites such as GameSpot and 1UP indicate that the controls are negatively impacted by certain visual effects. The game takes place on a rocking boat (Cold Fear Review) with frequently changing camera angles (Cold Fear: Lukewarm Curiosity). These factors frustrated the reviewers and may have frustrated my participants as well.

Beyond the mere functionality of the game, participants may have felt removed from the game's story. The sense of autonomy can be influenced by how immersed the participant feels in the game. Games with a rich story create a feeling of presence within the game, leading to greater identification with and enjoyment of the lead character. As a result of this immersion, participants tend to yield a higher level of physiological arousal which lasts longer after game play than if there was no story (Schneider, Lang, Shin, & Bradley, 2004). The current study only provided a brief explanation of the game, which may not have been sufficient to provide gamers with a feeling of presence. Future research could approach this issue by showing a video about the game, or requiring the participant to play for a significant period before the lab session. Doing so may result in more profound increases in blood pressure.

There were many limitations to this study. In addition to the small number of participants in each condition, many participants had to be removed from certain analyses due to smoking (six) or reaching the cold pressor time limit (15). After about half the data had been collected, it came to my attention that one or more of the research assistants had informed the participants of the time limit for exposure to the cold pressor. The methodology of the study indicated that participants were not supposed to be aware of any time limitations as it may influence the results (Blasco & Bayés, 1988). It is possible that this knowledge enabled the participants to withstand the pain for just long enough to beat the time limit. Fifteen participants, equally distributed across conditions, made it to the time limit of 4 minutes; however, I do not know how many of them were aware of the time limit. Due to the anonymity of the data, and the fact that it was unknown which research assistants disclosed this information, it was impossible to remove the data recorded by that particular research assistant. One way to amend this would be to have a standard recording explaining the cold pressor task. The current study utilized a script; however, it is clear that some research assistants took liberties with the script by explaining the time limit. By utilizing a tape recording, all participants would hear the exact same directions in the exact same intonation.

Future research should examine experienced gamers versus nongamers more closely. Due to the small sample size, I could not examine this issue thoroughly. Many participants had indicated that they played video games heavily in high school but not while in college. Accounting for previous versus current gameplay habits could add to the literature concerning the relationship between regular exposure to video games and cardiovascular responding.

The current findings suggest that analgesia elicited through video game may not extend beyond the game play session. While this study did not examine pain perception during game play, numerous case studies (Hoffman et al., 2000; Kolko & Rickard-Figueroa, 1985; Vasterling et al., 1993) have shown that video games might serve as an effective analgesic via distraction. Studies with larger sample sizes are needed to confirm that. My findings, combined with the current literature, suggest that any effect of video games on pain lasts only as long as the distraction. These studies, however, have neglected to examine the potential role of blood pressure. Because my manipulation did not result in any significant increases in blood pressure, I cannot say for certain whether or not blood pressure is related to the pain reduction via video game play. Future research on pain reduction from video game distraction should include changes in blood pressure as a potential variable.

There is still a need for an effective manipulation of SIA for medical purposes. SIA is a very powerful phenomenon which could minimize the amount of medication administered to patients prior to medical procedures. Given that frustration and anger can result in increased pain perception (Greenwood et al., 2003; Rainville et al., 2005), future research should examine all the affective dimensions. Doing so may elucidate which emotions affect gameplay and enable researchers to find a suitable game which elicits stress without also resulting in frustration or anger. In addition to eliciting stress, future research should also ensure that any game selected results in a significant increase in blood pressure.

Fear about medical procedures only increases pain perception (Ahles, Blanchard, & Leventhal, 1983); however, fear may be a crucial component of SIA (Fanselow, 1986). Therefore, it may be beneficial to create an environment more conducive to fear, but not about the medical procedure. Researchers could do so by having participants play more of the game, perhaps even prior to the sessions. The sessions could also be played alone in the dark. By mimicking the feeling of a horror story, it is possible that the participant may feel more immersed in the game. By making the participant more invested in the character (Schneider et al., 2004) and immersed in the session, researchers might elicit the benefits of these stressful games (Przybylski et al., 2010; Ryan et al., 2006).

References

Ahles, T. A., Blanchard, E. B., & Leventhal, H. (1983). Cognitive control of pain: Attention to the sensory aspects of the cold pressor stimulus. *Cognitive Therapy and Research, 7,* 159-178. doi: 10.1007/BF01190070

Allen, E. V., & Brown, G. E. (1932). Reynaud's disease: A critical review of minimal requisites for diagnosis. *The American Journal of the Medical Sciences, 183,* 187-194.

Anderson, C. A. (2003). An update on the effects of playing video games. *Journal of Adolescence, 27,* 113-122. doi: 10.1016/j.adolescence.2003.10.009

Anderson, C. A., & Bushman, B. J. (2001). Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: A meta-analytic review of the scientific literature. *Psychological Science, 12,* 353-359. doi: 10.1111/1467-9280.00366

Anderson, C. A., & Carnagey, N. L. (2009). Causal effects of violent sports video games on aggression: Is it competitiveness or violent content? *Journal of Experimental Social Psychology, 45,* 731-739. doi:10.1016/j.jesp.2009.04.019

Ballard, M. E., Hamby, R. H., Panee, C. D., & Nivens, E.E. (2006). Repeated exposure to video game play results in decreased blood pressure responding. *Media Psychology, 8,* 323-341. doi: 10.1207/s1532785xmep0804_1

Ballard, M. E., & Wiest, J. R. (1996). Mortal Kombat (tm): The effects of violent videogame play on males' hostility and cardiovascular responding. *Journal of Applied Social Psychology, 26,* 717-730. doi: 10.1111/j.1559-1816.1996.tb02740.x

Beecher, H. K. (1959). *Measurement of Subjective Responses: Quantitative Effects of Drugs.* New York: Oxford University Press.

Blasco, T., & Bayés, R. (1988). Unreliability of the cold pressor test method in pain studies. *Methods and Findings of Experimental Clinical Pharmacology, 10,* 767-772.

Bloom, A. S., Dewey, W. L., Harris, L. S., & Brosius, K. K. (1977). 9-nor-9beta-hydroxyhexahydrocannibinol, a cannabinoid with potent antinociceptive activity: Comparisons with morphine. *Journal of Pharmacology and Experimental Therapeutics, 200,* 263-270.

Bruehl, S., Burns, J. W., & McCubbin, J. A. (1998). Altered cardiovascular/pain regulatory relationships in chronic pain. *International Journal of Behavioral Medicine, 5,* 63-75. doi: 10.1207/s15327558ijbm0501_5

Bruehl, S., Chung, O. Y., Diedrich, L., Diedrich, A., & Robertson, D. (2007). The relationship between resting blood pressure and acute pain sensitivity: effects of chronic pain and alpha-2 adrenergic blockade. *Journal of Behavioral Medicine, 31,* 71-80. doi: 10.1007/s10865-007-9133-4

Burns, J. W. (1997). Anger management style and hostility: Predicting symptom-specific physiological reactivity among chronic low back pain patients. *Journal of Behavioral Medicine, 20,* 786-793. doi:10.1097/01.psy.0000238211.89198.e4

Burns, J., Labbe, E., Arke, B., Capeless, K., Cooksey, B., Steadman, A., & Gonzales, C. (2002). The effects of different types of music on perceived and physiological measures of stress. *Journal of Music Therapy, 39,* 101-116. Retrieved from http://www.chinamusictherapy.org/file/doc/The%20Effects%20of%20Different%20Types%20of%20Music%20on%20Perceived%20and%20Physiological%20Measures%20of%20Stress.pdf

Cold Fear. (2005) [Video game]. Ubisoft.

Cold Fear Review [Review of the video game *Cold Fear*, produced by Ubisoft, 2005]. (n.d.). Retrieved from http://www.gamespot.com/ps2/action/coldfear/review.html?om_act=convert&om_clk=gssummary&tag=summary%3Bread-review

Cold Fear: Lukewarm Curiosity [Review of the video game *Cold Fear*, produced by Ubisoft, 2005]. (n.d.). Retrieved from http://www.1up.com/do/reviewPage?cId=3147295

Ditto, B., France, J., & France, C. R. (1997). Risk for hypertension and pain sensitivity in women. *International Journal of Behavioral Medicine, 4,* 117-130. doi: 10.1016/S0167-8760(98)00057-9

Duschek, S., Schwarzkopf, W., & Schandry, R. (2008). Increased pain sensitivity in low blood pressure. *Journal of Psychophysiology, 22,* 20-27. doi: 10.1027/0269-8803.22.1.20

Edwards, L., Ring, C., France, C. R., al'Absi, M., McIntyre, D., Carroll, D., & Martin, U. (2007). Nociceptive flexion reflex thresholds and pain during rest and computer game play in patients with hypertension and individuals at risk for hypertension. *Biological Psychology, 76,* 72-82. doi: 10.1016/j.biopsycho.2007.06.005

Edwards, L., Ring, C., McIntyre, D., Carroll, D., Clarke, R., Webb, O., & Martin, U. (2006). Increases in arousal are associated with reductions in the human nociceptive flexion reflex threshold and pain ratings: Evidence for dissociation between nociception and pain. *Journal of Psychophysiology, 20,* 259-266. doi: 10.1027/0269-8803.20.4.259

Fanselow, M. S. (1986). Conditioned fear-induced opiate analgesia: A competing motivational state theory of stress analgesia. *Annals of the New York Academy of Science, 467,* 40-54. doi: 10.1111/j.1749-6632.1986.tb14617.x

Ford, G. K., & Finn, D. P. (2008). Clinical correlates of stress-induced analgesia: Evidence from pharmacological studies. *Pain, 140,* 3-7. doi: 10.1016/j.pain.2008.09.023

Ghione, S., Rosa, C., Mezzasalma, L., & Panattoni, E. (1988). Arterial hypertension is associated with hypalgesia in humans. *Hypertension, 12,* 491-497. Retrieved from http://hyper.ahajournals.org/cgi/reprint/12/5/491

Girdler, S. S., Maixner, W., Naftel, H. A., Stewart, P. W., Moretz, R. L., & Light, K. C. (2005). Cigarette smoking, stress-induced analgesia and pain perception in men and women. *Pain, 114,* 372-385. doi: 10.1016/j.pain.2004.12.035

Greenwood, K. A., Thurston, R., Rumble, M., Waters, S. J., & Keefe, F. J. (2003). Anger and persistent pain: current status and future directions. *Pain, 103,* 1-5. doi:10.1016/S0304-3959(03)00132-5

Guasti, L., Cattaneo, R., Rinaldi, O., Rossi, M. G., Bianchi, L., Gaudio, G., . . . Venco, A. (1995). Twenty-four-hour noninvasive blood pressure monitoring and pain perception. *Hypertension, 25,* 1301-1305. Retrieved from http://hyper.ahajournals.org/cgi/content/full/25/6/1301

Hébert, S., Béland, R., Dionne-Fournelle, O., Crête, M., & Lupien, S.J. (2005) Physiological stress response to video-game playing: The contribution of built-in music. *Life Sciences, 76,* 2371-2380. doi: 10.1016/j.lfs.2004.11.011

Hoffman, H. G., Doctor, J. N., Patterson, D. R., Carrougher, G. J., & Furness, T. A. (2000). Virtual reality as an adjunctive pain control during burn wound care in adolescent patients. *Pain, 85,* 305-309. doi:10.1016/S0304-3959(99)00275-4

Hohmann, A. G., & Suplita, R. L. II. (2006). Endocannabinoid mechanisms of pain modulation. *The AAPS Journal, 8*, E693-E708. doi: 10.1208/aapsj080479

Kolko, D. J., & Rickard-Figueroa, J. L. (1985). Effects of video games on the adverse corollaries of chemotherapy in pediatric oncology patients: A single-case analysis. *Journal of Consulting and Clinical Psychology, 53,* 223-228. doi: 10.1037/0022-006X.53.2.223

Kurrikoff, K., Inno, J., Matsui, T., & Vasar, E. (2008). Stress-induced analgesia in mice: Evidence for interaction between endocannabinoids and cholecystokinin. *European Journal of Neuroscience, 27,* 2147-2155. doi: 10.1111/j.1460-9568.2008.06160.x

Larbig, W., Elbert, T., Rockstroh, B., Lutzenberger, W., & Birbaumer, N. (1985). Elevated blood pressure and reduction of pain sensitivity. In J. Orlebeke, G. Mulder, & L. van Doornen (Eds.). *Psychophysiology of Cardiovascular Control* (pp. 113-122). New York: Plenum.

McCraty, R., Barrios-Choplin, B., Atkinson, M., & Tomasino, D. (1998). The effects of different types of music on mood, tension, and mental clarity. *Alternative Therapies in Health and Medicine, 4,* 75-84.

McIntyre, D., Edwards, L., Ring, C., Parvin, B., & Carroll, D. (2006). Systolic inhibition of nociceptive responding is moderated by arousal. *Psychophysiology, 43*, 314-319. doi: 10.1111/j.1469-8986.2006.090407.x

Minor, M. W. (1970). Experimenter-expectancy effect as a function of evaluation apprehension. *Journal of Personality and Social Psychology, 15,* 326-332.

Mosher, D. L., O'Grady, K. E., & Katz, H. A. (1980). Hostility-guilt, guilt over aggression, and self punishment. *Journal of Personality Assessment, 44,* 34-40. doi: 10.1207/s15327752jpa4401_4

Przybylski, A. K., Rigby, C. S., & Ryan, R. M. (2010). A motivational model of video game engagement. *Review of General Psychology, 14,* 154-166. doi: 10.1037/a0019440

Rainville, P., Bao, Q. V. H., & Chrétien, P. (2005). Pain-related emotions modulate experimental pain perception and autonomic responses. *Pain, 118,* 306-318.

Randich, A., & Hartunian, C. (1983). Activation of the sinoaortic baroreceptor reflex arc induces analgesia: Interactions between cardiovascular and endogenous pain inhibition systems. *Physiological Psychology, 11,* 214-220.

Ruma, E. H., & Mosher, D. L. (1967). Relationships between moral judgment and guilt in delinquent boys. *Journal of Abnormal Psychology, 71,* 122-127. doi: 10.1037/h0024444

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion, 30,* 347-363. doi: 10.1007/s11031-006-9051-8

Schneider, E. F., Lang, A., Shin, M., & Bradley, S. D. (2004). Death with a story: How story impacts emotional, motivational, and physiological responses to first-person shooter video games. *Human Communication Research, 30,* 361-375.

Segal, K. R., & Dietz, W. H. (1991). Physiologic responses to playing a video game. *Archives of Pediatrics and Adolescent Medicine, 145,* 1034-1036.

Snowboard Supercross 3. (2003) [Video game]. EA Sports BIG.

Soul Calibur 3. (2005) [Video game]. Namco.

Suplita, R. L. II, Eisenstein, S. A., Neely, M. H., Moise, A. M., & Hohmann, A. G. (2008) Cross-sensitization and cross-tolerance between exogenous cannabinoid antinociception and endocannabinoids-mediated stress-induced analgesia. *Neuropharmacology, 54,* 161-171. doi: 10.1016/j.neuropharm.2007.07.006

Vasterling, J., Jenkins, R. A., Tope, D. M., & Burish, T. G. (1993). Cognitive distraction and relaxation training for the control of side effects due to cancer chemotherapy. *Journal or Behavioral Medicine, 16,* 65-80. doi: 10.1007/BF00844755

Wade, J. B., Price, D. D., Hamer, R. M., Schwartz, S. M., & Hart, R. P. (1990). An emotional component analysis of chronic pain. *Pain, 40,* 303-310. doi: 10.1016/0304-3959(90)91127-5

Weich, K., & Tracey, I. (2009). The influence of negative emotions on pain: Behavioral effects and neural mechanisms. *NeuroImage, 47,* 987-994. doi:10.1016/j.neuroimage.2009.05.059

Willer, J. C., Dehen, H., & Cambier, J. (1981). Stress-induced analgesia in humans: Endogenous opioids and naloxone-reversible depression of pain reflexes. *Science, 212,* 689-690. doi: 10.1126/science.6261330

Appendix A

Visual Analog Scale

No Pain at all Unbearable Pain

Appendix B

IRB Approval Notice

From	IRB <irb@appstate.edu>
To	ballardme@appstate.edu
Cc	jocoyka@appstate.edu
Date	Fri, Aug 21, 2009 at 12:55 PM hide details 8/21/09
Subject	IRB Notice
mailed-by	appstate.edu

To: Mary Ballard
Psychology
CAMPUS MAIL

From: Lisa Curtin, Institutional Review Board
RE: Notice of IRB Approval by Full Board Review

Study #: 09-0273

Study Title: Stress-Induced Analgesia through Video Games
- Hide quoted text -

Submission Type: Initial

Approval Date: 8/21/2009
Expiration Date of Approval: 8/17/2010

This submission has been approved contingent upon the changes described under Study Specific Details by the above IRB for the period indicated above.

Study Specific Details:

Date of birth should be removed from the questionnaire and replaced with year of birth.

Explain the symptoms of Reynaud's disease on the informed consent for those that may not be aware of Reynaud's disease.

Investigator's Responsibilities:

Federal regulations require that all research be reviewed at least annually. It is the Principal Investigator's responsibility to submit for renewal and obtain approval before the expiration date. You may not continue any research activity beyond the expiration date without IRB approval. Failure to receive approval for continuation before the expiration date will result in automatic termination of the approval for this study on the expiration date.

You are required to obtain IRB approval for any changes to any aspect of this study before they can be implemented. Should any adverse event or unanticipated problem involving risks to subjects occur it must be reported immediately to the IRB.

CC:
Kathleen Jocoy, Psychology

Appendix C

Informed Consent

APPALACHIAN STATE UNIVERSITY

Informed Consent for Participants in Research Projects Involving Human Subjects

Title of Project: Stress-Induced Analgesia Through Video Game Play

Investigator(s): Kathleen Jocoy, Dr. Mary Ballard (Psychology)

I. Purpose of this Research/Project: This study is aimed at determining if video games or other activities have the ability to affect pain perception in college-aged males.

II. Procedures: You will complete a basic demographic form and resting measures of heart rate and blood pressure will be gathered. Then, you will either play video games or draw for 10 minutes. Heart rate and blood pressure measures will be taken after the game play/drawing and for 10 minutes following game play or drawing. Then, you will engage in a pain task where you will place your non-dominant hand in a bucket of ice-cold water called the cold pressor. After the cold pressor, a final blood pressure reading will be taken. The entire session will take approximately 45 min.

III. Risks: Participation in this study will result in mild to moderate pain and/or stress. Neither the pain nor stress will last beyond the length of the study. A researcher will be standing by in case you want to leave the experiment for any reason.

IV. Benefits: Your participation in this study will allow us to develop a better understanding of the relationship between blood pressure, stress and pain. The long term goal is to provide a method of reducing pain associated with minor medical procedures. There is no guarantee of direct benefits to you. However, increased knowledge regarding the reduction of pain through short term stress will benefit society.

V. Extent of Anonymity and Confidentiality: Do not put your name on anything other than this consent form. The remainder of the forms you complete will be identified only by a participant number. Thus, there will be no way of identifying your responses once you have left the experiment, making them anonymous. The information gathered from this study will be kept completely confidential. All records will be kept in a locked room in the psychology department and will only be seen by Dr. Mary Ballard and her research assistants. The records will be kept for 5 years after the publication of the results, as required by the American Psychological Association, and then destroyed.

VI. Compensation: You will receive course credit in compensation for your participation.

VII. Freedom to Withdraw: You may discontinue your participation at any time without penalty. You are free not to answer any of the questions or respond to any experimental situation without penalty.

VIII. Approval of Research: This research project has been approved by the Institutional Review Board of Appalachian State University.

Institutional Review Board
Approval Date: August 21, 2009
Expires On: August 18, 2010
Study #: 09-0273
Initials: kj

IX. Participant's Responsibilities: I voluntarily agree to participate in this study and to complete the questionnaires described above. I ascertain that I am at least 18 years of age.

X. Participant's Permission: I have read and understand the Informed Consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent:

Participant signature ____ Date ________

Should I have any questions about this research or its conduct, I may contact:

Dr. Mary Ballard	(828) 262-2714	ballardm@pm.appstate.edu
Investigator(s)	Telephone	e-mail
Robert L. Johnson	**828-262-2692**	**johnsonrl@appstate.edu**
Administrator, IRB	Telephone	e-mail

Graduate Studies and Research; Appalachian State University; Boone, NC 26608

Subjects must be given a complete copy (or duplicate original) of the signed Informed Consent.

Appendix D

Game Experience Questionnaire

Game Experience Questionnaire

Participant #________

How frustrating did you find playing the video game today?

1--------------------2--------------------3--------------------4--------------------5

1	2	3	4	5
not at all frustrating	**somewhat frustrating**	**moderately frustrating**	**very frustrating**	**extremely frustrating**

How stressful did you find playing the video game today?

1--------------------2--------------------3--------------------4--------------------5

1	2	3	4	5
not at all stressful	**somewhat stressful**	**moderately stressful**	**very stressful**	**extremely stressful**

How enjoyable did you find playing the video game today?

1--------------------2--------------------3--------------------4--------------------5

1	2	3	4	5
not at all enjoyable	**somewhat enjoyable**	**moderately enjoyable**	**very enjoyable**	**extremely enjoyable**

How relaxing did you find playing the video game today?

1--------------------2--------------------3--------------------4--------------------5

1	2	3	4	5
not at all relaxing	**somewhat relaxing**	**moderately relaxing**	**very relaxing**	**extremely relaxing**

How exciting did you find playing the video game today?

1--------------------2--------------------3--------------------4--------------------5

1	2	3	4	5
not at all exciting	**somewhat exciting**	**moderately exciting**	**very exciting**	**extremely exciting**

How boring did you find playing the video game today?

1--------------------2--------------------3--------------------4--------------------5

1	2	3	4	5
not at all boring	**somewhat boring**	**moderately boring**	**very boring**	**extremely boring**

How much experience have you had playing the game you played today?

1--------------------2--------------------3--------------------4--------------------5

1	2	3	4	5
no experience	**a little experience**	**moderate experience**	**quite a bit of experience**	**extensive experience**

Table 1

Blood Pressure (BP) and Pain Ratings of Those With and Without a Family History of Hypertension

Variable	Positive Family History		Negative Family History	
	n	*M* (*SD*)	*n*	*M* (*SD*)
Systolic BP 1	21	130.76 (7.87)	45	120.96 (8.96)
Diastolic BP 1	21	83.10 (10.68)	45	78.62 (7.45)
Systolic BP 2	20	126.20 (8.90)	45	118.62 (8.56)
Diastolic BP 2	20	80.85 (7.98)	45	76.64 (7.62)
Systolic BP Avg	21	128.50 (7.58)	45	119.79 (7.75)
Diastolic BP Avg	21	82.38 (9.33)	45	77.63 (7.05)
Pain Threshold	20	23.95 (22.71)	43	28.54 (36.88)
Pain Tolerance	18	35.64 (24.30)	42	49.46 (49.76)
Pain Rating	21	3.88 (1.42)	45	3.71 (1.35)

Note: Avg = average.

Table 2

Means and Standard Deviations of Affective Dimensions by Condition

	Cold Fear			Soul Calibur 3			Snowboard Supercross 3			Drawing		
Affective Dimension	*n*	*M* (*SD*)	95% CI	*n*	*M* (*SD*)	95% CI	*n*	*M* (*SD*)	95% CI	*n*	*M* (*SD*)	95% CI
Frustrating	10	2.80 (1.14)	[1.99, 3.61]	12	1.33 (.65)	[.92, 1.75]	11	1.18 (.41)	[.91, 1.45]	13	1.08 (.27)	[.91, 1.24]
Stressful	10	2.00 (1.16)	[1.17, 2.83]	12	1.17 (.39)	[.92, 1.41]	11	1.00 (.00)	[1.0, 1.0]	13	1.15 (.38)	[.93, 1.38]
Enjoyable	10	2.30 (.68)	[1.82, 2.78]	12	3.42 (.79)	[1.82, 2.78]	11	3.27 (.91)	[2.67, 3.88]	13	2.92 (.76)	[2.46, 3.38]
Relaxing	10	2.00 (1.16)	[1.82, 2.78]	12	2.83 (1.03)	[2.18, 3.49]	11	3.09 (.94)	[2.46, 3.73]	13	2.92 (.86)	[2.40, 3.44]
Exciting	10	2.60 (1.27)	[2.00, 3.20]	12	2.75 (.75)	[2.27, 3.23]	11	2.45 (.93)	[1.83, 3.08]	13	1.77 (.83)	[1.27, 2.27]
Boring	10	2.60 (1.27)	[1.70, 3.50]	12	1.92 (1.08)	[1.23, 2.61]	11	1.82 (.98)	[1.16, 2.48]	13	2.08 (.95)	[1.50, 2.65]
Experience	10	1.30 (.67)	[.82, 1.78]	12	1.92 (1.31)	[1.08, 2.75]	11	1.73 (1.27)	[.87, 2.58]	13	2.54 (1.19)	[1.55, 2.27]

Note. CI = confidence interval.

Table 3

Means and Standard Deviations of Blood Pressure (BP) Changes by Condition

	Change in Systolic BP			Change in Diastolic BP		
Condition	*n*	*M* (*SD*)	95% CI	*n*	*M* (*SD*)	95% CI
Cold Fear	15	.10 (7.98)	[-4.32, 4.52]	15	1.90 (7.99)	[-2.53, 6.33]
Soul Calibur 3	19	1.03 (7.05)	[-2.37, 4.42]	19	-1.23 (6.38)	[-4.10, 2.05]
Snowboard Supercross 3	17	-1.56 (5.67)	[-4.47, 1.36]	17	1.34 (3.00)	[-.22, 2.87]
Drawing	18	-.56 (6.48)	[-2.12, .99]	18	-2.50 (5.11)	[-5.04, .04]

Note. CI = confidence interval.

Table 4

Means and Standard Deviations for Measures of Pain Perception

	Pain Threshold			Pain Tolerance			Subjective Rating		
Condition	*n*	*M* (*SD*)	95% CI	*n*	*M* (*SD*)	95% CI	*n*	*M* (*SD*)	95% CI
Cold Fear	16	31.89 (41.15)	[9.96, 53.81]	15	30.60 (27.00)	[15.64, 45.56]	16	3.65 (1.56)	[2.82, 4.49]
Soul Calibur 3	16	22.02 (17.81)	[12.53, 31.51]	16	62.95 (64.55)	[28.55, 97.34]	19	3.75 (1.53)	[3.01, 4.48]
SSX3	17	21.48 (24.02)	[9.13, 33.83]	16	41.14 (37.72)	[21.05, 61.25]	17	3.85 (1.20)	[3.32, 4.46]
Drawing	19	38.83 (47.32)	[16.02, 61.64]	15	43.29 (29.43)	[27.00, 58.76]	19	3.68 (1.23)	[3.09, 4.27]

Note. CI = confidence interval; SSX3 = Snowboard Supercross 3.

Table 5

Correlations of Pain Measures and Other Dimensions (Change)

Measure	1	2	3	4	5
1. Hours of Video Games Per Week	-	-	-	-	-
2. Threshold	.05	-	-	-	-
3. Tolerance	.29*	.05	-	-	-
4. Subjective Rating- Pain	-.15	-.57**	-.12	-	-
5. Subjective Rating- Frustrating	.22	-.21	-.19	.29*	-

* $p < .05$. ** $p < .01$.

VITA

Kathleen Anne Jocoy was born in Douglasville, Georgia on December 10, 1985. She attended primary school in Asheville, North Carolina and completed her grade school in Fort Mill, South Carolina. She graduated from Fort Mill High School in May 2004. The following autumn, she entered Winthrop University to study psychology. During her time at Winthrop she worked as a research intern at the University of North Carolina at Charlotte and was nominated for the Outstanding Researcher Award. She was awarded the Bachelors of Arts degree in psychology in May of 2008. In the fall of 2008, she accepted a research assistantship in Psychology at Appalachian State University and began study towards a Master of Arts degree. The M.A. was awarded in December 2010.

Ms. Jocoy is a member of Psi Chi, Phi Kappa Phi, and Pi Gamma Mu. She was also nominated for the Graduate Teaching Award and inducted into the Cratis D. Williams Honor Society in January 2010. Her parents are Gregg and Nancy Jocoy.