DETECTION OF PHYSIOLOGICAL AND AFFECTIVE DESENSITIZATION TO VIOLENT VIDEO GAMES USING FACIAL ELECTROMYOGRAPHY

A Thesis
by
GLENNA LEE READ

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Abstract

DETECTION OF PHYSIOLOGICAL AND AFFECTIVE DESENSITIZATION TO VIOLENT VIDEO GAMES USING FACIAL ELECTROMYOGRAPHY

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Research regarding the deleterious effects of violent video games has been inconsistent. Some evidence, using the framework of the General Aggression Model (GAM), suggests that exposure to violent video games decreases physiological arousal and blunts affective responses (i.e., produces desensitization) to subsequent exposure to violent or negative stimuli (Bartholow, Bushman, & Sestir, 2006; Carnagey, Anderson, & Bushman, 2007b). Some researchers have questioned the validity of these findings (Ferguson & Kilburn, 2010). The current experimental study examined physiological and affective desensitization to violent video game play through the framework of the GAM. Participants played a violent or non-violent video game. Afterwards, they were exposed to pleasant, neutral, and aggressive images. Facial EMG was used to assess participants' reactions to the images by measuring the intensity of negative affect indicated by visually imperceptible movements of the brow muscle region (i.e., *corrugator supercilii*; CS). Heart rate (HR), blood pressure (BP), and self-reported affective valence and arousal were also gathered. It was hypothesized that participants who played the violent video game would demonstrate less negative affect as measured by reactivity in the CS region and less HR reactivity to violent images than participants who played the nonviolent video game, thus demonstrating physiological and affective desensitization. It was also expected that participants who played the violent video game would differ from those who played the nonviolent game in their ratings of aggressive images. None of the hypotheses were supported. Results indicated the violent video game did not produce physiological and affective desensitization, supporting more recent findings that suggest the GAM is not the most valid model to explain the effect of violent video games.

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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.

Detection of Physiological and Affective Desensitization to Violent Video Games Using Facial Electromyography

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Abstract

Research regarding the deleterious effects of violent video games has been inconsistent. Some evidence, using the framework of the General Aggression Model (GAM), suggests that exposure to violent video games decreases physiological arousal and blunts affective responses (i.e., produces desensitization) to subsequent exposure to violent or negative stimuli (Bartholow, Bushman, & Sestir, 2006; Carnagey, Anderson, & Bushman, 2007b). Some researchers have questioned the validity of these findings (Ferguson & Kilburn, 2010). The current experimental study examined physiological and affective desensitization to violent video game play through the framework of the GAM. Participants played a violent or non-violent video game. Afterwards, they were exposed to pleasant, neutral, and aggressive images. Facial EMG was used to assess participants' reactions to the images by measuring the intensity of negative affect indicated by visually imperceptible movements of the brow muscle region (i.e., *corrugator supercilii*; CS). Heart rate (HR), blood pressure (BP), and self-reported affective valence and arousal were also gathered. It was hypothesized that participants who played the violent video game would demonstrate less negative affect as measured by reactivity in the CS region and less HR reactivity to violent images than participants who played the nonviolent video game, thus demonstrating physiological and affective desensitization. It was also expected that participants who played the violent video game would differ from those who played the nonviolent game in their ratings of aggressive images. None of the hypotheses were supported. Results indicated the violent video game did not produce physiological and affective desensitization, supporting more recent findings that suggest the GAM is not the most valid model to explain the effect of violent video games.

Detection of Physiological and Affective Desensitization to Violent Video Games Using Facial Electromyography

Violent video games are of increasing concern; people spend more time now than ever before playing video games, and much of the content of video games is violent (Anderson et al., 2003). Previous research on the effects of violent video games has found that exposure to violent video games increases aggression (Anderson & Dill, 2000; Anderson & Morrow, 1995; Ballard & Lineberger, 1999; Bartholow & Anderson, 2002; Bartholow, Bushman, & Sestir, 2006; Cooper & Mackie, 1986; Irwin & Gross, 1995; Polman, de Castro, & van Aken, 2008; Sestir & Bartholow, 2010) and decreases prosocial behavior (Bushman & Anderson, 2009; Funk, Buchman, Jenks, & Bechtoldt, 2003; Sheese & Graziano, 2005; Silvern & Williamson, 1987). Other studies have found that the effects of exposure to violent video games persist over time and desensitize individuals to subsequent exposure to violence (Carnagey et al., 2007b; Staude-Müller, Bliesener, & Luthman, 2008). The current study examined the potential desensitizing effects of violent video games on physiological and affective responding to violent images.

Because the effects of violent video games have been shown to be deleterious in scientific settings, violent video games have been cited as one of the catalysts for several school shootings, including shootings in Paducah, Kentucky; Jonesboro, Arkansas; Virginia Tech; and the widely publicized Columbine High School shooting in Littleton, Colorado. Some researchers believe there are links between violent game play and violent acts (Anderson & Bushman, 2001; Anderson & Dill, 2000; Bartholow et al., 2006; Bushman & Anderson, 2002; Carnagey, Anderson, & Bartholow, 2007a). Recent evidence has shown that video games, in relation to other forms of media, may be particularly detrimental (Calvert & Tan, 1994; Polman et al., 2008). Violent video games provide a unique situation relative to other, more passive, forms of violent media (i.e., television, movies, music, etc.) because the participant is actively engaged in the aggressive and violent behaviors perpetrated by an on-screen character. For example, Polman and colleagues (2008) found that children who played a violent video game demonstrated increased aggressive behavior in a free-play session in the days following game play compared to participants who watched someone else play a violent video game or who played a nonviolent game. Similarly, Calvert and Tan (1994) found greater levels of physiological arousal in participants who played a violent video game than in participants who simply observed someone else play a violent video game. Increases in physiological arousal are related to increases in aggressive behavior and hostility (Anderson & Bushman, 2001; Ballard & Wiest, 1996; Bushman & Anderson, 2002; Carnagey et al., 2007a, 2007b). Researchers have also found that repeated exposure to violent video games can produce decreases in “emotion-related physiological reactivity” (i.e., desensitization) in response to subsequent exposure to violence (Carnagey et al., 2007b, p. 490). Physiological desensitization may be associated with increased acceptance of violence and aggression (Carnagey et al., 2007b; Funk, Baldacci, Pasold, & Baungardner, 2004) and decreased prosocial behavior (Bushman & Anderson, 2009; Carnagey et al., 2007b).

Despite research indicating that exposure to violent video games has potential negative repercussions, violent video games have become increasingly commonplace in American households. Many of the most popular games have Mature (M) ratings (Imagine Games Network [IGN], 2011). According to the Entertainment Software Rating Board

(ESRB), the organization responsible for issuing ratings to computer and video games, a rating of M indicates that the game may contain "intense violence, blood and gore, sexual content and/or strong language" and is intended for use by those ages 17 and over (ESRB, n. d.). Consequently, video game distributors are prohibited from selling games with an M rating to individuals under the age 17.

Although youth access to M-rated video games has decreased in recent years, most of the research to date has focused on the effects of violent video game play in children and adolescents; but, the effects of video game violence are not age specific and have been found in both children (Anderson & Bushman, 2001; Funk et al., 2003; Silvern & Williamson, 1987) and adults (Anderson & Bushman, 2001; Bushman & Anderson, 2002; Carnagey et al., 2007b). Carnagey and colleagues (2007a) emphasize the need for video game research with adult participants, as more adults, especially college-aged adults, are playing video games.

The General Aggression Model

The General Aggression Model is a widely accepted model used to explain the purported link between exposure to violent video games, desensitization, and aggression (GAM; Anderson & Bushman, 2002). The GAM was developed to explain the effect of violent video games on aggression, but it can also be generalized to other forms of violent media. According to the GAM, playing violent video games produces an interaction between person (e.g., trait hostility and state hostility) and situational (e.g., exposure) factors, which, in turn, creates changes in the person's internal state. As described below, these internal state changes may include changes in affect, cognition, and arousal that can affect the individual's appraisal of events. If desensitization occurs due to exposure to violence, this can, theoretically, affect appraisal in such a way that the likelihood of aggressive behavior increases while the likelihood of prosocial behavior decreases (Anderson & Bushman, 2002).

Situational Factors

For the process of the GAM to be activated, one must first be exposed to a situational factor, such as violent video games (Anderson & Bushman, 2002). If one is not exposed to violent media, it is unlikely that one will progress through the GAM. Thus, self-reported exposure to violent video games (Bartholow et al., 2006; Funk et al., 2004) or playing a nonviolent game in an experimental session (Bushman & Anderson, 2002; Bushman & Anderson, 2009; Carnagey et al., 2007b; Cooper & Mackie, 1986; Funk et al., 2003; Polman et al., 2008; Sestir & Bartholow, 2010; Williams, 2009) are typically used as factors in video game research.

Person Factors

Person factors, in combination with situation factors (i.e., exposure to violent video games), contribute to progression through the GAM. For instance, rather than finding uniform increases in aggression across participants, Unsworth, Devilly, and Ward (2007) found that state hostility moderated the relationship between trait hostility and exposure to violent video games. Participants with high trait hostility who reported lower levels of hostile affect before game play reported higher levels of anger after violent video game play than those who reported higher levels of hostile affect before game play. Most of the participants showed no change in hostile affect after violent video game play. These findings indicate that exposure to violent video games may affect people with dissimilar temperaments differently and may, in some cases, serve to relax some people.

To investigate the effect of trait hostility on information processing, Kirsh, Olczak, and Mounts (2005) had participants play either a nonviolent or a violent video game. They found that participants who were high in trait hostility showed more interference on an "emotional" Stroop task after playing a violent video game than participants who were low in trait hostility. An "emotional" Stroop task differs from a traditional Stroop task in that participants are asked to identify the color of emotionally laden (e.g., negatively valenced) and nonemotionally laden (i.e., neutral) words. Mood-congruent, emotionally laden words produce more interference on the emotional stroop task because participants tend to pay more attention to these words (Sharma & McKenna, 2001). According to the authors, and in accordance with previous work on the GAM (Anderson & Bushman, 2002), it follows that participants who are high in trait hostility will identify negatively-valenced words more slowly after playing a violent video game than participants who are low in trait hostility after playing a nonviolent video game. This increased salience of negative stimuli may prompt greater changes in internal state for those high in trait hostility than for individuals low in trait hostility.

Internal State Changes

The interaction of person and situation factors produce changes in internal state such as changes in affect, cognition, and/or arousal. Previous research has found that exposure to violent video games increases negative affect and hostility and may, in turn, lead to aggressive actions. For instance, Barlett, Harris, and Baldassaro (2007) demonstrated that participants who spent more time engaged in a first person shooter (FPS) video game reported increased negative affect or increased levels of hostility. Gentile, Lynch, Linder, and Walsh (2004) found that participants who reported high levels of exposure to violent video games were more hostile at school, reported getting in more physical altercations, and were more likely to argue with teachers than participants who reported low levels of exposure. However, these studies are correlational and thus, causal conclusions cannot be drawn from them.

Increased access to aggressive cognitions, the second component of internal state, also results from exposure to violent video games (Anderson & Bushman, 2001; Bushman & Anderson, 2002; Calvert & Tan, 1994; Carnagey et al., 2007a). Calvert and Tan (1994) found that playing a violent video game, as opposed to watching someone else play a violent video game, resulted in an increase in aggressive thoughts. Additionally, people who are exposed to violent video games may also ascribe aggressive cognitions to others. For example, in one study, participants who played a violent video game were more likely to complete story stems with aggressive themes than those who played a nonviolent video game. They were also more likely to describe the characters as behaving aggressively and thinking aggressive thoughts (Bushman & Anderson, 2002).

Some research on arousal, the third component of internal state, suggests that playing a violent video game is associated with increases in physiological arousal. As an illustration, Calvert and Tan (1994) found that participants who played a violent game had an increased heart rate (HR) compared to those that observed others playing a violent video game. Ballard and Wiest (1996) found elevated levels of systolic blood pressure (SBP) and HR in those who played a very violent video game versus those who played a nonviolent game. In the same study, they found that increased physiological arousal was also associated with increased levels of hostility.

Nonviolent video games may produce increases in physiological arousal that are similar to those elicited by playing violent video games (Ballard, Hamby, Panee, & Nivens, 2006; Lanningham-Foster et al., 2006; Wang & Perry, 2006). Ballard and colleagues (2006) found that changes in arousal in response to violent video game play were also present after playing other genres of arousing games (e.g., horror and sports). This suggests that changes in physiological arousal may not apply exclusively to violent video games, but may, in fact, extend to other genres. It is essential for video game researchers to ensure that differences in arousal in response to video game play are due to the violent or nonviolent content of the game, rather than differences in levels of arousal elicited by the game, per se.

The effects of violent video games on arousal are not limited to the time during game play or immediately afterwards and may result in desensitization over time. Ballard and colleagues (2006) found that both SBP and diastolic blood pressure (DBP) responding decreased over several sessions of game play across a 3-week period. Additionally, some researchers have found that participants who are repeatedly exposed to violent video games may exhibit decreased physiological arousal in response to subsequent exposure to other forms of media violence (Carnagey et al., 2007b; Staude-Müller et al., 2008). Such decreases in arousal in response to other violent images following violent video game play are conceptualized as physiological desensitization. Carnagey and colleagues (2007b) found decreased galvanic skin responding (GSR) and HR responding in those who had played a violent video game in response to subsequent exposure to videotaped violence. Similarly, Staude-Müller et al. (2008) found evidence of physiological desensitization (decreased HR and GSR) in participants who played an aggressive video game compared to those that played a less violent version of the same game. However, participants in the both the violent and less violent video game conditions reported similar levels of valence and arousal elicited by the images. Staude-Müller and colleagues (2008) suggest that appraisal of images is a cognitive process that does not reflect the current emotional state of the participant. Therefore, physiological responding, rather than self reported affect, may be a more accurate way to determine if desensitization has taken effect.

Appraisal

According to the GAM, affective, cognitive, and arousal-related changes in an individual's internal state interact to increase the likelihood that an individual will interpret ambiguous situations in a negative manner (Bushman & Anderson, 2002). Repeated exposure to violent video games may lead individuals to become habituated to violence and consistently appraise violence differently than individuals who have not been repeatedly exposed to violent video games (i.e., desensitization). Kirsh (1998) found that participants who played violent video games were more likely than participants who played nonviolent video games to evaluate ambiguous actions of characters in stories as hostile. This finding suggests that exposure to violent video games leads to a more negative appraisal of situations. In addition, Kirsh and Mounts (2007) found that participants who played a violent video game took longer to identify the emotion on happy faces than participants who played a nonviolent game, indicating that exposure to violent media can interfere with the appraisal of emotion-laden stimuli. The tendency to appraise events as more negative in nature or to take longer to identify positive events may lead to decreases in prosocial behavior and/or increases in aggressive behavior.

Behavioral Outcomes of the GAM

Some researchers have found that, after being exposed to violent media, participants demonstrate less empathy for real life victims (Funk et al., 2003), show lowered emotional reactions to affective stimuli, and perceive violent acts as less severe (Deselms & Altman, 2003). Thus, theoretically, individuals who have progressed through the GAM become desensitized to real life instances of violence and are less likely to help others in need and/or to act in more hostile ways towards others (Anderson et al., 2003; Anderson & Dill, 2000; Anderson & Morrow, 1995; Ballard & Lineberger, 1999; Bartholow & Anderson, 2002; Bartholow et al., 2006; Bushman & Anderson, 2009; Funk et al., 2003; Irwin & Gross, 1995; Polman et al., 2008; Sestir & Bartholow, 2010; Sheese & Graziano, 2005; Silvern & Williamson, 1987).

In fact, reduced prosocial behavior after violent video game use has been evidenced in several studies (Bushman & Anderson, 2009; Funk et al., 2003; Sheese & Graziano, 2005; Silvern & Williamson, 1987). Funk and colleagues (2004) found that children who reported high levels of exposure to violent media showed reduced levels of empathy on the Children's Empathy Questionnaire. Sheese and Graziano (2005) found that adults who played a violent video game showed reduced cooperative behavior and increased exploitive behavior in a modified Prisoner's Dilemma game relative to those who played a nonviolent game or no game at all.

According to the GAM, exposure to violent video games decreases the likelihood of engaging in prosocial behavior by decreasing the probability that an individual will interpret an incident as an emergency while simultaneously decreasing sympathy for the victim, essentially desensitizing the individual to violent events. Three cognitive processes must occur in order for an individual to intervene to help someone in need (Latané & Darley, 1970). First, an individual must realize that there is an emergency occurring. Next, the individual must recognize the seriousness of the event. Finally, the individual must realize that he or she is responsible to intervene and to help the victim. According to Carnagey and colleagues (2007b), exposure to violent video games can interfere with any one of these three processes.

In a study designed to investigate the effect of exposure to violent video games on prosocial behavior, Bushman and Anderson (2009) staged a fight outside of a room in which a participant was seated. They found that participants who played a violent video game took longer to help a "victim" in another room and judged a "fight" heard in another room as less serious than participants who played a non-violent video game. The authors argue that these results indicate that even short-term exposure to violent video games is sufficient to reduce prosocial behavior and to desensitize individuals to violence (Bushman & Anderson, 2009).

In addition to predicting reduced prosocial behavior, the GAM also predicts increases in aggressive behavior. Aggression is defined as behavior with the intent to harm another human being (Anderson et al., 2003). It has been conceptualized as increased physical aggression (Irwin & Gross, 1995; Polman et al., 2008), increased play with aggressive versus non-aggressive toys, the apparent administration of a harsh punishment (Cooper & Mackie, 1986), the amount of time a confederate's hand is held in a cold-pressor device (Ballard & Lineberger, 1999), the intensity of an unpleasantly loud noise blast delivered as punishment to a confederate (Anderson & Dill, 2000; Bartholow & Anderson, 2002), and the unnecessary killing of video game characters (Anderson & Morrow, 1995). The numerous ways in which aggression is conceptualized across different studies results in complications in interpreting and generalizing findings. For instance, Ferguson and Rueda (2009) found that a measure of aggression frequently used to study violent video games, the modified Taylor competitive reaction time task (TCRTT), does not directly measure aggression. The TRCTT is a reaction time task in which participants believe they are delivering loud noise blasts to an opponent. Using measures of trait aggression and self-reported violent criminal behavior, Ferguson and Rueda (2009) found that the TRCTT was not indicative of the likelihood that an individual would act aggressively. The authors suggest that measures of aggression commonly used to investigate the effects of violent video games in experimental sessions may not be valid and may not be indicative of the likelihood of individuals to commit aggressive acts in real-life.

Additionally, researchers sometimes conceptualize the same measures of aggression differently across different studies (see Adachi & Willoughby, 2011; Ferguson & Kilburn, 2010). For example, Adachi and Willoughby (2011) found that in some studies noise blasts were considered aggressive depending on the intensity of the blast delivered. In other studies, noise blasts were considered aggressive if they were delivered for a longer duration. These findings suggest that research with more precise and objective measures of aggression and negative affect is needed before researchers can draw conclusions about the nature of the relationship between violent video games and aggression.

Despite these, and other, methodological critiques, some researchers maintain that there are irrefutable causal links between violent video game play and increases in aggressive behavior (Anderson et al., 2003). According to Anderson and colleagues (2003), there is “unequivocal evidence that media violence increases the likelihood of aggressive and violent behavior in both immediate and long-term contexts” (p. 81). Although the statement above is certainly compelling, increases in aggression are not uniform across participants (Kirsh et al., 2005; Unsworth et al., 2007), and some studies have not found consistent increases in aggression or hostility after violent video game play (Ballard et al., 2012; Cooper & Mackie, 1986; Ferguson & Rueda, 2010; Williams & Skoric, 2005).

Methodological Critique of the GAM

Although the GAM is currently the most popular framework used to discuss the effects of exposure to violent video games on aggression, the inconsistent findings cited above have led researchers to question the validity of the GAM. In a critique of meta-analyses supporting the GAM, several researchers suggest that the GAM is so frequently supported because studies that do not find significant effects are rarely published (Ferguson & Kilburn, 2009; Ferguson & Kilburn, 2010). Moreover, Ferguson and Kilburn found the influence of violent video games on aggressive behavior and violence to be minimal. The authors cite evidence that there is actually a negative correlation between the number of violent video games sold and rates of violent crime in industrialized nations.

In addition, findings regarding the GAM have been inconsistent. The GAM posits that exposure to violent video games increases aggressive cognitions, aggressive affect, and physiological arousal. In contrast, Ballard and colleagues (2012) found that participants who played a violent video game did not demonstrate increased cardiovascular reactivity (HR and SBP) compared to participants who played a nonviolent game. In the same study, participants who played the violent video game actually rated the experimenters more positively than participants who played the nonviolent video game.

Sheese and Graziano (2005) found that, after playing a violent video game, participants were no more likely than those who played a nonviolent game to expect that their partner was untrustworthy (or planning to defect) in a Prisoner's Dilemma-type game.

This finding is counter to the appraisal component of the GAM in which exposure to violent video games is presumed to change the way in which people appraise other's motives.

Some researchers have not found increases in behavioral aggression after violent video game play. Williams and Skoric (2005) discovered, in a longitudinal study, that participants who played a violent video game did not demonstrate an increase in aggressive cognitions or report more arguments with friends or partners than those who were not exposed to the violent video game. Similarly, Ferguson and Rueda (2010) found that participants who played violent video games did not aggress more and did not demonstrate more hostile feelings or depression than participants who played nonviolent video games. In fact, follow-up analyses, in which the authors examined responses on a self-reported exposure to violent video games measure, revealed that reported exposure to violent video games was negatively correlated with hostile feelings and depression after a frustrating and stressful task. Although this research is correlational, the researchers suggest that violent video games may actually provide an outlet for depressed individuals by helping them manage hostile feelings and promoting self-efficacy.

Although violent video games have been cited as the cause of societal ills, the research surrounding the influence of violent video games on aggressive behavior has not been consistent. Violent video games have been found to increase aggression, ameliorate aggression, and to have no impact on aggression, depending on the study. Currently, the effect of violent video games has been studied most often through the use of the GAM. Some recent research has been critical of the validity of the GAM. Through the use of physiological measures, the current research aimed to elucidate the nature of the relationship between violent video games and aggression-related affect.

Overview of the Current Study

The present study aimed to investigate one component of the GAM: changes in internal state. Specifically, I examined changes in arousal and affect prompted by exposure to violent video games. While there are many studies on the desensitizing effects of violent video games, relatively few have used physiological measures to examine physiological desensitization in relation to negative stimuli (Ballard et al., 2006; Bartholow et al., 2006; Carnagey et al., 2007b; Engelhardt, Bartholow, Kerr, & Bushman, 2011). In this study, I examined the effects of violent video games on physiological and affective desensitization in college students through the use of facial electromyography (EMG) and measures of HR and BP. The use of facial EMG in this context decreases sensitivity to demand characteristics and is novel.

In light of the critique regarding the imprecise methods and materials used in previous research to measure aggression-related constructs, facial EMG was used to determine affect in this study. Facial EMG is used to measure muscle contractions associated with various facial expressions and can detect contractions that are too small to be visually detectable (Dimberg, 1990; Stern, Ray, & Quigley, 2001). Facial EMG is a relatively unobtrusive, objective, and precise measure of the muscular activity associated with particular affective states (Blascovich, Vanman, Mendes, & Dickerson, 2011; Dimberg, 1990). The use of facial EMG to detect affective desensitization eliminated potential biases in measurement and interpretation that were present in previous studies on the relationship between violent video games and aggression. Further, physiological measures are considered a more accurate measure of affect than self-report because of the potentially unconscious nature of affective states (Blascovich et al., 2011; Staude-Müller et al., 2008). Additionally, facial EMG and other physiological measures eliminate response bias present in self-report (Blascovich et al., 2011).

When employed in research on affect, facial EMG is most often used to measure the activity of the *zygomaticus major* and *corrugator supercilii* muscle regions, located in the cheek and the brow, respectively (Blascovich et al., 2011). The *zygomaticus major* region is activated when participants view pleasant imagery. Unpleasant, disgusting, and/or violent imagery activates the *corrugator supercilii* region (Brown & Schwartz, 1980). The *corrugator supercilii* region shows a linear effect of valence, such that very unpleasant imagery elicits more activity in this muscle region than mildly unpleasant imagery. Pleasant imagery inhibits *corrugator supercilii* activity (Lang, Greenwald, Bradley, & Hamm, 1993; Larsen, Norris, & Cacioppo, 2003).

Larsen et al. (2003) found that measures taken in the *corrugator supercilii* region were more sensitive to stimuli than measures taken in the *zygomaticus major* region. This is due, in part, to proximity of *zygomaticus major* to other muscle groups in the face (Blascovich et al., 2011). Additionally, *zygomaticus major* shows a curvilinear effect of valence, such that both very pleasant imagery and very unpleasant imagery elicit high levels of activity, rendering the activity of this muscle difficult to interpret (Larsen et al., 2003). Because of the issues cited above, in the current study, the activity of the *zygomaticus major* region was not examined.

In addition to facial EMG, several cardiovascular (CV) measures were recorded throughout the study, including diastolic blood pressure (DBP), systolic blood pressure (SBP), and heart rate (HR). Heightened levels of these measures are associated with distress (Walden & Smith, 1997) and increased physiological arousal (Anderson & Bushman, 2001).

After playing either a violent or nonviolent video game, facial EMG was used to determine activity of the *corrugator supercilii* muscle region in response to aggressive, pleasant, and neutral images. Increased activity in the *corrugator supercilii* area is indicative of increased negative affect (Larsen et al., 2003). Therefore, in accordance with previous research on desensitization and the GAM, the first hypothesis was that participants who were exposed to violent video games would demonstrate a more subdued negative facial expression, or lower *corrugator supercilii* region activity in response to aggressive images than would individuals who played a nonviolent control game, indicating that physiological desensitization had taken effect. The second hypothesis was that participants who played the violent video game would also demonstrate physiological desensitization compared to participants who played the nonviolent game as indicated by reduced HR reactivity to aggressive images. Previous research on the affective and cognitive components of the GAM suggest that participants who play a violent video game will appraise and rate images differently than participants who play a nonviolent game (Bushman & Anderson, 2002). Thus, hypothesis three was that participants who played a violent video game would report being less sad in response to aggressive images on the Self-Assessment Manikin (SAM) than those who played a nonviolent game (Bradley & Lang, 1994). In addition to the three hypotheses, I examined *corrugator supercilii* area activity and HR reactivity in response to the neutral images as an exploratory research question. Previous research on violent video games and appraisal suggests that participants exposed to violent video games will interpret ambiguous, or neutral, stimuli as being more hostile than participants who play a nonviolent video game (Kirsh, 1998; Kirsh & Mounts, 2007). Therefore, it was expected that participants who played a violent video game would demonstrate decreased *corrugator* *supercilii* region activity and HR reactivity as compared to those who played a nonviolent game, indicating physiological desensitization, in response to neutral images.

Method

Pilot Study

The pilot study was used to determine if images drawn from the International Affective Picture System (IAPS) were appropriate for use in an experimental study.

Participants. Participants included 60 female and male undergraduate college students at a mid-sized southeastern university. Participants enrolled in classes during summer session were recruited through psychology courses and were offered extra credit in those courses in return for participation. Participants enrolled in classes during the fall semester were recruited through an online subject pool and received course credit for their participation. All participants were treated in a way that is consistent with ethical guidelines set forth by the Institutional Review Board (IRB), the American Psychological Association (APA), and Appalachian State University. Approval for this study, #11-0262, was obtained from the IRB on April 14, 2011 (see Appendix A).

Materials. Materials for the Pilot Study included 45 images drawn from the IAPS and a rating packet on which participants recorded their responses.

Images. A total of 45 images were drawn from the IAPS. The IAPS is a set of photographs used to evoke a range of affective responses. The IAPS is used frequently in conjunction with facial EMG. Thus, there is substantial research investigating the relationship between the activity of the *corrugator supercilii* muscle region and the relative valence of pictures (Bradley, Codispoti, Cuthbert, & Lang, 2001; Bradley & Lang, 2007; Lang et al., 1993; Larsen et al., 2003). Fifteen pleasant, 15 neutral, and 15 aggressive images were selected and agreed upon by two independent researchers. All images were rated and approved by 6 lab members (2 males and 4 females). Additionally, ratings of images were obtained from the IAPS Tech Manual to ensure that ratings of the lab members were consistent with ratings obtained by previous researchers (Lang, Bradley, & Cuthbert, 2008). All images were displayed to the participants for 5 s each via a PowerPoint presentation.

Rating packet. Participants recorded their responses directly on the forms. The packet included a demographic question about the gender of the participant and questions regarding content and emotional responses to the 45 images. Specifically, participants were asked to circle the word that best described the image. Choices included “aggressive,” “neutral,” and “pleasant.” Participants were asked to rate, on a scale of 1 (not at all) to 5 (very much), the extent to which the image exemplified the word chosen previously. Participants were also asked what emotion the image elicited and were given a series of choices (fear, happy, sad, joy, anger, none, anxious, peaceful, relaxed, bored) or were allowed to insert a word of their choosing. They were then asked, on a scale of 1 (not at all) to 5 (very much), the extent to which the image made them feel the specified emotion (see Appendix C).

Procedure. Participants were seated in groups of 10-20 in a classroom. Participants first read an informed consent form and were allowed the opportunity to ask questions regarding the study. Participants were then directed to look over the response packet and to examine the word bank (fear, happy, sad, joy, anger, none, anxious, peaceful, relaxed, bored) written on a chalkboard at the front of the classroom. The images were displayed via a PowerPoint presentation on a large screen at the front of the classroom. Each image was displayed for 5 s. There was a 25 s break after each image for the participants to record their responses.

Analyses. The percentage of participants who rated each image as belonging to the expected valence category (i.e., pleasant images rated as pleasant, neutral images rated as neutral, and aggressive images rated as aggressive) was calculated for each image. Additionally, a total valence score for each image was calculated by determining if each participant chose a word to describe the emotion elicited by the image that was consistent with the expected valence category of the image (i.e., aggressive word descriptors for aggressive images, pleasant word descriptors for pleasant images, and neutral word descriptors for neutral images). If the rating word was consistent with the expected valence, the numerical scores for the questions “to what extent does this image exemplify the word chosen above?” (on scale of 1 to 5) and “to what extent does this image make you feel this way?” (on scale of 1 to 5) were added together. If the rating word was not consistent with the expected valence, the question was given a score of zero. The highest score for each image was 10 and the lowest was 0, with higher scores indicative of more appropriate valence ratings. A total score was averaged for each image to create an overall valence score (ranging from 0 to 10) for all 45 images.

Results. Three aggressive, three neutral, and three pleasant images that had the highest percentage ratings were chosen for use in the experimental study. All images selected were rated by at least 90% of the participants as fitting into the expected valence category. When more than one image had the same percentage rating, the valence score was used to determine the best image for use in the study. The pleasant images chosen were an image of three puppies, an image of an elderly couple on bicycles, and a flowery beach scene. The neutral images chosen were the shadow of a man, an image of a picnic table, and a dock scene. The aggressive images chosen were an image of an angry dog, an image of a child with a gun pointed at the viewer, and an image of a man holding a woman at knifepoint. See Table 1 for percentage ratings, valence ratings, and IAPS affect and arousal ratings.

Experimental Study

The experimental study was designed so that video game condition (violent or nonviolent) was the independent variable and heart rate (HR) reactivity, *corrugator supercilii* muscle region reactivity, and self-reported affective response to images were the dependent variables.

Participants. Participants included female (*n* = 49) and male (*n* = 51) undergraduate college students at a southeastern comprehensive university. The participants were primarily Caucasian (*n* = 81). The remaining participants were African American (*n* = 6), Hispanic (*n* = 6), Asian (*n* = 3), Multiracial (*n* = 2), or did not specify race (*n* = 2). Participants who were enrolled in introductory psychology courses were recruited through an online subject pool and received course credit for their participation. Students in the introductory psychology courses could choose to participate in studies or complete other reasonable alternatives for course credit. Previous exposure to violent video games was not a criterion for selection of participants. Participants were asked to refrain from ingesting nicotine or caffeine or exercising for 3 hr prior to the study. All participants were treated in a way that is consistent with ethical guidelines set forth by the IRB, the APA, and Appalachian State University. Approval for this study, #11-0319, was obtained from the IRB on May 18, 2011 (see Appendix D).

Materials. Materials in the Experimental Study consisted of an 8-min progressive muscle relaxation (PMR) and guided breathing audio tape, a violent and a nonviolent video game, 9 IAPS images identified in the Pilot Study, the Self-Assessment Manikin (SAM), facial electromyography (EMG), cardiovascular data, a Demographics and Exposure Questionnaire, and a Game Experience Questionnaire.

Progressive Muscle Relaxation (PMR) and guided breathing audio. An audio taped PMR and guided breathing session was administered to obtain baseline facial electromyography readings. The session consisted of the oral instructions of a licensed clinical psychologist guiding the participant through 8-min of PMR and guided breathing.

Video games. Both the nonviolent and violent games were played on the Nintendo Wii video game console. There were several considerations in choosing the games. To prevent confounds, the two games must be equal in terms of competitiveness, difficulty, and the pace of action (Adachi & Willoughby, 2011). The violent video game used was MadWorld Wii (rated M [mature]; SEGA of America, Inc., San Francisco, CA). MadWorld Wii is an extremely graphic video game in which the goal is to kill people in the most creative way. To accentuate the violence, the cartoon-like graphics are black and white, except for red blood. Players advance through open environments searching for victims. Points are awarded for innovative and brutal methods of violence. Players may impale victims with signposts, slam them against spikes on the wall, chop their heads off with chainsaws, tear their hearts out, throw them into moving trains, or employ multiple combinations of violent moves. The nonviolent video game used was Super Mario Galaxy 2 (rated E [everyone]; Nintendo of America, Inc., Redmond, WA). The goal of Super Mario Galaxy 2 is to collect power stars in each level by completing puzzle-like tasks. The graphics are cartoon-like and the player is allowed to explore open worlds freely. Players roam worlds, collect coins and starbits, and jump on enemies. Unlike MadWorld Wii, there is color throughout the whole game, and there is no blood or gore. When players jump on enemies, the enemies disappear. The two games were chosen for similarity in graphics and game play style. In addition, both games are rated positively on metacritic.com (2011).

Images. Aggressive, neutral, and pleasant images were selected from the IAPS (Lang, Bradley, & Cuthbert, 1999) in the pilot study. Ratings of pleasantness and arousal using the SAM (Bradley & Lang, 1994) were obtained from 100 individuals for each image in the database by Lang, Bradley, and Cuthbert (2008). Nine images (three pleasant, three neutral, and three aggressive) were selected for use in the pilot study described above. They were presented in a random order to each participant.

The Self-Assessment Manikin (SAM). Participants were asked to report affect and arousal in response to the images using the SAM. The SAM consists of a series of figures from which participants can indicate levels of affect and arousal. The affect (pleasantness) dimension consists of figures that range from very sad (frowning) to very happy (big smile). Participants indicated arousal by choosing one of a series of figures ranging from very relaxed (closed eyes) to very aroused (eyes wide open and shaking). The SAM was presented on a computer using E Prime, version 2.0. Participants chose the figure presented on the screen using the corresponding number on the keyboard.

Facial electromyography data (EMG). Biopac model mp150 was used to record EMG data from the *corrugator supercilii* muscle region using reusable Ag/AgCl electrodes that were 4mm in diameter. Bipolar recording was employed to reduce artifacts associated with noise interference. Electrode gel was used as a conductant. Before the electrodes were applied, the muscle site was cleaned with a gentle soap and alcohol and abraded to remove dead skin cells and dirt so that inter-electrode impedances were lowered to 10 kΩ or less, as measured by an impedence meter (Blascovich et al., 2011; Fridlund & Cacioppo, 1986; Hess, 2009). Based on a screening procedure, 9 people were unable to participate in the study because researchers were unable to lower their inter-electrode impedances to 10 kΩ or less. Data was sampled at a rate of 1000 Hz (Fridlund & Cacioppo, 1986; Hess, 2009; Konrad, 2005). Data was recorded during 6 s of image presentation, as done by Lang et al. (1993) and Larsen et al. (2003). Recordings were collected in a soundproofed and dimly lit room to reduce auditory and electrical interference (Blascovich et al., 2011). Facial EMG data was recorded with AcqKnowledge 4.2 software and was synced with E Prime, version 2.0, on the computer on which the experiment was displayed. Facial EMG data was recorded during the PMR and guided breathing session and for each of the 9 images which were presented for 6 s each.

Cardiovascular data. HR, SBP, and DBP were monitored using an Omron Deluxe Wrist Blood Pressure Monitor Model HEM 650. HR data was also collected with a CMS-60C Color Pulse Oximeter. HR, SBP, and DBP data were recorded by the experimenter on a data sheet.

Demographics and Exposure Questionnaire. Demographic information (age, gender, ethnic background/race, class status) was obtained at the end of the study. Previous exposure to violent video games was assessed using questions regarding the frequency of video game play every day and every week, what types of video games the participant reported playing most frequently, and the type of console used (see Appendix F).

Game Experience Questionnaire. A Game Experience Questionnaire (Ballard et al., 2012) was given at the conclusion of the experiment as a manipulation check. The Game Experience Questionnaire assesses attitudes towards the game played during the experimental session. Questions include "how enjoyable/(stressful/boring/frustrating/ exciting/relaxing) did you find playing the video game today?" For these questions, participants respond on a 5-point Likert-type scale that ranged from 1 (not at all) to 5 (extremely). The Game Experience Questionnaire also addresses how well the participant thought they played during the gaming session and how much experience they have had playing the game they played during the experimental session. For these questions, participants also answered on a 5-point Likert-type scale (see Appendix G).

Procedure. Participants were seated in a comfortable reclining chair in a soundproofed room at the beginning of the experimental session read and signed an informed consent form. Electrodes were placed above the *corrugator supercilii* muscle region according to the guidelines of Fridlund and Cacioppo (1986) and Huang, Chen, and Chung (2004).

Participants were acclimated to the experimental session by engaging in an eight-min relaxation session consisting of an audio recording that led the participant through a PMR/guided breathing session. Facial EMG was recorded during the session. The first 6 s of the last min of the relaxation session was used as the baseline. After the relaxation session, participants' resting BP and HR were taken. These measures were used as baseline BP and HR measures. Participants then played either a violent or a nonviolent video game for 20 min. BP and HR were measured directly after completion of the game play session.

Although participants were still hooked up to the electrodes due to time constraints, facial EMG activity was not recorded during game play.

Following game play, participants were directed to look at a computer screen. Facial EMG data was recorded while participants viewed the 9 pleasant, neutral, and aggressive images presented in a randomized order. Images were presented for 6 s each. There was a short break after the presentation of each image. During this break, HR was recorded with the oximeter. Participants rated their emotional reactivity and level of arousal on the SAM in response to the previous image; the participant was instructed to choose the figure that best represented their affective reaction and level of arousal by pressing the number on the keyboard that corresponded with the SAM figure on the screen. BP and HR were taken at the end of the presentation of the pictures. Finally, participants completed demographic and video game history forms. All participants were fully debriefed about the nature of the study at the conclusion of the experimental session, thanked, and given credit for their participation.

Results

Preliminary Data Analysis

An independent samples t-test was used to compare the number of min per day male and female participants reported playing video games. On average, male participants (M = 65.95, SD = 71.22) reported playing games for more min per day than female participants (M = 12.45, SD = 29.26); $t(98) = -4.88$, $p < .001$.

An independent samples t-test was used to compare results of responses to the Game Experience Questionnaire in the violent game play and nonviolent game play conditions as a manipulation check. See Table 2 for means, standard deviations, and *t* and *p* values.

Compared to the violent video game participants found the nonviolent game to be more enjoyable, more exciting, more relaxing, and less boring. In contrast, the nonviolent and violent games did not differ in terms of evoking stress and frustration. Both games were rated as “somewhat frustrating” and “somewhat stressful.” Participants in both conditions reported having little to no experience with the game they played. Overall, participants in both conditions reported playing “somewhat like I wanted to play” to “just like I wanted to play.”

Data Reduction

The EMG data for the *corrugator supercilii* was transformed from the raw state before analyses were conducted. The EMG signal was rectified to produce an absolute value and the data was converted from volts (V) to microvolts (μV) (Blascovich et al., 2011; Dimberg, 1990; Hess, 2009). Finally, a log transformation was used on the EMG data to reduce the large variation in the scores and to prevent exclusion of important data points that might be considered outliers.

For the analyses, the activity of the *corrugator supercilii* muscle region was averaged over six s of image presentation for each image. The combined means of *corrugator supercilii* region responding to the three aggressive images was calculated and used in the analysis to test the first hypothesis. For the exploratory analysis, the average of *corrugator supercilii* region responses to the three neutral images was calculated. In both analyses, the first six sec of the last min of the relaxation session were averaged and used as the baseline.

To examine the second hypothesis, HR responses to the three aggressive images were averaged. In the exploratory analyses, mean HR response to the three neutral images was used. In both analyses, the HR taken after the relaxation session was used as the baseline.

Test of Main Hypothesis

An analysis of covariance (ANCOVA) was used to investigate the first hypothesis, that participants in the violent video game condition would demonstrate desensitization in response to aggressive images as indicated by decreased *corrugator supercilii* region activity. Baseline *corrugator supercilii* region activity was used as a covariate in the analysis (Blascovich et al., 2011). Video game condition (violent versus nonviolent) was the between-subjects factor and *corrugator supercilii* region response to the aggressive images was the dependent variable. The covariate was significant, $F(1, 97) = 49.18$, $p < .001$. There was no significant effect of video game type on *corrugator supercilii* region activity in response to aggressive images after controlling for baseline *corrugator supercilii* region activity, $F(1, 97) = 1.83$, $p = .179$, $\eta^2 = .019$ (See Table 3 for all means and standard deviations).

In order to investigate the second hypothesis, that participants who played the violent video game would demonstrate desensitization through decreased HR responding to aggressive images, a separate ANCOVA was conducted. Video game condition (violent versus nonviolent) was the between-subjects factor and HR response to aggressive images was the dependent variable. The covariate, baseline heart rate, was significant, $F(1, 96) = 273.94$, $p <.001$. There was no significant effect of video game type after controlling for baseline HR scores, $F(1, 96) = .151$, $p = .698$, $\eta^2 = .002$.

A one-way analysis of variance (ANOVA) was conducted to test hypothesis 3, which compared mean differences in self-reported ratings of sadness in response to aggressive images on the Self-Assessment Manikin. Video game condition (violent or nonviolent) was the independent variable. The dependent variable was the average of self-reported affective responses to the aggressive images. There was no effect of condition on ratings of aggressive images, $F(1, 98) = .003$, $p = .958$, $\eta^2 = .000$.

Exploratory Analyses

Additional exploratory analyses were performed to examine the effect of the violent video game on *corrugator supercilii* and HR reactivity in response to neutral images. An ANCOVA was used to examine the effects of the video game condition (violent versus nonviolent) on *corrugator supercilii* region activity in response to the neutral images. Baseline *corrugator supercilii* region activity was used as a covariate in the analyses (Blascovich et al., 2011). Video game condition was the between-subjects factor and *corrugator supercilii* response to the neutral images was the dependent variable. The covariate was significant, $F(1, 97) = 46.96$, $p < .001$. There was no significant effect of video game type on *corrugator supercilii* region activity in response to neutral images after controlling for baseline *corrugator supercilii* region activity, $F(1, 97) = 2.28$, $p = .134$, $\eta^2 = .023$.

In order to investigate the second exploratory question, that participants who played the violent video game would demonstrate desensitization through decreased HR responding to neutral images, another ANCOVA was conducted. Video game condition (violent versus nonviolent) was the between-subjects factor and HR response to the neutral images was the dependent variable. The covariate was significant, $F(1, 96) = 302.17$, $p < .001$. There was no significant effect of video game type after controlling for baseline HR scores, $F(1, 96) = .141$, $p = .709$, $\eta^2 = .001$.

Discussion

This study was designed to investigate desensitization to violent video games using the framework of the General Aggression Model (GAM). The GAM posits that exposure to video game violence affects perception of real-life violence and can lead to an increase in the likelihood that one will engage in a violent act, particularly due to the potentially desensitizing effects of video games. Some research has found that video game violence produces desensitization, as well as increases in aggressive behavior and decreases in prosocial behavior (Anderson et al., 2003; Anderson & Dill, 2000; Anderson & Morrow, 1995; Ballard & Lineberger, 1999; Bartholow & Anderson, 2002; Bartholow et al., 2006; Bushman & Anderson, 2009; Funk et al., 2003; Irwin & Gross, 1995; Polman et al., 2008; Sestir & Bartholow, 2010; Sheese & Graziano, 2005; Silvern & Williamson, 1987).

This study focused on one component of the GAM: internal state changes. Desensitization, as evidenced through internal state changes, was examined using several physiological (i.e., HR, BP) and affective (i.e., self-report and *corrugator supercilii* region activity) measures. Three hypotheses, based on the GAM, were tested: (1) that desensitization would be evidenced through decreased *corrugator supercilii* region responses to aggressive images in those who played a violent video game as compared to those who played a nonviolent video game, (2) that, compared to those who played a nonviolent video game, those who played a violent video game would demonstrate decreased HR responding to aggressive images, and (3) that those in the violent video game condition would rate aggressive images as less sad than participants in the nonviolent video game condition. Exploratory analyses of *corrugator supercilii* region reactivity, heart rate responses, and self-reported affective responses to neutral images were also examined.

The results did not support any of the hypotheses. Specifically, there was no evidence of a significant difference between participants in the violent video game condition and the nonviolent video game condition in regards to *corrugator supercilii* region activity, HR responding, or self-reported affective appraisal of aggressive images. If desensitization had occurred, we should have found decreases in the activity of the *corrugator supercilii* region, which would indicate a blunting of negative affect (Brown & Schwartz, 1980), decreased HR responding to the aggressive images, and reports of affective desensitization in terms of self-reported appraisal of the aggressive images. Taken together, these findings do not support the GAM, which suggests that both physiological and affective desensitization should occur in response to violent video games (Carnagey et al., 2007b; Staude-Müller et al., 2008).

Exploratory analyses revealed that game condition (violent versus nonviolent) also failed to impact HR responding, *corrugator supercilii* region activity, or self-reported affective responding to the neutral images. Based on previous research supporting the GAM, it was expected that, if desensitization occurred, neutral images would be perceived as more aggressive in nature by those who played a violent game due to a bias in appraisal processes (Kirsh, 1998; Kirsh & Mounts, 2007). Although contrary to the predictions of the GAM, our finding is consistent with other research that found that violent video game play does not negatively affect responses to neutral images (Bowen & Spaniol, 2011; Staude-Müller et al., 2008). Taken together, these findings contradict the appraisal component of the GAM.

One possible explanation for the findings is that short-term (20 min) exposure to violent video games is not sufficient to produce desensitization that persists over time. This explanation is contrary to the finding of Carnagey et al. (2007b), who found that 20 min exposure to violent video games was sufficient to elicit lasting effects on physiological responding. In addition, previous research has found that the effects of violent video games last for several minutes (Barlett, Branch, Rodeheffer, & Harris, 2009) to an hour (Deselms & Altman, 2003). Therefore, if desensitization was present, we should have been able to detect it, particularly given the sensitivity of the *corrugator supercilii* measure. Thus, it seems that, in the present study, violent versus nonviolent game play had no significant desensitizing impact on affective state and physiological responding as measured by *corrugator supercilii* area activity, HR, and self-report.

Although the findings of the current study are contrary to the hypotheses and to a number of studies that support the GAM (Ballard & Wiest, 1996; Bartholow et al., 2006; Calvert & Tan, 1994), they are consistent with more recent findings that are critical of this model (Ballard et al., 2012; Bowen & Spaniol, 2011; Ferguson & Rueda, 2010; Williams & Skoric, 2005). Ballard and colleagues (2012) found no differences in physiological reactivity between those who played a violent game and those who played a non-violent game. Further, evaluations of experimenters were more positive when participants had played the violent game than when they had played the nonviolent game. Thus, neither the internal state change nor the behavioral outcome assumptions of the GAM were supported by Ballard and colleagues (2012). Other researchers have found no evidence of cognitive desensitization following video game play (Bowen & Spaniol, 2011), no correlation between violent video game play and aggressive behavior (Ferguson & Rueda, 2010), no effect of violent video game play on desensitization (Regenbogen, Herrmann, & Fehr, 2010), and no effect of violent video game play on appraisal (Sheese & Graziano, 2005).

Research using the framework of the GAM to examine the relationship between violent video game play and the purported mechanisms that lead to negative behavioral outcomes (increased aggression and decreased prosocial behavior) has been inconsistent. Critics of the GAM have highlighted methodological problems present in this research, including unstandardized measures of aggression, systematic differences in violent and nonviolent games, and issues of generalizability associated with artificial laboratory environments (Adachi & Willoughby, 2011; Ferguson & Dyck, 2012; Ferguson & Kilburn, 2010; Ferguson & Kilburn 2009). For instance, as discussed in the introduction, researchers have conceptualized the same measure of aggression in different ways (e.g., a noise blast considered aggressive based on duration or intensity; Adachi & Willoughby, 2011). Unstandardized measures tend to inflate the effect sizes and overestimate of the effects of violent video games, including desensitization and aggression (Ferguson & Kilburn, 2009). Another critique is that differences in violent and nonviolent video games, other than violent content, used in studies supporting the GAM could produce differences in desensitization and aggression. Specifically, differences in the level of frustration caused by the games could produce differences in arousal and aggressive behavior that are not related to the violent or nonviolent content of the game (Adachi & Willoughby, 2011). Finally, the artificiality of a laboratory setting may influence participants' responses to be consistent with their perception of the expectations of the experimenter (Ferguson & Dyck, 2012) and may not generalize to the real world. As an illustration, participants who play a violent video game may perceive that the researcher is investigating aggression and, thus, may exaggerate aggressive behavior to be consistent with the assumed hypotheses. Additionally, participants' knowledge that they are being observed in the laboratory has the potential to influence physiological readings (Blascovich et al., 2011).

The current study aimed to improve upon some of the previous critiques of research supporting the GAM. Specifically, one strength of the current study is that we used an objective physiological measure of affect, facial EMG, to examine desensitization and to test the GAM. Facial EMG is relatively free of response bias as compared to traditional measures of affect (i.e., surveys and self-reported affect). Because facial EMG can detect unconscious automatic affective responding to stimuli, participants cannot filter their responses. Using this more objective measure, we found no differences in responding to the aggressive images between those who had played the violent versus the nonviolent game. Consistent with the expectations of Ferguson and Kilburn (2009), our findings indicate that when potential weaknesses and inconsistencies in measurement of negative affect are addressed and eliminated, no evidence of desensitization occurs.

Another strength of the current study was that images were drawn from a standard set of images and were pilot tested to ensure that they were perceived as pleasant, aggressive, or neutral. Additionally, in the pilot study, the participants' affective ratings of the images were consistent with the ratings of those collected by Lang et al. (2008). Subsequently, it can be concluded that failure to find evidence of desensitization was not due to the stimuli used.

One limitation is that the experimenter was present in the room for the duration of the study. Although the experimenter remained silent and out of sight while facial EMG was recorded, the presence of the experimenter in the room has the potential to influence physiological recordings (Blascovich et al., 2011).

Another potential weakness is the video games used. Perhaps they failed to produce desensitization because of the unrealistic cartoon graphics in the games. Previous research has found that individuals process video game violence differently from realistic violence (Bösche, 2009; Regenbogen et al., 2010). Bösche (2009) suggests that, because gamers are able to distinguish between real-life violence and video game violence, violent video games do not produce real disgust that is necessary to produce desensitization (Bösche, 2009). If this is the case, the cartoon-like nature of the video games in this study may have similarly failed to produce desensitization effects because the participants were able to easily separate video game violence from real-life violence portrayed in the aggressive images. If this is the case, video games in general would not be realistic enough to produce desensitization and exposure to violent video games should not lead one to progress through the stages of the GAM.

Another weakness of the present study is that the two games were not pilot tested to ensure that they were equal in terms of competitiveness and difficulty, as suggested by Adachi and Willoughby (2011). Competitiveness and difficulty can potentially influence frustration levels, which could, in turn, influence physiological arousal and affect (Brooks, 2000; Williams, 2009). This was not the case in the current study, as the participants rated the games used as equal in terms of frustration and stress meaning that, in this case, failure to find desensitization was not due to differences in the video games other than violence.

If the findings cited above to support the GAM generalize to the real world, it might be expected that a positive correlation between the sales of violent video games and violent crimes committed would exist. However, researchers have found no correlation between the increase in violent video game consumption and rates of violent crime (Ferguson & Kilburn, 2010). Recent research suggests that the aggression elicited by violent video games is different from aggression necessary to produce actual increases in aggressive actions (Bösche, 2009). Bösche posits that players (excluding those who belong to clinical populations) are able to distinguish between realistic violence and video game violence and, thus, do not perceive participating in aggressive behavior in the context of a video game to be harmful. Rather, participation in video game violence is viewed as a form of mock aggression. Mock aggression differs from aggression in that there is no intent to harm (Ballard, Green, & Granger, 2003). Because aggression in violent video games is viewed as harmless, the participants do not hesitate to engage in video game violence. The playful nature of mock aggression in a violent video game could, in turn, alter the participants' perception of aggression in the laboratory setting. Aggression committed in a laboratory setting could be viewed by the participants as not real, or harmless, particularly since it is likely that they know they cannot ethically be allowed to perpetrate real harm in an experimental setting. Thus, even if violent video games increase aggression-like, or mock aggressive, responses in a laboratory setting, this may not translate to an increase in aggression in real-world settings. No research to date has examined participants' aggressive intent or their perception of aggression in laboratory settings following violent video game play. Thus, the pathway from situation factor (exposure to violent video games) to behavioral outcomes (increased aggression and decreased prosocial behavior) proposed by the GAM may not be the best way to describe the effect of violent video games because people are able to separate video game fantasy from reality (Bösche, 2009).

This study is one of the first to investigate desensitization to violent video games through the use of facial EMG. The results indicate that, compared to nonviolent games, violent video games do not produce physiological and affective desensitization, two processes that are hypothesized to lead to aggressive behavior. Although some researchers believe that there is no question that violent video games cause aggression (Anderson et al., 2003; Anderson & Bushman, 2001; Huesmann, 2010), research on the adverse effects of violent video games is inconsistent. The contradictory evidence suggests that the judgment of violent video games as conclusively harmful has been handed down prematurely.

Future research should examine the activity of the *zygomaticus major* muscle region in conjunction with the activity of the *corrugator supercilii* muscle region. Because activity in the *zygomaticus major* muscle is indicative of positive affect and activity in the *corrugator supercilii* muscle is indicative of negative affect (Brown & Schwartz, 1980), they are typically examined together (Blascovich et al., 2011). Investigation of both of these muscle regions would enable researchers to investigate the influence of violent video games on both positive and negative affect. Investigation of activity in the *zygomaticus major* muscle region could further support or refute the finding that desensitization does not occur as indicated by activity in the *corrugator supercilii* muscle region.

The effect of violent video game play on appraisal of positive stimuli should also be examined in more depth. Violent video game play could affect interpretation of pleasant images differently than either aggressive or neutral images, indicating a need to investigate the effect of video games on processing of positive stimuli. Future research could also examine perceptions of helping behavior in others. For example, researchers could examine if people who play violent video games perceive prosocial behavior less positively than those who do not play violent video games.

Finally, further research is needed to determine if the unrealistic violence portrayed in video games is sufficient to produce desensitization and to lead to real-world aggression. Future research could investigate the perception of aggression as harmful in a laboratory setting (e.g., does the participant believe that a noise blast is actually causing damage to an opponent's ears). If aggression elicited by violent video games is not perceived as harmful (i.e., mock aggression), rather than as aggression with the intent to harm (as proposed by the GAM), the pathway by which exposure to violent video games leads to real-world behavioral outcomes should be re-examined. In conclusion, more research is needed before it can be conclusively stated that there is a causal link between violent video games and aggressive behavior.

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Table 1

Images Selected from Pilot Study for Use in Experimental Study

Image	Valence	Pilot	% Rated as Expected	IAPS Affect	IAPS Arousal	IAPS #
Three Puppies	Pleasant	9.18	100	8.34	5.41	1710
Elderly Couple	Pleasant	8.73	98.36	7.80	3.99	2530
Flowery Beach	Pleasant	8.92	100	8.05	3.22	5760
Shadow of Man	Neutral	6.65	93.44	5.18	2.96	2880
Picnic Table	Neutral	4.71	96.72	5.38	2.63	7026
Dock Scene	Neutral	6.56	96.72	4.88	3.32	7036
Angry Dog	Aggressive	8.14	100	3.09	6.51	1525
Kid with Gun	Aggressive	8.68	98.36	2.17	6.90	2811
Mugging	Aggressive	9.10	100	1.96	6.94	6313

Table 2

Comparison of Game Type With Regard to the Game Experience Questionnaire

GEQ Variable	Violent M (*SD*)	Nonviolent M (*SD*)	t(97)	p
Enjoyable*	2.30 (*1.04*)	3.29 (*.96*)	-4.92	<.001
Stressful	2.10 (*1.13*)	1.80 (*.74*)	1.58	.116
Boring*	2.40 (*1.07*)	1.78 (*.80*)	3.29	.001
Frustrating	2.00 (*1.05*)	2.00 (*.84*)	.00	1.000
Exciting*	2.28 (*.97*)	2.76 (*.99*)	-2.41	.018
Relaxing*	1.66 (*.89*)	2.57 (*.96*)	-4.90	<.001
How Well Played	2.75 (*1.00*)	2.67 (*.97*)	.38	.709
How much Experience	1.17 (*.56*)	1.24 (*.52*)	-.648	.519

Note. *indicates significance $p<.05$

Table 3

Means and Standard Deviations of EMG, HR, and SAM Data by Condition

Data Type	Image Valence	Violent M (*SD*)	Nonviolent M (*SD*)
Electromyography (EMG)	Aggressive	2.44 (*.30*)	2.38 (*.30*)
Electromyography (EMG)	Neutral	2.64 (*.31*)	2.40 (*.32*)
Heart Rate (HR)	Aggressive	76.20 (*12.40*)	76.91 (*12.20*)
Heart Rate (HR)	Neutral	76.67 (*12.29*)	77.43 (*12.34*)
Affect Rating	Aggressive	4.25 (*.62*)	4.26 (*.64*)
Affect Rating	Neutral	2.69 (*.40*)	2.74 (*.54*)

Note. EMG data is reported as the log of the mV. HR data is reported as beats per minute. Affect data was gathered from the SAM and is described in the methods section.

Appendix A

To: Glenna Read
Psychology
CAMPUS MAIL

From: Robin Tyndall, Institutional Review Board

Date: 4/14/2011

RE: Notice of IRB Exemption

Study #: 11-0262

Study Title: Emotional Responses to Pictures
Exemption Category: (2) Anonymous Educational Tests; Surveys, Interviews or Observations

This submission has been reviewed by the IRB Office and was determined to be exempt from further review according to the regulatory category cited above under 45 CFR 46.101(b). Should you change any aspect of the proposal, you must contact the IRB before implementing the changes to make sure the exempt status continues to apply. Otherwise, you do not need to request an annual renewal of IRB approval. Please notify the IRB Office when you have completed the study.

Best wishes with your research!

CC:
Mary Ballard, Psychology

Appendix B

Appalachian STATE UNIVERSITY

Consent to Participate in Research

Emotional Responses to Pictures

Principal Investigator: Glenna Read (PI), Dr. Mary Ballard (Faculty Advisor)
Department: Psychology
Contact Information: 310-A Smith-Wright Hall, 828-262-2714

What is the purpose of this research?

You are being invited to take part in a research study about emotional responses to different types of images. If you take part in this study, you will be one of about 120-180 people to do so. By doing this study we hope to learn about the affective nature of images.

What will I be asked to do?

The research procedures will be conducted in 211 Smith-Wright Hall. You will need to come here one time during the study. This visit will take about 30-45 minutes. The total amount of time you will be asked to volunteer for this study is 30-45 minutes.

You will be asked to look at 45 images projected onto a large screen and to fill out a form assessing whether you think each image is positive, negative, or neutral, and the degree to which you think the image fits one of those categories. In addition, you will also be asked to list the emotion that each image elicits and the intensity of the aforementioned emotion. *You should not volunteer for this study if are under 18 years of age.*

What are possible harms or discomforts that I might experience during the research?

To the best of our knowledge, the risk of harm for participating in this research study is no more than you would experience in everyday life. We know about the following risks or discomforts that you may experience if you choose to volunteer for this study: You may find some of the images we show to be distressing. If so, we can tell you about some people who may be able to help you with these feelings.

What are the possible benefits of this research?

Other than enjoying viewing the pleasant images, there may be no immediate personal benefit from your participation, but the information gained by doing this research may help others in the future.

This study should help us learn about the emotional nature of the images displayed. In addition, the ratings of these images are intended for use in future research investigating physiological desensitization to violent video games.

Will I be paid for taking part in the research?

We will not pay you for the time you volunteer while being in this study.

How will you keep my private information confidential?

Your information will be combined with information from other people taking part in the study. When we write up the study to share it with other researchers, we will write about the combined information. You will not be identified in any published or presented materials.

We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information or what that information is.

Participants are not to put their name on anything other than the consent form; the consent form will be stored separately from the data. The remainder of the forms will be identified only by a participant number. There will be no way of identifying participants' responses once they leave 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, Glenna Read, and the 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. No one other than RAs will have access to the participants in the lab.

Who can I contact if I have questions?

The people conducting this study will be available to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator at 828-262-2714. If you have questions about your rights as someone taking part in research, contact the Appalachian Institutional Review Board Administrator at 828-262-2130 (days), through email at irb@appstate.edu or at Appalachian State University, Office of Research and Sponsored Programs, IRB Administrator, Boone, NC 28608.

Do I have to participate? What else should I know?

Your participation in this research is completely voluntary. If you choose not to volunteer, there will be no penalty and you will not lose any benefits or rights you would normally have. If you decide to take part in the study you still have the right to decide at any time that you no longer want to continue. There will be no penalty and no loss of benefits or rights if you decide at any time to stop participating in the study.

This research project has been approved, as required, by the Institutional Review Board of Appalachian State University. This study was approved on April 4, 2011. This approval will expire on April 4, 2012 unless the IRB renews the approval of this research.

I have decided I want to take part in this research. What should I do now?

The person obtaining informed consent will ask you to read the following and if you agree, you should indicate your agreement:

- I have read (or had read to me) all of the above information.
- I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers.
- I understand that I can stop taking part in this study at any time.

- I understand I am not giving up any of my rights.
- I have been given a copy of this consent document, and it is mine to keep.

By continuing on to the tasks described above, you acknowledge you have read and agree to the descriptions and terms outlined in this consent form, and voluntarily agree to participate in this research.

Appendix C

Image 1:

a. Circle the word that best describes this image:

aggressive neutral pleasant

b. To what extent does this image exemplify the word chosen above?

not at all **very much**
1……………2……………3……………4……………5

c. What emotion does this image elicit? ____________________

d. To what extent does this image make you feel this way?

not at all **very much**
1……………2……………3……………4……………5

Appendix D

To: Glenna Read

Psychology
CAMPUS MAIL

From: Julie Taubman, Institutional Review Board

Date: 5/18/2011

RE: Notice of IRB Approval by Expedited Review (under 45 CFR 46.110)

Study #: 11-0319

Study Title: Detection of Physiological Desensitization to Violent Video Games Using Facial Electromyography

Submission Type: Initial

Expedited Category:

Approval Date: 5/18/2011

Expiration Date of Approval: 5/16/2012This submission has been approved by the Institutional Review Board for the period indicated. It has been determined that the risk involved in this research is no more than minimal.

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. Best wishes with your research!

CC:
Mary Ballard, Psychology

Appendix E

Appalachian STATE UNIVERSITY

Consent to Participate in Research

Detection of Physiological Desensitization to Violent Video Games Through the Use of Facial Electromyography
Principal Investigator: Glenna Read (PI), Dr. Mary Ballard (Faculty Advisor)
Department: Psychology
Contact Information: 310-A Smith-Wright Hall, 828-262-2714

What is the purpose of this research?

You are being invited to take part in a research study about desensitization to violent video games. If you take part in this study, you will be one of about 180 people to do so. By doing this study we hope to learn about the effects of video game play on responding to images.

What will I be asked to do?
The research procedures will be conducted in 211 Smith-Wright Hall. You will need to come here one time during the study. This visit will take about 1 hour. The total amount of time you will be asked to volunteer for this study is 1 hour.

Non-invasive electrodes will be attached to the muscle site over your brow. After the electrodes are attached, you will have your blood pressure taken and then engage in five minutes of progressive muscle relaxation. You will then play a video game for 20 minutes. Blood pressure will be taken again. After game play, you will be directed to look at a computer screen and look at images. After the presentation of each image you will be asked to evaluate how the image made you feel. Blood pressure will measured one last time and then you will be asked to fill out a survey about your typical video game use.
You should not volunteer for this study if are under 18 years of age.

What are possible harms or discomforts that I might experience during the research?

To the best of our knowledge, the risk of harm for participating in this research study is no more than you would experience in everyday life or a routine doctor's visit. However, you may find the video game to be graphic in nature. If you find any of the images to be particularly upsetting or distressful, we will provide information for the student counseling center.

What are the possible benefits of this research?

Other than enjoying playing the video game, viewing the images, and the muscle relaxation procedure, there may be no immediate personal benefit from your participation, but the information gained by doing this research may help others in the future.

This study should help us learn about the effects of video games on emotional responding to images.

Will I be paid for taking part in the research?

We will not pay you for the time you volunteer while being in this study. You will receive 3 ELC's for your participation in the study. You will still receive 3 ELC's if you choose to withdraw from the study.

How will you keep my private information confidential?

Your information will be combined with information from other people taking part in the study. When we write up the study to share it with other researchers, we will write about the combined information. You will not be identified in any published or presented materials.

We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information or what that information is.

Participants are not to put their name on anything other than the consent form; the consent form will be stored separately from the data. The remainder of the forms will be identified only by a participant number. There will be no way of identifying participants' responses once they leave 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, Glenna Read, and the 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. No one other than RAs will have access to the participants in the lab.

Who can I contact if I have questions?

The people conducting this study will be available to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator at 828-262-2714. If you have questions about your rights as someone taking part in research, contact the Appalachian Institutional Review Board Administrator at 828-262-2130 (days), through email at irb@appstate.edu or at Appalachian State University, Office of Research and Sponsored Programs, IRB Administrator, Boone, NC 28608.

Do I have to participate? What else should I know?

Your participation in this research is completely voluntary. If you choose not to volunteer, there will be no penalty and you will not lose any benefits or rights you would normally have. If you decide to take part in the study you still have the right to decide at any time that you no longer want to continue. There will be no penalty and no loss of benefits or rights if you decide at any time to stop participating in the study.
This research project has been approved, as required, by the Institutional Review Board of Appalachian State University. This study was approved on May 18, 2011. This approval will expire on May 16, 2012 unless the IRB renews the approval of this research.

I have decided I want to take part in this research. What should I do now?

The person obtaining informed consent will ask you to read the following and if you agree, you should indicate your agreement:

- I have read (or had read to me) all of the above information.
- I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers.

- I understand that I can stop taking part in this study at any time.
- I understand I am not giving up any of my rights.
- I have been given a copy of this consent document, and it is mine to keep.

Participant's Name (PRINT) Signature
Date

Appendix F

Please complete the following demographic information

Age __________ Date of Birth ______________ Ethnic Background/Race ______________

Class Status: Freshmen_______ Sophomore________ Junior________ Senior_________

Gender: ________

On average, how many hours/minutes do you play video games each *day*? ______________

Of this, how many hours/minutes do you play *individually*? ____________________

Of this, how many hours/minutes do you play with *someone else*? ______________

On average, how many hours/minutes do you play video games each *week*? ____________

Of this, how many hours/minutes do you play *individually*? ____________________

Of this, how many hours/minutes do you play with *someone else*? ______________

What types of video games do you commonly play? (e.g., sports, fighting, role playing)

____

____

____

What type of video game do you play *most often*? ____________________________________

Appendix G

Game Experience Questionnaire

How enjoyable did you find playing the video game today?

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

How stressful did you find playing the video game today?

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

How boring did you find playing the video game today?

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

How frustrating did you find playing the video game today?

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

How exciting did you find playing the video game today?

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

How relaxing did you find playing the video game today?

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

How well did you play today in comparison to how well you wanted to play?

1-------------------	2-------------------	3-------------------	4-------------------	5
not at all like I wanted play	**somewhat like I wanted to play**	**just like I wanted to play**	**somewhat better than I thought I'd play**	**much better that I thought I'd play**

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

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

Vita

Glenna Lee Read was born in Atlanta, Georgia to Allyson and Henry Read. She graduated with advanced honors and a Bachelor of Arts in Psychology from Georgia State University in December 2009. In Fall of 2010, she enrolled at Appalachian State University to pursue a Master of Arts in General Experimental Psychology and was awarded this degree in December 2012.