

THE EFFECT OF VIOLENT VIDEO GAME EXPOSURE  
ON EMOTION MODULATION OF STARTLE  
AND AGGRESSION

A DISSERTATION IN  
Psychology

Presented to the Faculty of the University  
of Missouri-Kansas City in partial fulfillment of  
The requirements for the degree

DOCTOR OF PHILOSOPHY

by  
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2014

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AND AGGRESSION

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University of Missouri – Kansas City, 2014

ABSTRACT

Video games are quickly becoming the most widely accessible, and used, form of entertainment, with those that contain violence have consistently been the most popular. Building on previous research examining other forms of media, a growing body of literature suggests a connection between violent video game exposure and increased aggression. The General Aggression Model (GAM), has been developed to help explain this relationship, which combines decades of aggression research into a single model. While the GAM describes several routes to increased aggression there are only two cognitive routes. These cognitive routes are desensitization (diminished natural negative response) and priming (pre-activation of neural circuitry related to aggression), and the current study competitively tests these two routes in relation to violent video game exposure (VVGE) using Emotion Modulated Startle (EMS).

The objective psychophysiological measure EMS assesses emotional state through either potentiation, or inhibition of the startle response. The startle response is a negative-defensive response, a negative emotional state enhances the startle response through priming, while a positive emotional state diminishes the startle response. In the context of VVGE, if priming is

the primary route to increased aggression, EMS would predict a primed startle response while viewing violent-negative images, and therefore a larger startle response post exposure. If desensitization is the primary route EMS would predict a diminished startle response reflecting less negative priming by the emotional state elicited by VVGE.

In the present study EMS was used to assess the effects of both chronic and acute violent video game exposure by comparing baseline and pre-post gameplay (violent, nonviolent) EMS for participants with high and low violent video game exposure. A modified Taylor Competitive Reaction Time Task (TCRTT) was used after completing the post-gameplay EMS session to assess aggression.

The results of this study suggest that desensitization is the primary cognitive route to increased aggression with decreased EMS responses to violent negative images associated with chronic and acute VVGE. The relationship between desensitization and laboratory aggression was also examined, finding an increased level of aggression exhibited after acute violent video game exposure, but only for those with high chronic VVGE.

## APPROVAL PAGE

The faculty listed below, appointed by the Dean of the College of Arts and Sciences have examined a dissertation titled “The Effect of Violent Video Game Exposure on Emotion Modulation of Startle, and Aggression,” presented by Wade R. Elmore, candidate for the Doctor of Philosophy degree, and certify that in their opinion it is worthy of acceptance.

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CHAPTER 1  
INTRODUCTION

**Violent Video Games: The Need for Greater Understanding**

Video games as a form of entertainment have reached an unprecedented level of accessibility and use in the United States. The birth of the video game industry is marked with the introduction of PONG in 1972, a virtual take on table tennis, and the first highly popular video game. From these humble beginnings, video games have gone through a metamorphosis. Ascending from a fledgling specialty niche to the largest and most profitable segment of the entertainment industry while also advancing from a ball bounced back and forth between two paddles to an almost life like depiction of virtual environments with their own laws of physics, cultures, and races. The increase in quality of video games, reflected in market share, has been, and continues to be, fueled by advances in technology allowing for more realistic graphics, and more complex and immersive environments for players to become engaged.

Although there are many genres of video game, including sports, puzzle and racing games, the most popular games as assessed by sales are generally those with the highest level of and most realistic violent depictions. The largest release day sales have consistently been for video games with violent content, with the most recent, and largest, being the 2013 release of Grand Theft Auto V having record breaking single day sales of \$800 million, followed by Call of Duty: Black Ops 2 and Grand Theft Auto IV with \$500 million each. These three games are all cutting-edge creating highly realistic and immersive experiences for the players and all rated “M for Mature” citing violence, drug use and sexual content portrayed in the games (Garside, 2013). The overall popularity of these ultra-violent video games is also apparent in that only five percent of games rated by the entertainment software rating board were rated as “M for Mature,”

a rating usually obtained for graphic and realistic depictions of violence, but sales of these games accounted for 17.4 percent of games sold in 2009 (Entertainment Software Association, 2010).

As violent video games' popularity has increased, so has a concern about the effects of the growing exposure to the newest form of violent media. The concern about violent video games grew out of a previous literature investigating aggression in general, and the effects of exposure to violent media on increased aggression. Although there has been some debate in recent years about the implications for real world aggression (Bushman & Huesmann, 2014; Elson & Ferguson, 2014a; Ferguson, 2010; Huesmann, 2010), the literature has consistently found a positive relationship between violent video game play and aggression similar to that found for exposure to other violent media such as film and television (Anderson et al., 2010; Bushman & Anderson, 2009). The next section will discuss the theories and models for increased aggression, which relate to violent media and violent video game exposure.

## CHAPTER 2

### REVIEW OF THE LITERATURE

#### **Violent Media Research:**

##### **Building A Model For Increased Aggression Through Violent Media Exposure**

Violent media research began over a decade before the first video game was ever played (Goranson, 1970). At the time, researchers were trying to understand an increase in violent crime in America that began in 1960 and had more than tripled by 1974 (Ferguson, 2010; Bureau of Justice Statistics, 2011). By the time *Death Race* hit the market in 1976, nearly 150 scholarly papers had been written showing a positive correlation between exposure to violent media and increased aggression in children and adolescents (Rothenberg, 1975). During the same period there was a paradigmatic shift in psychological science known as the Cognitive Revolution. The Cognitive Revolution equated to a shift away from Behaviorism, the study of only explicit behavior, towards the study of information processing and how behavior change can occur in the absence of reward and punishment. The Cognitive Revolution led to the development of many new theories of learning, that could be applied directly to aggression, violence, and exposure to violent media.

In 1961, Albert Bandura and colleagues published “Transmission of Aggression Through Imitation of Aggressive Models” (Bandura, Ross, & Ross, 1961). This paper described an experiment in which children exposed to violent and aggressive behavior performed by an adult model were significantly more likely to perform similar behaviors when given the opportunity. Bandura later theorized that observation of violence and aggression could increase the likelihood of a similar response, depending on the consequences observed for the perpetrator. If the perpetrator was not punished for their violence or aggression the observer could learn that these

are acceptable responses (Bandura, 1973; Bandura, 1978). Bandura's theory was applicable to violent media research in the repeated modeling of violent action by the characters, with little or no reprisal. This could then relieve the natural or previously learned inhibitions towards violent or aggressive actions, leaving the impression that such actions are acceptable

Berkowitz (1984) contends that although disinhibition or permission granting may occur through violent media exposure, as proposed by Bandura, priming could also contribute to the observed differences in aggression after exposure to violent media. Berkowitz's Cognitive-Neoassociationistic Model describes the relationship between observation and behavior through the process of priming. Priming refers to activating memory structures including emotions, behaviors, and thoughts that are connected semantically in the mind (Collins & Loftus, 1975). Priming, in this context, results in spreading activation caused by the observation of violence or aggression to related information and pathways, including those related to response and behavior (Berkowitz, 1984). The spreading activation associated with violent media exposure facilitates further activity along those pathways predisposing these pathways over others not primed. In short, exposure to violent media makes thoughts and behaviors associated with violence more likely and easier to initiate through spreading activation.

Dolf Zillmann (Zillmann, 1979) further elaborated on the cognitive models of Bandura and Berkowitz, with the addition of physiological arousal. Zillmann's Excitation Transfer Theory (ETT) is based on a two-factor model of emotion where both arousal and cognitive appraisal contribute to emotion. The ETT states that the experience of emotion is based on the level of arousal and how that arousal is cognitively evaluated and attributed. The interdependence of arousal and cognition in emotional experience can explain increased aggression due to violent video game exposure via two routes. The heightened arousal naturally

caused by viewing violence can be wrongly attributed (misattributed) to another event in real life, causing the emotion to be cognitively connected with the wrong source (Zillmann, 1988). The same arousal can also be misattributed to the emotion of anger, causing the experience of anger which may persist well beyond exposure to that violent media (Anderson & Bushman, 2002).

Rowell Huesmann (Huesmann, 1988) built upon the previous work of Bandura, Berkowitz, and Zillmann with Script Theory. Scripts are designs for social behavior that lay out a course of action based on previous experience, the emotion of the actor, and the actor's evaluation of the situation. Similar to Bandura's Social Learning Theory, scripts are learned through enactive learning, the experience of the actor's own behavior, or vicarious learning by way of other's actions (Huesmann, 1988). Scripts are similar to the associations described by Berkowitz, but are more complex including goals, emotions, and action plans within each script (Anderson & Bushman, 2002). A script is formed through repeated exposure and rehearsal, linking antecedent events, emotions, complex reactions, and intended outcomes into an automated sequence or program for behavior (Huesmann, 1988). As scripts may be formed and rehearsed both through behavior and observation, they then can be created by exposure to passive violent media, such as television and film, as well as active violent media, such as violent video games.

The General Aggression Model (GAM), the first unifying model of aggression incorporating the Social Learning Theory, Excitation Transfer Theory, Cognitive Neo-Associative Theory, and Script Theory, was developed by Craig Anderson and Brad Bushman (Anderson & Bushman, 2002). The GAM encompasses a combination of variables brought by both the individual and the situation in an interactive combination known as an episode. Within

an episode, the GAM describes three determinants that may lead to increased aggression: Inputs, Routes, and Outcomes.

Inputs are personal factors brought to the episode and can include things such as personality traits, genetics, beliefs, attitudes, values, goals, and scripts. The inputs section also includes situational factors such as cues, provocation, frustration, discomfort, drugs, and incentives (Anderson & Bushman, 2002). The personal factors brought to the inputs section should be relatively stable characteristics of the person, but these variables can change over time. For instance, Scripts as described by Huesmann, can change based on experience and rehearsal either increasing or decreasing the number of aggressive scripts. Given the high level and repetitive nature of violent media exposure in the United States, the process of script acquisition is biased towards an increase in aggressive scripts, although exposure to nonviolent or prosocial resolutions could create and rehearse scripts that are not aggressive (Huesmann & Miller, 1994). The situational factors are dynamic by nature: as the situation varies, so do these variables. The existence of aggression related cues in the situation could prime aggression-related networks making them more accessible. For example, exposure to weapon names primes aggression-related words in a reaction time task, as compared to animal names, supporting Berkowitz's Cognitive Neo-Associative Model. The interaction of the slowly adapting personal factors and the highly dynamic situational variables sets the stage for the routes to behavior in the GAM.

Routes in the GAM represent the way personal and situational variables (Inputs) influence the outcome of the episode. There are three routes of influence: Cognition, Affect, and Arousal. Cognition is thought to primarily be influenced through priming and scripts. Both of these cognitive attributes can be affected through both personal and situational variables by

increasing the accessibility of aggressive concepts and related behavioral programs (Anderson & Bushman, 2002).

Affect can also be influenced through both personal and situational factors. Personal variables such as trait hostility and trait aggressiveness can increase state hostility and can influence the outcome of an episode (Bushman, 1995). Situational variables have also been shown to influence Affect, including uncomfortable temperatures (Anderson, Deuser, & DeNeve, 1995), pain (Anderson, Anderson, Dill, & Deuser, 1998), and exposure to violent media (Arriaga, Esteves, Carneiro, & Monteiro, 2006; Barlett, Harris, & Baldassaro, 2007; Bluemke, Friedrich, & Zumbach, 2010), all of which have been shown to increase state hostility.

Arousal is the third route through which the Inputs can influence the outcomes of an episode. As Zillmann (1979) described, a heightened level of arousal caused by the situation can increase the likelihood of aggressive outcomes particularly if there is provocation or frustration in the situation, resulting in a misattribution of the arousal to one of these situational factors resulting in anger. Furthermore, Zillmann describes an interdependency between cognitive evaluation and heightened arousal in that high levels of arousal may impair the ability to appraise the causes of the arousal and cognitive evaluation may default to more automatic processing (Zillmann, 1988).

The final stage of the GAM addresses the appraisal and decision processes when determining behavior in the episode, and is referred to as outcomes. Outcomes are comprised of an automatic pathway and a controlled pathway, both of which depend on the present internal state of the individual. The automatic process, termed “immediate appraisal,” happens quickly with little to no effort by the individual, and will reflect personal and situational variables. The controlled pathway, termed “reappraisal,” occurs after the immediate appraisal if there are



sufficient resources to further evaluate the situation. If there are sufficient resources such as time and cognitive capacity, the individual will evaluate the outcome of the immediate appraisal. If the outcome is important, and unsatisfying to the individual, he or she will continue to reappraise the situation until either the resources are extinguished, or the outcome is satisfying. Once the cycle of reappraisal has ended, a decision is made resulting in thoughtful action. If there are insufficient resources for further consideration, then the immediate appraisal is acted on, resulting in an impulsive action (Anderson & Bushman, 2002).

The GAM represents the first unified model of aggression, and encompasses decades of research on aggression and the mediating factors that increase aggression. One area the authors of the GAM have focused on is exposure to violent media (Bushman, 1995; Anderson et al., 1995; Anderson et al., 1998), and in more recent years, violent video game exposure (Anderson, 2003; Anderson, 2004; Anderson & Bushman, 2001; Anderson & Bushman, 2002; Anderson, & Bushman, 2007; Bushman & Anderson, 2002; Carnagey & Anderson, 2004; Carnagey, Barlett, Harris, & Bruey, 2008; Funk et al., 2003; Gentile et al., 2004; Gentile & Kirsh, 2003; Hollingdale & Greitemeyer, 2013). While the GAM was developed specifically to better understand the relationship between exposure to violent media and increased aggression, the principles described in the GAM could explain other changes in behavior associated with video game play. Buckley and Anderson (2006) expanded the GAM beyond aggression, to be applicable to all video game related learning and behavior changes including increased prosocial behaviors (Gentile & Groves, 2014; Prot, Anderson, & Gentile, 2014). Buckley and Anderson named this new expanded model the General Learning Model, and included a few developmental and social cognitive theories along with the GAM. While the focus of the present research is the negative effects of violent video game exposure, it is important to acknowledge that the same

routes being tested can lead to both positive and negative effects of video game play depending on the game content. As evidence supporting a connection between violent video game exposure and aggressive behavior increases, researchers have focused on understanding what is happening within the complex interaction of the person and the situation. The next section reviews recent studies investigating the connection between violent video game exposure and aggressive behavior.

### **Violent Video Game Research**

Little research was done examining violent video game influences on violence until the depictions of violence reached a level of realism that was close to that of other forms of violent media. Early research generally focused on video games as a whole, examining the psychological principles involved in video game play, such as gender role depictions creating and perpetuating stereotypes (Loftus & Loftus, 1983), and schedules of reinforcement leading to addicted levels of game playing (Braun & Giroux, 1989). Given the symbolic nature of violence in video games at this time, there is little question why there was a lack of real concern about the effects of violence in video games, as it was really little more than an electronic version of taking a chess piece. As the characters in video games evolved from blips on the screen, to cartoon-like characters, to realistic representations of humans in a three dimensional world, the concern and amount of research into violence in video games grew.

As a result of the Congressional Hearings on Violent Video Games, spurred by the release of *Mortal Kombat* in 1992, the effects of violent video games became a priority of social scientists. This resulted in a profusion of research establishing violent video games as a risk to increased aggression equal to, if not greater than, other forms of violent media (Anderson, Deuser, & DeNeve, 1995; Funk & Buchman, 1996; Huesmann & Miller, 1994; Irwin & Gross,

1995; Paik & Comstock, 1994; Scott, 1995). Although social scientists had begun to describe risk of violent video games, it was not until the atrocities leading up to and including the Columbine massacre that the dangers of violent video games received the attention from popular media, and the public. In 1998, the year before the Columbine Massacre, two reviews of the violent video game literature were written with very similar findings.

The first review examined the literature including both correlational and experimental studies by Griffiths (1999). Griffiths concluded that, given the mix of methodologies and results in the twenty-one studies he reviewed, no real conclusions could be made about the effects of violent video games. Griffiths concluded that more systematic and standardized measures of aggression, type of violent video game, and age of participants could lead to more definitive results (Griffiths, 1999). The second review, published the same year, also found mixed results and had similar conclusions discussing a lack of programmatic research that might shed light on the relationship between violent video game exposure and aggression (Dill & Dill, 1999). As with Griffiths' review, Dill and Dill's review includes games dating back to the first violent video games up through modern more realistic and violent video games. Dill and Dill point out that of the four studies using these modern realistic violent games, three found a significant positive relationship between game play and aggression, while the remaining study had methodological issues that made interpretation difficult (Dill & Dill, 1999). The criticisms of violent video game research made in these reviews continue to be echoed in subsequent meta-analyses of violent video game research.

In his meta-analysis of violent video games and aggression, Sherry (2001) discusses the several domain-specific theories that could explain increased aggression from violent video game exposure, and also discusses the inherent differences between violent video games and

other forms of violent media. The differences include level of activity, with video games being highly active, compared to other forms of violent media, which are generally passive (e.g., watching a film). Violent video games also require concentration by the player, while other forms of media can be experienced without concentration. The relative lack of realism in video games, at the time of this review, compared to other forms of violent media could also be an important difference given prior research showing the level of realism in violent media is related to increased aggression (Sherry, 2001). In his analysis Sherry found a weak correlation between violent video game play and aggression ( $r = .15, d = .30, n = 2722$ ) suggesting a relationship between violent video game exposure and increased aggression. Sherry concludes that given the variety, and inconsistency, of research methodologies including age of the participants, measures of aggression, type of game played, and length of game played, this relationship should be interpreted cautiously. Like others, Sherry suggests a more paradigmatic line of research replicating prior research into the effects of other types of violent media (Sherry, 2001).

Craig Anderson and Brad Bushman also published a meta-analysis of the violent video game literature in 2001. In this review, Anderson and Bushman apply the GAM as a unifying theory to explain the increases in aggression found across the different types of violent media including violent video games. Given the comprehensive nature of the GAM, the inclusion criteria, although large, are clearly defined: any study examining the effects of violent video game play on aggressive cognition, aggressive affect, aggressive behavior, physiological arousal, or prosocial behavior were included. These criteria allowed the inclusion of 35 studies, ten more studies than Sherry included in his meta-analysis published the same year. While Anderson and Bushman do not include an overall correlation coefficient between violent video game play and measures of aggression, as Sherry does, the authors delineate levels of association across the

aforementioned inclusion criteria. These analyses resulted in significant relationships between all of the coded groups; Aggressive Behavior ( $r = .19$ ), Prosocial behavior ( $r = -.16$ ), Aggressive cognition ( $r = .27$ ), Aggressive affect ( $r = .18$ ), Physiological arousal ( $r = .22$ ). Although effects sizes were not reported for any of these analyses, Anderson and Bushman concluded that given the similarity between violent television and violent video games, and the significant relationship found in every category tested, there is clear support for the hypothesis that violent video game play increases aggression as predicted by the GAM (Anderson & Bushman, 2001).

In response to criticism by the video game industry, and a handful of other social scientists, Craig Anderson conducted another meta-analysis of violent video game research in 2004. These criticisms focused on the conclusions that could be drawn from such a wide variety of methods employed in violent video game research. To counter these criticisms, Anderson conducted a best practices meta-analysis coding included studies for all aspects of good experimental design. A total of 45 studies were included in the original set to be coded, while only 32 were included in the best practices analysis. Anderson chose not to report the statistics associated with each of the outcome variables analyzed, instead representing them graphically with their average effect sizes, comparing the best practices and sub-optimal practices. It is clear that the best practices studies mirror the findings of the previous meta-analysis (Anderson & Bushman, 2001), with less variation. The not-best-practice studies are also in the same direction as the best practice studies, but they are smaller with much more variation (Anderson, 2004). Anderson concludes that the evidence is clearly showing a relationship between violent video game play and increased aggression, and that the only piece lacking is that of longitudinal evidence to support the connection.

In order to further curtail criticisms about violent video game research, Douglas Gentile published a more theoretical review of the literature, drawing largely from the GAM, in 2005. In this review Gentile compares the correlations of violent media and aggression to lead exposure and IQ, citing stronger correlations between violent media and aggression, and suggesting that the debate over the effects of violent media on aggression be concluded. Gentile applies the GAM to violent video game research, and in doing so outlines strengths and weaknesses in video game research design for which the GAM would not predict differences between groups. For example, measuring trait hostility should not show differences, because according to the GAM trait hostility is a personal variable that only changes over repeated exposures to violent media. This is in contrast to measuring state hostility, which may detect differences caused by the situation. Gentile also discusses the strengths and weaknesses of experimental, correlational, and longitudinal designs in determining the effects of violent video games on aggression, suggesting they all have a place in the literature, and that more longitudinal research needs to be done in violent video game research to replicate findings from research in other forms of media violence. Gentile follows with a thorough review of the literature looking at the three study designs and concludes that the evidence, when considered together, is strong enough to establish violent media, including violent video games, as a risk factor for aggressive behavior (Gentile & Stone, 2005).

In response to Anderson's (2004) meta-analysis, and Gentile and Stone's (2005) review of the literature, Sherry (2007) published a paper examining the similarities of violent video games and violent television and film. Sherry questioned the assumption that violent video games have, or should have, the same effects on aggressive behavior as other forms of violent media. Sherry first reiterates the discussion from his earlier paper, pointing out differences in the

experience of violent video games versus other forms of violent media: that violent video games are an active versus passive experience, requiring more concentration, with less realistic visuals. Sherry then discusses evidence that motivation to play video games also differs from the motivation to watch violent television or film. He points out research suggesting that the primary reasons for playing video games are the challenge of beating the game or friends, for the ability to do something not possible in real life, such as flying, and for typical entertainment value, such as a reason to gather with friends and diversion (Sherry, 2007). To discriminate between violent video games and violent television, Sherry then examines several domain specific theories within this meta-analysis.

He finds little to support Social Learning Theory. Behavioral measures of aggression were less sensitive to the effects of violent media exposure than self reports. Social Learning Theory predicts this difference due to the social sanctions against aggressive behavior. Social Learning Theory predicts modeling of human characters in the video game would increase aggression more than modeling by nonhuman characters in the video game, while the data suggest the opposite with more aggression exhibited after playing games with nonhuman characters. Social Learning Theory also predicts sanctioned violence within a video game would further increase aggressive behavior. Sherry (2007) finds that destructive violence in video games increases aggressive behavior more than sanctioned violence. Social Learning Theory would also predict a positive relationship between play time and aggression, and again the data suggest otherwise, with a significant negative correlation between play time and aggressive behavior. Overall, these data do not support the Social Learning Theory as a route to increased aggression from violent video game play (Sherry, 2007).

Sherry (2007), with data from his meta-analysis, next examines the Excitation Transfer Theory as a means to increased aggression. Excitation Transfer Theory predicts that heightened arousal would increase aggressive behavior. Although there are no tests of arousal effects in the studies included in Sherry's meta-analysis, he concludes that there is support for the arousal effect in the negative correlation between aggression and duration of game play. Sherry suggests that the higher level of aggression found in those playing for shorter periods of time could be a result of the dissipation of arousal that would normally occur over longer periods of game play.

Sherry also evaluated the predictions of the Cognitive Neoassociationistic Theory (CNT) given the data in his meta-analysis. The CNT predicts that any violence would increase aggression regardless of character type (human vs. nonhuman), or type of violence (destructive vs. sanctioned). The CNT also predicts higher aggression measures for older versus younger participants given the larger amount of aggression-related information to be activated. Sherry concludes that there is mixed support for the first prediction, citing less aggression in participants playing sports games containing violence than those playing games containing destructive or sanctioned violence. Sherry contends that violence, regardless of the setting, should equally activate violence related information pathways. Sherry's contention may be too restrictive given that sports violence could be categorically different within information networks with no intention to harm the target of the violence, but to only win the sport being played. Sherry also notes support for the CNT by higher levels of aggression in older participants based on more extensive cognitive networks, from more experience with aggression than in younger participants (Sherry, 2007).

Sherry proposed his own hypothesis of increased aggression as result of violent video game play. Sherry (2007) suggests a combination of priming and arousal, with the effects being



very short lived, dissipating with the arousal associated with the game, (Sherry, 2007). Concluding that the social influence of video games are negligible directly counters Gentile (2005), and also counters Anderson's (2004) view that video game violence exposure is a clear risk factor for aggressive behavior. Sherry's final conclusion is that more targeted testing of the mechanisms through which violent video game play can increase aggression offers the most valuable information as to the how violent video games affect their players.

Another meta-analysis on the effects of violent video game play was published in 2007a by Christopher Ferguson. In his meta-analysis, Ferguson seeks to rectify several problems he identified with earlier meta-analyses and reviews. Restricting his meta-analysis and review to only studies of the effects of video games, Ferguson removes the risk of conflating the findings of violent video game research with that of other forms of violent media. Additionally, Ferguson included studies investigating visuospatial cognition, one positive outcome associated with video game play. To better clarify the potential influence of violent video games on aggression, Ferguson's study focuses solely on modern video games produced between 1995 and 2005. In addition, in order to correct for a common concern with meta-analyses, referred to as the "file drawer effect," Ferguson performed a publication bias analysis to account for unpublished studies with null findings.

Ferguson (2007a) finds a positive relationship between violent video game play and aggression (pooled  $r = 0.14$ ), similar to Sherry (2001), but slightly weaker than Anderson and Bushman (2001). Ferguson also found that there was publication bias in both of these areas of research, and calculated a corrected effect size for both aggression (pooled  $r = .04$ ) and visuospatial cognition (pooled  $r = .36$ ). Although the corrected effect sizes for both were diminished, the effect size for aggression was reduced beyond significance while the relationship

between violent video game play and increased visuospatial skill remained significant. Ferguson concluded that there is evidence for the positive effect of increased visuospatial cognition of playing violent video games, but none for negative effect of increased aggression (Ferguson, 2007).

Concurrently, Rowell Huesmann (2007) also published a review of the violent media research including violent video games, with conclusions opposing to those of Sherry (2007) and Ferguson (2007a) about the relationship between violent video game exposure and aggression. Despite the assertions that video games are similar to, but different from, other forms of violent media, Huesmann discusses them under the same umbrella, continuing to include violent video game research with the more robust violent television literature. Huesmann reviews two “key” meta-analyses one looking at the effects of violent television on aggression (Paik & Comstock, 1994), and another examining the effects of violent video games (Anderson & Bushman, 2001), both of which found a significant relationship between exposure to violent television and video games respectively ( $r_+ = .19$ ). Huesmann concludes his discussion of experimental and longitudinal research, largely from the television violence literature, by saying “experiments unambiguously show that viewing violent video, films, cartoons or TV dramas or playing violent video games ‘cause’ the risk to go up that the observing child will behave seriously aggressively toward others immediately afterwards” (Huesmann, 2007, p. 6). Furthermore, Huesmann equates violent media exposure to other public health risks, such as smoking stating that the relationship between smoking and cancer is only slightly higher than that of violent media exposure to aggressive behavior. Although he draws the parallel that not every child exposed to violent media will acquire the affliction of violent behavior, he argues that this does not diminish the need to address the threat (Huesmann, 2007).

In response to Huesmann's (2007) review, Christopher Ferguson and John Kilburn published a meta-analysis in 2009 questioning both the conclusions of Huesmann, and the relationship between violent video games and aggression (Ferguson & Kilburn, 2009). In their critical meta-analytical review, Ferguson and Kilburn replicate the methods of Ferguson's earlier meta-analysis (Ferguson, 2007), varying the dates of inclusion from 1995-2005 to 1998-2008, and focusing only on the link to aggression.

In their analysis, Ferguson and Kilburn again found evidence of publication bias for seven of the seventeen study types, with only two study types found to conclusively have no publication bias. This means that of the 17 types of studies analyzed, only two demonstrated no bias towards only publishing papers with significant positive relationships between violent video games and aggression. This led Ferguson and Kilburn to complete their meta-analysis providing effect sizes both corrected and uncorrected for publication bias, finding slightly stronger effects before correction. The uncorrected effect size of  $r = .14$  is weak, but comparable to those found in earlier meta-analyses (Anderson & Bushman, 2001; Sherry, 2001; Sherry, 2007). The effect size found after correction for publication bias is weaker with a pooled  $r = .08$ , smaller than the findings of earlier meta-analyses. Ferguson and Kilburn then evaluate the different methodologies employed in the studies included, finding that aggression measures that were unstandardized/unreliable produced the highest effects, (pooled  $r = .24$ ), as compared to reliable measures (pooled  $r = .08$ ) (Ferguson & Kilburn, 2009). Ferguson and Kilburn conclude that their analysis does not support either a correlational or causal link between violent video game play and aggression, and that the statements by Huesmann comparing exposure to violent video games to smoking is completely unfounded (Ferguson & Kilburn, 2009).

Partly in response to the work of Sherry (2001), Ferguson (2007), Sherry (2007), and Ferguson and Kilburn (2009), and to include a large number of new studies investigating both positive and negative effects of video game play conducted in eastern and western cultures, Craig Anderson and colleagues published another meta-analysis (Anderson et al., 2010). This is by far the largest meta-analysis to date, including over 130 papers, found through PsycINFO, MEDLINE, and several Japanese databases, for a total of more than 130,296 participants and 381 effect-size estimates. In this analysis, Anderson et al. replicated the effect size of Anderson and Bushman (2001) for the full sample data (pooled  $r = 0.189$ ), and found even stronger effects for the best practices data with a pooled  $r$  equal to 0.244.

Anderson et al. (2010) categorize the data into the following six outcome variables: weak and strong methodology, respectively; aggressive behavior ( $r = 0.163, 0.244$ ), aggressive cognition ( $r = .0138, 0.175$ ), aggressive affect ( $r = 0.155, 0.124$ ), prosocial behavior ( $r = -0.078, -0.110$ ), empathy/desensitization ( $r = -0.116, 0.194$ ), and physiological arousal ( $r = 0.085, 0.184$ ). Although there was no correction for publication bias, these are by far the strongest effect sizes to date, bolstered by the much larger data set, and nearly 70 percent of the included studies qualifying for best practices. Given these findings, Anderson et al. conclude that there is clear support for a relationship between violent video game exposure and a wide variety of outcome variables related to aggression, and that these relationships are predicted by social-cognitive models including the GAM. They also call for more research looking into the longitudinal effects of violent video game exposure and approaches precisely assessing the immediate effects of exposure.

More recently Greitemeyer and Mügge (2014) expanded the previous work by Ferguson and Kilburn (2009), and Anderson et al. (2010) looking at both the positive and negative effects

of video games. Recognizing the growing literature investigating General Learning Model (GLM), and the positive/prosocial effects of prosocial games (Gentile et al., 2009; Greitemeyer, Agthe, Turner, & Gschwendtner, 2012; Greitemeyer, Osswald, & Brauer, 2010; Greitemeyer & Osswald, 2009; Jerabeck & Ferguson, 2013; Saleem, Anderson, & Gentile, 2012), Greitemeyer and Mügge conducted a meta-analysis comparing the prosocial and antisocial effects following the three routes described in the GLM and GAM. As the publication of research investigating prosocial effects of prosocial video games began in 2009, and rate at which the content and technology of video games increases, Greitemeyer and Mügge (2014) included only studies published in 2009 or after. Papers investigating prosocial and antisocial outcomes were also required to have dependent variables representative at least one of the three routes to change described in the GLM. Papers were found via PsychINFO, Scopus, and Google Scholar, and included if they were published in either english or german as well as meeting all other inclusion criteria. Despite the narrow window of publication, and the other criteria, 98 independent studies were identified with 364 coded effect sizes, and 36,965 participants.

At the highest level of analysis, Greitemeyer and Mügge (2014) compared effects of playing prosocial and antisocial video games collapsed across the three prosocial and antisocial outcomes. The results of this analysis found that those playing violent antisocial games were higher on the antisocial outcomes and lower on prosocial outcomes ( $r = .18, z = 12.70, p < .001$ ), and those who played prosocial games were higher in prosocial outcomes and lower in antisocial outcomes. ( $r = .22, z = 7.72, p < .001$ ). A more detailed analysis found differences within each of the routes in the predicted direction for each of the routes for each type of video game, except there was no decrease in prosocial cognition after playing a violent antisocial game, and there were no differences in arousal related to type of video game played. Given the ongoing debate

regarding the connection between violent video games and increased aggression (Anderson & Bushman, 2001; Anderson, 2004; Anderson et al., 2010; Bushman & Huesmann, 2014; Elson & Ferguson, 2014a; Ferguson, 2010; Ferguson, 2007; Huesmann, 2010), Greitemeyer and Mügge (2014) chose to code the studies by authorship, grouping those studies with Anderson or Bushman as an author (primary proponents of aggression connection), those with Ferguson as an author (primary opponent of the aggression connection), and those with neither listed as author. With this coding Greitemeyer and Mügge (2014) were able to compare the effect sizes from these group to see similarities between these groups. This analysis found that studies with Anderson or Bushman listed as an author were very similar to those without Anderson or Bushman, or Ferguson with similar effect sizes ( $r = .19$ ,  $r = .20$  respectively), while those with Ferguson listed as an author were different ( $r = .02$ ). Greitemeyer and Mügge (2014) conclude that there seems to be a small but consistent effect of violent video game exposure on aggression ( $r = .19$ ), and a similar effect of prosocial video games on prosocial outcomes ( $r = .22$ ). Furthermore they suggest that future video game research should consider any prosocial aspects of violent video games, such as cooperative play, when looking at aggression, as they may diminish the increase in aggression.

Although the majority of research being published in this area continue to support a connection between violent video game exposure and increased aggression and other negative outcomes (Bushman & Huesmann, 2014; Gentile, Li, Khoo, Prot, & Anderson, 2014; Greitemeyer & Mügge, 2014; Greitemeyer, 2014; Krcmar, Farrar, Jalette, & McGloin, 2014; Prot et al., 2014; Yang, Huesmann, & Bushman, 2014), the debate over the negative effects of this exposure in the literature continues, primarily driven by the work of Christopher Ferguson and Cheryl Olson questioning the methodological rigor of previous research (Elson & Ferguson,

2014a; Ferguson, Garza, Jerabeck, & Ramos, 2013; Ferguson & Olson, 2014; Ferguson, Olson, Kutner, & Warner, 2010; Ferguson & Olson, 2013; Ferguson, 2014; Kutner & Olson, 2008; Olson et al., 2009; Olson, Kutner, & Warner, 2008). In their 2014 paper, Elson and Ferguson, again question the methodology used in previous investigations of the effects of violent video game exposure, and therefore the findings of those studies, but for the first time propose an alternative theory to the General Aggression Model (GAM), they call the Catalyst Theory (CT). Elson and Ferguson via the CT suggest that some people have a biological, and/or genetic predisposition to increased aggression, which is moderated by environmental factors over time, and this total disposition is then susceptible to environmental factors that can act as a catalyst toward increased situational aggression. In this theoretical model violent video games are considered to be an environmental catalyst, which can increase aggressive behavior in those already prepared to be aggressive. Elson and Ferguson maintain that this is not a causal relationship, as the video game does not cause the person to become more aggressive, but may shape aggressive behavior or cue those disposed to aggression to act in a similar way to that experienced in the video game. The CT varies from the GAM in that the GAM attributes a direct causal relationship between exposure to violent video games and increased aggression through changes in the three routes of cognition, affect, and arousal. In conclusion, Elson and Ferguson cite the methodological inconsistencies and weaknesses, publication bias, and “media moral panic” for the inflated importance of the data suggesting a causal connection between violent video game exposure and increased aggression (Elson & Ferguson, 2014a, p. 10). Furthermore, to overcome these limitations they recommend performing more research using “a corpus of precise and valid measurements for the different aspects of aggressiveness (thoughts, emotions, and behaviors)” which could help to clarify the relationship between violent video game

exposure, and increased aggression (Elson & Ferguson, 2014a, p. 10). This highly critical review of the existing violent video game literature, particularly those lending support to the GAM, drew several responses from other researchers in the field.

Bushman and Huesmann (2014), Krahe (2014), and Warburton (2013), all wrote papers responding to the criticisms laid out in Elson and Ferguson's 2013 paper. Bushman and Huesmann respond to both the Catalyst Theory (CT), as well as the critique of previous research investigating the effects of violent video game exposure. The basic criticism of the CT by Bushman and Huesmann is that the only difference between it and other theories of aggression, such as the General Aggression Model (GAM), is the level of emphasis placed on the biological and genetic components. Bushman and Huesmann continue suggesting that the broad nature of what can be a "catalyst" makes the CT unfalsifiable, generally untestable, and therefore useless as a model or theory. In response to Elson and Ferguson's critique of the literature, Bushman and Huesmann begin with a critique of the "vote counting" method used for the review of the literature, suggesting that this method focuses on only those effects found to be statistically significant, while ignoring the more important effect sizes of the studies reviewed. They continue to defend the previous methods used, and previous publications supporting the connection between violent video game exposure similarly to previous papers published in response to these criticisms. Bushman and Huesmann for the first time draw attention to the distinction between experimental realism and mundane realism as described by Aronson and Carlsmith (1968), and again by Berkowitz and Donnerstein (1982) who note that experimental realism, or the level to which participants are able to get so involved in the procedures that they lose their sense of being in an experiment, is more important than how closely the measure looks like the real world. Bushman and Huesmann argue that while most laboratory measures of



aggression are low in mundane realism (physical resemblance to the real world), these measures are high in experimental realism. Finally Bushman and Huesmann call into question the “rhetorical techniques” used by Elson and Ferguson to shape opinion of the research, and researchers being published in the field (Bushman & Huesmann, 2014).

Barbara Krahe’s (2014) response begins with a critique of Elson and Ferguson’s choice to omit the extensive research supporting a connection between more general violent media exposure and increased aggression. Krahe suggests that both the General Aggression Model, and the Catalyst Theory are not specific to the video game form of media, and suggests that this omission is made because this large robust literature is “not in line with the desired conclusions” (Krahe, 2014, p. 56). Like Bushman and Huesmann (2014), Krahe also criticizes the use of a narrative review as opposed to the more meaningful meta-analysis approach to reviewing the literature referring to it as “a step backwards from recent meta-analyses that provide comprehensive and up-to-date reviews of the evidence” (Krahe, 2014, p. 56). Krahe continues to explain how the mediation found in (Möller & Krahe, 2008), cited by Elson and Ferguson as evidence of no direct longitudinal path between violent video game exposure and aggression, actually supports the GAM, through a long term increase in hostile attributions, and normative acceptance of aggression that is related to violent video game exposure. Krahe also commented on Elson and Ferguson’s critique of the realism and external validity in the violent video game literature. Krahe expresses concern for the use of violence and aggression interchangeably by Elson and Ferguson, and makes that point that while violence is a form of aggression, aggression itself is any act meant to cause harm to another, and aggression not violence is what laboratory measures of aggression test. In conclusion Krahe suggests that moving forward violent video game exposure research should focus on understanding why exposure leads to increased

aggression, as the literature has moved beyond the question of does it increase aggression (Krahé, 2014).

Wayne Warburton's response takes a much more theoretical approach, first focusing on the context within which the violent video game research exists, citing the decades of research published suggesting that media in general can affect thoughts, feelings, and behaviors (Warburton, 2013). Warburton suggests that within this context we should expect video games to have similar effects, unless there is a reason to expect otherwise, but as of yet we have found no evidence suggesting a difference. Warburton then shifts his response to a discussion of comparing "apples and oranges" in which he clarifies, much like Krahé (2014), the difference between aggression and violence (Warburton, 2013, p. 62). In this section Warburton expands the previous aggression vs. violence discussion by suggesting that violence, as an extreme form of aggression, "with no single factor being necessary or sufficient to elicit violence," which suggests that conflating these two distinct, but related constructs is particularly misleading, and that we should not see changes violent crime rates based on violent media consumption (Warburton, 2013, p. 62). Warburton further suggests that the evidence linking violent media exposure (including video games) to increased aggressive thoughts, feelings and behaviors has surpassed reasonable doubt, and the research should begin to look to understand the barrier conditions which lead to the strongest effects of violent video game exposure.

The debate continues in Elson and Ferguson's response to the responses of Bushman and Huesmann (2014), Krahé (2014), and Warburton (2013). In their response, Elson and Ferguson (2014), for the most part, defend their previous paper from three critical responses. In such Elson and Ferguson, continue to question the methodological validity of previous violent video game literature, citing that the papers referenced by Bushman and Huesmann (2014), and Krahé

(2014), in support of the TCRTT measure of aggression, do not in fact support their contentions. For example, Giancola and Parrott 2008, used the TCRTT, but their use differs from violent video game research in that it used pain induced via electric shock as aggression, instead of the loud noise used typically violent video game research. Elson and Ferguson (2014) suggest that the loud noise does not compare to electroshock because it does not actually cause pain in the aggressor. Elson and Ferguson (2014), again reiterate their concerns with the methodology used in the largest meta-analysis (Anderson et al., 2010) expressed in early critiques of the literature. They conclude the paper expressing concern for the direction the field of violent media research had taken, and suggest, “it may be time for this field to consider serious changes in both theory and communicating to the public” (Elson & Ferguson, 2014b, p. 6).

Throughout the ongoing debate, one thing that everyone agrees on is the need for more research focusing specifically on the mechanisms that may be underlying the increase in aggression. Anderson et al. (2010), in the largest meta-analysis to date, suggest that arousal and emotional responses to violent video game exposure could be assessed via methods typically employed in social neuroscience and social psychophysiology, to better understand the underlying mechanisms leading to increased aggression. Elson and Ferguson (2014a, pg. 10), state “With a corpus of precise and valid measurements for the different aspects of aggressiveness (thoughts, emotions, and behaviors), study results could no longer be subjected to interpretations from drastically different perspectives.” Bushman and Huesmann (2014, pg. 53) conclude that “it is time to move beyond the question of whether violent video games and other forms of media violence increase aggression, to focus instead on why violent media increase aggression”. Krahé (2014 pg. 58) suggests, “the way forward in the media violence debate is to focus on the evidence and its compatibility with existing theories that seek to explain the

process underlying media violence effects”. Warburton (2013) calls for research focusing on the barriers of the effects of violent media exposure, to better understand what conditions allow for these effects. The use of highly controlled and validated measures such as those employed in social psychophysiology and social neuroscience may be able to answer these calls to research. Despite their strengths there are relatively few studies in this literature using these methods, most of which have looked only at arousal to determine the influence of Excitation Transfer Theory on increased aggression related to violent video game play. These studies have found relatively weak results suggesting increased arousal for both violent and nonviolent video games (Gentile & Stone, 2005).

Recent scholarship employing social psychophysiological methods (Carnagey, Anderson, & Bushman, 2007) has focused on the role of arousal in desensitization to violent media. In a study comparing arousal levels while viewing realistic violence, playing a violent video games, and playing nonviolent video games, Carnagey et al. found differential arousal while viewing realistic violence for those who played violent and nonviolent video games. Carnagey et al. used two measures of arousal, skin conductance response and heart rate. As they predicted, those who played the violent video game had both lower heart rate and skin conductance response while viewing the video of realistic violence suggesting desensitization of the normal adverse physiological response to violence after only a brief exposure to violent video game play. This is an example of how the use of precise time locked physiological measures allows for more direct testing of the underlying mechanisms responsible for increased aggression after violent video game exposure.

In another investigation of desensitization, Arriaga, Monteiro, and Esteves (2011) focused on emotional desensitization after violent video game play. Building on the work by

Carnagey et al. (2007), Arriaga et al. added a self-report measure of emotional reaction to the measures of physiological desensitization. By adding a measure of perceived emotional reaction to negative violent images Arriaga et al. was able to examine whether changes in physiological reaction correlate to changes in the actual emotion felt by the participant. As was hypothesized, both physiological responses and reported emotion intensity for negative violent images was reduced after violent video game play.

Bartholow, Bushman, and Sestir (2006), and Engelhardt, Bartholow, Kerr, and Bushman (2011) have taken a different approach, investigating desensitization as a mechanism for increased aggression using event related potentials (ERP). Bartholow et al. (2006) found that previous violent game exposure could desensitize players to violent images, and that this desensitization could be detected in a decreased P300 ERP amplitude, an ERP component related to evaluative processing of emotional stimuli. Furthermore, they found a relationship between both previous violent video game exposure and decreased P300 amplitude and increased aggression (Bartholow et al. 2006). Engelhardt et al. (2011) built on these findings by adding an experimental manipulation of acute video game exposure (25 minutes of violent or nonviolent video game exposure) replicating the previous findings, and finding a decreased P300 ERP amplitude for violent video game players relative to pre-gameplay amplitudes. Combined these data suggest that repeated long term, and acute short term exposure to violent video games are associated with both decreased P300 ERP amplitudes, as well as increased aggression in the laboratory.

Together, these studies reveal how cognitive psychophysiology and cognitive neuroscience can bring a new, more detailed understanding of the mechanisms underlying the effects of violent video games. While there is a growing body of literature that desensitization to

violent images after exposure to violent media is occurring and this is associated with increased laboratory aggression (Arriaga, Monteiro, & Esteves, 2011; Bartholow, Bushman, & Sestir, 2006; Carnagey, Anderson, & Bushman, 2007; Engelhardt, Bartholow, Kerr, & Bushman, 2011), the question remains as to whether the link between desensitization and aggression in this context is emotion. Building on previous research by Elmore, Bennett, Marte, and Filion (in preparation), which found a significant decrease in the negative emotion experienced while viewing violent negative images after violent video game play, the present research will extend this finding to determine if this decrease in emotional response is related to changes in aggression. In the next section, I will discuss the present research in depth, specifically the hypotheses, and how emotion modulated startle (EMS), a psychophysiological index of emotion, combined with a measure of aggression may connect emotional desensitization to aggression.

### **Present Research**

Given the growing behavioral evidence that violent video game exposure increases aggression, the present research seeks to clarify the route through which this increase in aggression may be occurring. As described in the GAM (Anderson & Bushman, 2002), there are several routes through which violent video game exposure could increase aggressive behavior, but to date little research has tried to parse out which route is responsible. According to the GAM a combination of personal and situational variables create a person's present internal state. Personal variables, such as trait hostility, cannot be experimentally controlled, but they can be controlled for statistically in an attempt to account for the variance in the outcome variable that they explain. On the other hand, situational variables can be experimentally controlled and manipulated particularly well in the laboratory. The purpose of the current study is to use a

combination of statistical and experimental controls to accurately assess the present internal state of the participants.

Departing from previous research, the present research will objectively assess the present internal state of the participants by measuring the emotion modulation of the startle eyeblink response. By focusing on the present internal state, this study directly assesses the effects of short-term violent video game exposure on the hypothesized routes by which the outcome behaviors are influenced. According to the GAM, the present internal state is composed of the three interacting components of affect, cognition, and arousal. The present research is designed to test two possible influences on the cognitive aspect of the present internal state while statistically and experimentally controlling for the influence of arousal and affect. The influence of arousal can be, and often is, negated in violent video game research by pilot testing and choosing violent and nonviolent games that induce the same level of arousal, the method employed in the present research (Anderson et al., 2010). Affect, or person's present mood/emotional state can be influenced by the situational variables, and can be controlled in the laboratory setting. The typical situational variables that influence affect in the present internal state are provocation, pain, extreme temperatures, or anything that makes the individual uncomfortable. These variables can be kept constant throughout the testing of all participants to alleviate the possible influence of these differing across testing sessions. What remains after controlling these two aspects are the cognitive influences, which are the focus of the present research.

Cognitive aspects are those that are related to knowledge networks, and perception. Short-term violent video game exposure is hypothesized to act cognitively in two ways. The first is spreading activation, or priming of knowledge networks associated with violence and

aggression. Priming would predict a predisposition to aggression through partial activation, or readying, of these networks. A second cognitive process hypothesized to occur with violent video game exposure is desensitization. Desensitization is a process of dissociation, or habituation of the natural negative emotional response to violence and aggression. The GAM predicts that exposure to violence without consequence can diminish the negative emotional response and dissociate violent cues from the typically associated consequences of pain and suffering also associated with negative emotions. In the present study emotion modulation of startle while viewing emotion-eliciting pictures will be used to assess the presence of priming or desensitization after short-term violent video game play. Building on previous findings (Elmore, Bennett, Marte, & Filion, in preparation), a measure of aggression will also be used to examine whether any cognitive differences found will in turn be related to increased aggression. Furthermore, the participants will be categorized as either a high violent video game exposure group or low violent video game exposure group based on previous video game exposure, allowing for an examination of possible long-term desensitization or priming in individuals with high violent video game exposure.

## **Measures**

### **Emotion Modulated Startle**

Emotion Modulated Startle (EMS) is a phenomenon in which the natural startle response is modified, either strengthened or weakened, by the emotional state of the person being startled. The startle response is a natural reflexive response, elicited by an unexpected environmental stimulus. As the stimulus eliciting the response is aversive, usually a loud noise with a nearly instant onset, the startle response is a negatively valenced defensive response. The startle response is most often measured in humans through the eyeblink response which has been shown



to be the first and most reliable component to the startle response. Many techniques have been used to measure the startle eyeblink response, but the most reliable method is electromyography (EMG) of the orbicularis oculi. Recording EMG of the orbicularis oculi is done with two small electrodes placed on orbicularis oculi muscle (the muscle surrounding the eye) referenced to the activity of the mastoid bone, and records with great detail the activity of this muscle responsible for closing the eyelid. Decades of research have demonstrated that the startle response can be modified by several psychological factors such as cognitive load, attention, and emotion of the participant (Filion, Dawson, & Schell, 1998). The route to startle modification by emotion is described in the Biphasic Emotion Theory.

The Biphasic Emotion Theory describes emotions in one of two motivational states, either appetitive or defensive. Appetitive motivation is associated with positive emotions such as happiness, love, and desire. Defensive motivation is associated with negative emotions such as fear, anxiety, and disgust (Lang, 1995). The startle response, being a negative or defensive response, is facilitated by a defensive motivational state or inhibited by an appetitive motivational state. Therefore, if a participant is experiencing a positive emotion, associated with an appetitive motivational state, when a startle response is elicited, the startle response (being incongruous with the motivational state) is diminished. In contrast, if a participant is experiencing a negative emotion associated with a defensive motivational state, the startle response is congruent with the motivational state, and therefore primed by the emotional state, facilitating and intensifying the startle response.

Emotion modulation of startle was first demonstrated using a series of affective pictures to elicit the emotional response state (Vrana, Spence, & Lang, 1988). This set of pictures was taken from the International Affective Picture System (IAPS), a set of over two thousand color

pictures with normative affect ratings ranging from unpleasant to pleasant, including neutral (Lang, 1995; Lang, Bradley, & Cuthbert, 2008). Vrana et al. (1998) found a linear relationship between startle response magnitude and emotional response state. Specifically, the startle response while in a positive/appetitive state being the smallest and the startle response while in a negative/defensive state being the largest. In the decades since the discovery of EMS, it has become a widely used tool in the assessment of emotion. The value of EMS over other measures of emotion lies in the startle response. The startle response, being a reflex, can be reliably elicited from most people in many situations using a probe (typically acoustic). Using a probe to elicit the startle response time locks the response to the probe allowing the measure emotion at a specific time point. Another advantage of EMS is it is unbiased, with the participant exhibiting little conscious control over the differences in the startle response, allowing for a quick and unbiased measure of emotional state without requiring the participant to stop and fill out a questionnaire or answer questions. Recognizing the versatility of a measure with these qualities, scientist have used EMS as an emotional probe to investigate fear and sexual arousal while viewing film (Jansen & Frijda, 1994), while smelling pleasant and unpleasant odors (Ehrlichman, Brown, Zhu, & Warrenburg, 1997), listening to pleasant and unpleasant music (Roy, Mailhot, Gosselin, Paquette, & Peretz, 2009), and viewing pleasant and unpleasant television scenes (Bradley, 2007), all confirming the linear relationship between emotion and startle intensity. Emotion modulation of startle has also been used to assess emotion regulation allowing for the accurate measure of both suppressed and enhanced emotion (Jackson, Malmstadt, Larson, & Davidson, 2000). Clinically, EMS has been able to detect emotional differences between people diagnosed with psychopathy showing a diminished facilitation of the startle response by negative emotion (Patrick, 1994). Emotion modulation of startle has been

used to show differences between people with generalized anxiety disorder and controls, suggesting heightened levels of anxiety activate a defensive emotional state (Ray et al., 2009). Emotion Modulated Startle has also been used to detect differences between victims of traumatic events who suffer from PTSD and those who do not (Griffin, 2008; Jovanovic, Norrholm, Sakoman, Esterajher, & Kozaric-Kovacic, 2009).

Although the relationship between emotion and startle response has been consistently demonstrated, and been used to differentiate clinical populations, EMS is not without limitation. It has been shown that inhibition and facilitation in EMS is associated with the perceived emotional intensity of the stimuli, and the level of arousal. This suggests an attentional component to the modulation as higher arousal should coincide with more attention. This has been shown while viewing pictures from the IAPS, with no difference between positive and negative pictures at low arousal, but as arousal rises the startle magnitude diverges quickly to the typical linear pattern (Lang, 1995). The influence of arousal was also shown while reading sentences with similar emotional content, but varied on arousal, finding that both facilitation and inhibition of the startle response were diminished in low arousal sentences (Witvliet & Vrana, 1995). These findings indicate that measuring EMS requires the emotion to be accompanied by arousal, and similar to valence, modulation of the startle response is linearly related to arousal. Both the appetitive and defensive motivational states with higher arousal are associated with more inhibition or facilitation of the startle response.

Another more technical limitation to EMS lies within the elicitation and measure of the startle response. The startle response is elicited by a sudden adverse environmental stimulus, and can be elicited through the visual, tactile and auditory sensory modalities, with auditory elicitation the most common. For a sound to elicit a startle response it needs to be sufficiently

sudden and adverse. Suddenness is achieved by creating a sound with a near instant onset, and made aversive through high intensity or volume. Given these requirements for startle elicitation doing so in a naturalistic environment can be difficult to impossible. The measurement of the startle eyeblink response, the first and most reliable component of the startle response, is also limited by the necessary equipment for its recording. The eyeblink response is measured using EMG, which requires the placement of two highly sensitive sensors around the eye to measure the muscle activity associated with eyeblink. These sensors are attached to a bio-amplifier that makes the small electrical signals large enough to measure while converting them into digital signals that are recorded on a computer. This combination of equipment also limits the mobility and ability to record startle eyeblink data in a naturalistic environment.

The limitations of EMS are easily overcome for use in the study of violent video games. As the IAPS picture set gives both valence and arousal ratings for the images, it is possible to select sets of positively and negatively valenced images that are equivalently different from a set of neutrally valenced images, and equally and sufficiently arousing to detect differences. Furthermore, in order to investigate priming and desensitization to violence, the set of images with negative valence can be selected to include images portraying violence. The limitations inherent to startle elicitation and eyeblink measure are negligible in the study of violent video games, as the natural environment for playing video games is conducive to both. The combination of the reliability and extensive research validating EMS, along with the easily surmountable limitations to the application of EMS to violent video game study, make it a perfect match for assessing the effects of violent video game play on emotion.

## Taylor Competitive Reaction Time Task

The Taylor Competitive Reaction Time Task (TCRTT) was developed by Stuart Taylor in his dissertation in 1965, but not published until 2006, as a behavioral measure of aggression that allows the participant to overcome the “social prohibitions” against aggressing (pg. 298). Although there was a delay in publishing Taylor’s dissertation, he began using the task with the earliest publication using the TCRTT was Epstein and Taylor in 1967. The TCRTT consists of a very simple reaction time task (pressing a button when a light changes) played against a confederate. When the participant “wins,” or presses the button first, she/he sets the intensity of a noxious stimulus delivered to the confederate, and when the participant “loses,” or is slower to press the button, a noxious stimulus is presented to them at the intensity the confederate sets (Taylor, 2006). As described by Giancola and Parrott (2008), the TCRTT can be used to measure aggression three ways; unprovoked aggression, mean aggression, and extreme aggression. Unprovoked aggression is measured as the first aggression response by the participants, who have yet to be aggressed upon by the confederate. Mean aggression is the mean of aggression responses by the participant across all trials won, measuring their overall aggression. Extreme aggression is the proportion of trials where the participant assigned the maximum intensity to their opponent, thought to represent their likelihood to maximize their aggression. Taylor (2006), and Epstein and Taylor (1967) found that participants were most aggressive (delivered the highest intensity of electroshock) when participants felt that the confederate was unreasonably aggressive, and equal in skill on the reaction time task.

The TCRTT remains one of the most widely used laboratory measures of aggression, and has been employed frequently in research investigating the effects of violent video games, although usually modified from Stuart’s original design (Giancola & Zeichner, 2006; Ferguson

& Kilburn, 2009; Anderson et al., 2010; Ferguson, 2010). The original TCRTT used electroshock as the form of aggression, while most current uses of the TCRTT use loud noises, eliminating the need for extra equipment to administer the shock (Ferguson, 2010). As outlined below, other modifications have been made in response to recent criticisms of the TCRTT that have questioned the construct validity of the measure (Capello, 2008, Tedeschi & James, 1996; Tedeschi, & Quigley, 2000, Ferguson, 2009).

In reaction to the criticism that the underlying motivation of the participants for aggressing was not being measured, Anderson and Murphy (2003) added a six-item questionnaire to assess the motivation of the participant when aggressing, either instrumental or revenge. Further criticisms of Taylor's original design include the lack of a no-electroshock (or nonaggression) condition, suggesting that this could lead to an expectation bias, or that the aggression seen is compliance to authority (Tedeschi, & Quigley, 2000). This criticism is, and has been, easily overcome by including a zero-aggression option for the participants (Anderson & Murphy, 2003, Anderson et al., 2004, Arriaga, Esteves, Carneiro, & Monteiro, 2008, Ferguson et al., 2008, Arriaga, Monteiro, & Esteves, 2011). Further criticism is that the sound blast modification of the TCRTT does not cause harm to the confederate even when set to the highest level (Ferguson & Rueda, 2009). Recent modifications including the use of hot sauce instead of noise blasts, or telling the participants that the highest setting can harm one's hearing have been tried, but these have not become widely used (Konijn, Bijvank, & Bushman, 2007, Lieberman, Solomon, Greenberg, & McGregor, 1999). Finally, Ferguson and Rueda (2009) additionally point out that there are no physical, legal, or social consequences for the aggression of the participant, and suggest that this may moderate actual aggression.

## Hypotheses

While previous research tends to support desensitization after acute violent video game exposure, the methods proposed for the present research allow for a competitive testing of both priming and desensitization (Bartholow, Bushman, & Sestir, 2006, Carnagey, Anderson, & Bushman, 2007, Arriaga, Monteiro, & Esteves, 2011, Engelhardt, Bartholow, Kerr, & Bushman, 2011). The two competing hypotheses will help determine if priming or desensitization is the primary route to increased aggression after acute and chronic violent video game exposure. On the one hand, if priming is the primary route towards aggression within the present internal state, the spreading activation to violent associations would be further increased when the participant is exposed to high arousal negative valence images from the IAPS, further potentiating the startle response. On the other hand, if desensitization is the primary route, the negative emotional response to violent high arousal images would be diminished thereby attenuating the startle eyeblink response. By testing these hypotheses simultaneously using emotion modulated startle (EMS), the present study will be answering the calls by Anderson et al. (2010), Ferguson (2010), and Sherry (2007) for the use of well-validated physiological measures to further understand the relationship between violent video games and aggression.

H1: If there is a long-term effect of violent video game exposure, then high exposure participants will respond to violent images differently than low exposure participants. H1a: If the cognitive route to this altered emotional responding is desensitization, and then the results will show diminished EMS responses to the violent images presented prior to game play as compared to positive images. The desensitization route would also predict a negative correlation between EMS to negative images and violent video game exposure, or that EMS responses to negative images decrease as exposure to violent video games increases prior to game play. H1b:

If the cognitive route is priming, the results will show a potentiated EMS response to the violent images presented prior to game play. The priming route would also predict a positive correlation between EMS to negative images and violent video game exposure, or that EMS responses to negative images increase as exposure to violent video games increases prior to game play.

H2: If there is a short-term effect, then acute exposure to violent video games will produce altered responding to violent images. H2a: If the cognitive route is desensitization, the results will show diminished EMS responses to violent negative images relative to their pre-game EMS responses to violent images. H2b: If the cognitive route is priming, the results will show a potentiated EMS responses to violent negative images relative to their pre-game EMS responses to violent images.

H3: If there are effects of violent video game exposure on aggression then there will be differences in the amount aggression as measured by the TCRTT. H3a: Participants who have higher long-term violent video game exposure will exhibit more aggression in the TCRTT, such that I will observe a positive correlation between violent video game exposure, and the measures of aggression derived from the TCRTT. In that long-term exposure to violent video games is related to either desensitization or priming, a negative or positive correlation (respectively) would be predicted with the pregame EMS responses to violent images and aggression as measured on the TCRTT. H3b: Participants who are assigned to the violent video gameplay condition will exhibit more aggression on the TCRTT than those assigned to the nonviolent video game play condition.



## CHAPTER 3

### METHODS

A pool of undergraduate students was recruited based on their gender, and previous experience with violent video games. Half of the participants played a violent video game and half played a nonviolent video game in the laboratory. The cognitive routes to increased aggression were assessed in these participants using emotion modulated startle (EMS) to violent images, both before and after playing the video games in the laboratory. Aggression was assessed using a modified Taylor Competitive Reaction Time Task (TCRTT) post gameplay. A detailed discussion of the design, participants, measures, and procedure follow.

#### **Design**

The current study was designed to evaluate the relationship between long-term and acute violent video game exposure, and both the cognitive routes to increased aggression (priming vs. desensitization), and laboratory measured aggression (Taylor Competitive Reaction Time Task). The relationship between long term exposure to violent video games and the cognitive routes to increased aggression was investigated by comparing the pregame emotion modulated startle (EMS) change scores (percent difference from neutral for valenced images) for the positive and negative images. The relationship was further examined by calculating correlations between the pregame positive and negative EMS change scores, and previous violent video game exposure. To evaluate the relationship between acute violent video game exposure, and the cognitive routes to increased aggression, the pre-game vs. post-game EMS change scores (percent difference between pre-game and post-game EMS responses) were compared between the two randomly assigned gameplay condition groups. This study was designed to evaluate the relationship between long-term violent video game exposure, and aggression in the laboratory through a

correlation between the participant's previous exposure to violent video games, and the amount of aggression exhibited in the TCRTT. The relationship between the cognitive routes to increased aggression and increased aggression was evaluated by correlating the pre-game EMS change score for negative images, and aggression on the TCRTT. The design evaluated the relationship between acute violent video game exposure and laboratory aggression by comparing the aggression exhibited by the two groups (violent game condition vs. nonviolent game condition) on the TCRTT.

### **Participants**

Based on the largest most comprehensive meta-analysis of the violent video game literature (Anderson et al., 2010) an effect size of 0.21 was estimated for the present research. Using this estimate of effect size, along with the parameters of the present research, a total sample size of 46 participants (23 per condition) was calculated using G\*Power 3.1. To account for the exclusion of data due to artifact in EMG recording, and non-responding to startle probe, commonly 10%, as well as data that must be excluded if the participant reports awareness of the deception during the TCRTT, a total sample size of 50 (25 per condition) was collected.

The sample for this study was drawn from the larger undergraduate body of the University of Missouri - Kansas City, using the online participant recruitment system Psychpool. Initially students interested in participating completed a short online questionnaire including gender, and a measure of their previous and ongoing violent video game exposure. Participants who identified as male in the initial questionnaire were invited to participate in the laboratory based portion of the study. Of the initial goal of 50 participants, 47 completed the laboratory portion of the study with a mean age of 23 (SD = 6.002).

## Measures

### Pregame Questionnaires

#### *Violent Video Game Exposure Estimate*

The violent video game exposure for each participant was calculated using a method modified from Bartholow, Bushman, and Sestir (2006). Participants reported how much time in hours they play weekly, as well as the games they play most often. Entertainment Software Rating Board (ESRB) ratings were used to determine the rating and violent content of each game. Smith, Lachlan and Tamborini (2003) found that violent games rated for adults contained more violent interactions per minute versus those rated for younger players. Given the varying levels of violence in video games those rated as “M for Mature” which contained violence were given a multiplier of 1, while those given a rating of “T for teen” which contained violence were given a multiplier of 0.5. The participant’s violent video game exposure score was calculated by multiplying the time playing violent video games by the appropriate multiplier for the ESRB age rating.

#### *Positive and Negative Affect Schedule*

The Positive and Negative Affect Schedule (PANAS) is a 20 item self-report affect scale, that is widely used to measure both positive (PA) and negative (NA) affect (Watson, Clark, & Tellegen, 1988, Crawford & Henry, 2004 ). The PANAS is a combination of two ten-item scales, which are measured on a five point Likert style rating for each item. The current use of the PANAS was to measure the state affect of the participants to assure that individual differences in affect before playing the video game were randomly distributed between the

gameplay conditions, as well as allowing a measure of the possible long-term effects of violent video game exposure.

### *Buss and Perry Aggression Questionnaire*

The Buss and Perry Aggression Questionnaire (BPAQ) is a 29 question self-report aggression inventory (Buss & Perry, 1992). The BPAQ measures four characteristics of aggression using a seven-point Likert-scale for responses: physical aggression, verbal aggression, anger, and hostility. Due to its reliability and ease of use, the BPAQ is the most widely used measure to characterize propensity to act aggressively in violent video game research (O'Connor, Archer, & Wu, 2001, Anderson et al. 2010, Bushman, Rothstein, & Anderson, 2010). In the present research the BPAQ was used along with state PANAS, and the pre-gameplay emotion modulated startle session to determine differences between high and low violent video game exposure groups.

## Physiological Measures of Violent Video Game Effects

### *Emotion Modulated Startle*

During both the pre-gameplay and post-gameplay EMS sessions the participants were shown a series of images consisting of twelve negative-violent images, and twelve positive images taken from the International Affective Picture System (IAPS). The images were presented in random order. Images were presented with a duration between 5 and 9 seconds (mean = 7 seconds), and were separated by an inter-trial interval between 10 and 20 seconds (mean = 15 seconds). A 105 dB(A) white-noise startle eliciting sound (probe) was played during 11 of the 12 picture presentation for each image type between 2 and 4 (mean = 3) seconds after picture onset. The probe was also presented during eleven of the inter-trial intervals to be used

as a baseline measure of the startle response. Eyeblink responses were measured by three Beckman style electrodes, two placed over the left orbicularis oculi, and the third served as a reference placed over the mastoid bone behind the left ear. All physiological recording was done using a BioPac MP150 via the EMG100C module, using the Acqknowledge 4.5 software. An amplification setting of 5000 was used for recording. Signals were filtered outside of 1 Hz (high-pass) and 500 Hz (low-pass) with a notch filter at 60 Hz. The pre-gameplay and post-gameplay EMS sessions were identical in procedure, while using separate sets of the images matched for arousal and valence. The image sets were counterbalanced between gameplay conditions.

#### *Autonomic Arousal During Gameplay*

Pulse rate was measured during gameplay as a measure of autonomic arousal to assure that the overall autonomic arousal elicited from each video game (violent vs. racing) was equivalent. Pulse rate was measured via photo plethysmography obtained from the participants left earlobe during gameplay. Recordings were conducted using a BioPac MP150 coupled with the PPG100C pulse plethysmography amplifier, and the TSD200C earclip transducer.

### Measures of Aggression

#### *Taylor Competitive Reaction Time Task*

The modified TCRTT to be used in the current research tried to account for previous criticisms. Instead of using noise blasts to aggress the participants assigned time for the Cold Pressor Task (detailed in next section), which like electroshock can induce pain without many of the limitations of electroshock. For each trial that the participant “lost” they saw the amount of time assigned to them by their competitor, and set the amount of time their competitor would

receive on the next trial if they “won,” between zero and 30 seconds. Participants were allowed not to aggress during the TCRTT by giving them the option of assigning zero time to their opponent after each trial. Following the traditional TCRTT participants “won” ten of the total 20 trials. After each set of four trials the participant were asked to perform the Cold Pressor Task, immersing their hand in ice water, for the assigned amount of time never exceeding two minutes.

### *The Cold Pressor Task*

The Cold Pressor Test is a commonly used method for inducing pain by submerging the hand and forearm in ice-water ( $\sim 0^{\circ}\text{C}$ ). The cold induces a slow mounting pain that quickly dissipates when the limb is removed from the water, and is widely used in the study of pain mitigation and analgesics in both adults and children (von Baeyer et al. 2005). As the purpose of the Taylor Competitive Reaction Time Task (TCRTT) is to study aggression, and was designed to use a pain inducing stimuli (i.e. Electroshock), while considering the most widely accepted definition of aggression as any behavior carried out with the intent to harm another individual, the present study will use the Cold Pressor Task as the form of aggression administered to the competitor (Anderson & Bushman, 2002). Although the competitor did not exist this gave the participant the impression that they were delivering a painful stimulus and therefore more closely resembled the original TCRTT and the accepted definition of aggression. The design of the TCRTT used in the present research accommodates the guidelines for use of the Cold Pressor Task in children by not allowing for a maximum submersion time of more than four minutes, and in fact will not exceed more than two minutes for participants (von Baeyer et al. 2005).

## Procedure

Before participants arrived they were randomly assigned to either the violent or nonviolent video game play condition. Upon arrival participants were asked to read and sign an informed consent form explaining the experiment and procedures. Participants were then asked to complete the pre-gameplay questionnaires (BPAQ & PANAS). Upon completion of the questionnaire, participants were asked to move into a sound attenuating room and seated in front of a 24-inch computer monitor. At this time the EMG sensors and headphones were placed on the participants in preparation for the pre-gameplay EMS recording. After the investigator had left the room, the participants completed the pre-gameplay EMS session. Upon completion of the pre-gameplay EMS session the investigator returned to the sound attenuating room to remove the headphones from the participant, attach the ear clip, and give instructions on how to play the assigned video game. Once the participant agreed that they were comfortable with the controls the investigator left the room, the participant played the assigned game for 20 minutes. Immediately following gameplay the investigator replaced the headphones and removed the ear clip, and the post-gameplay EMS session began. The post-gameplay EMS session followed the same specifications as the pre-gameplay session using a different set of pictures. The investigator returned to remove the headphones after the second EMS session, and gave the participant instructions about the competitive reaction time task that followed. Following the instructions the participants completed the Taylor Competitive Reaction Time Task. After participants completed the TCRTT any remaining questions were answered, and notes were taken on all participants who suspected deception with regard to the TCRTT.

## Planned Analyses

To detect any pregame differences between groups that may affect the experimental conditions, a series of t-test were be used comparing the scores for the two gameplay conditions from the PANAS, BPAQ, violent video game exposure questionnaire, and the pre-game measures of startle response by picture type (positive, negative-violent, and neutral responses). The alpha level will be .05, with no correction, as only one analysis will be run for each measure. To determine the long-term effects of violent video game exposure change scores will be calculated from neutral, and a t-tests will be used to compare the positive change scores between groups, and a t-test will be used to compare the negative change scores between groups. A correlation between previous violent video game exposure and both positive and negative emotion modulated startle will be used to better understand these relationships, with an adjusted alpha of .025 to correct for multiple analyses. In order to assess between group differences associated with video game condition, pre-post A 2 (gameplay condition: violent gameplay condition, nonviolent gameplay condition) x 3 (image valence: violent-negative images, positive images, neutral responses) ANOVA will be used with an alpha of .05. Finally, in order to assess differences in aggression associated with both long-term and short-term violent video game exposure, a 2 (high exposure group, low exposure group) x 2 (violent gameplay condition, nonviolent gameplay condition) full factorial MANOVA, comparing the means for unprovoked aggression, mean aggression, and extreme aggression, with alpha set to .05. To further understand this relationship single tailed correlations will compare the three measures of aggression with the previous violent video game exposure estimates, with an adjusted alpha level of .017 used to correct for multiple analyses.



## CHAPTER 4

### ANALYSES AND RESULTS

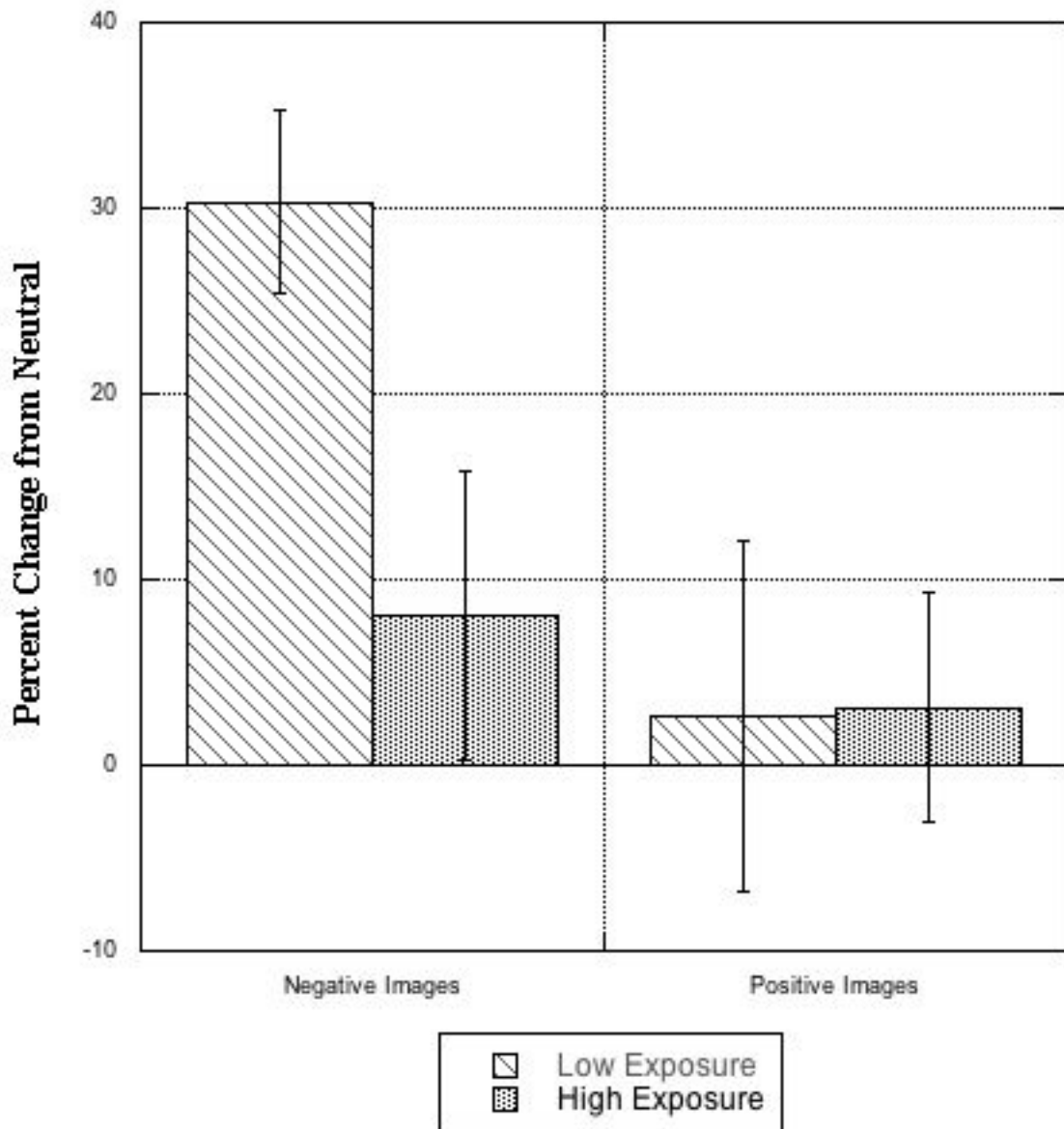
A series of t-tests was used to ensure that the randomly distributed groups and gameplay conditions were equivalent before the gameplay. These t-tests compared the two gameplay conditions on the Buss and Perry Aggression Questionnaire (BPAQ), the Positive and Negative Affect Schedule (PANAS), their prior violent video game exposure, and the pre-game measures of startle response by picture type (positive, negative-violent, and neutral responses). There were no differences found between conditions on any of these pre-game measures (all  $p > .05$ ).

*Table 1 Control Variables by Gameplay Condition*

	Gameplay Condition	Mean (SD)	Range
BPAQ	Nonviolent	80.58 (22.58)	49-147
	Violent	76.81(25.39)	44-150
PANAS Positive Affect	Nonviolent	30.16 (8.78)	14-47
	Violent	31.57 (7.81)	17-47
PANAS Negative Affect	Nonviolent	14.21 (3.26)	10-28
	Violent	13.43 (4.76)	10-21
Violent Video Game Exposure	Nonviolent	12.84 (12.01)	0-42
	Violent	10.74 (13.77)	0-40
Pregame Negative EMS	Nonviolent	.0402 (.0457)	0.00-0.17
	Violent	.0404 (.0381)	0.01-.012
Pregame Neutral EMS	Nonviolent	.0313 (.398)	0.00-0.16
	Violent	.0327 (.321)	0.01-0.14
Pregame Positive EMS	Nonviolent	.0369 (0.501)	0.00-0.19
	Violent	.0355 (.363)	0.01-0.15

Hypothesis one states that if there is a long-term effect of violent video game exposure, then high exposure participants will respond to violent images differently than low exposure participants. To test this hypothesis, the participants were divided into two groups based on their previous exposure to violent video games. The low exposure group consisted of those with

exposure scores below the median of seven, which made up 53.7% (22) of the sample, whereas the high exposure group were those above the median which was 46.3% (19). Given there was no difference between the neutral responses for the two groups, a percent change score was calculated then to standardize the pre-gameplay eyeblink responses using the following formula 
$$\frac{((\text{valenced image (positive, or negative-violent) startle}) - \text{neutral startle response}) / \text{valenced image (positive, or negative-violent) startle}) * 100}{}$$
. This change score represents the difference in emotionally modulated responses relative to the neutral baseline responses (Blumenthal et al., 2005). Finally, two t-tests were computed to compare the percent change EMS to negative images for the two exposure groups, and the percent change EMS to positive images for the two exposure groups. The results of these analyses show a difference between groups for the negative-violent pictures  $t(38) = 2.52, p = .016, d = .785$ , but not the positive pictures  $p = .973$ . The between group means, illustrated in Figure 1, for the negative-violent images (high = 8.03% SD = 32.83, low = 30.32% SD = 23.10) is in the direction supporting H1a, in that the high exposure group demonstrated much less negative reaction to the negative images. To better understand the relationship between long-term violent video game exposure and EMS to positive and negative images, correlations were computed between the violent video game exposure score and the positive and negative EMS change scores. A significant negative correlation was found between violent video game exposure and the EMS to violent negative images ( $r = -.440, n = 40, p < .01$ ) but not for positive images ( $r = -.109, n = 40, p > .05$ ). As shown in the scatterplot in Figure 2, the correlation between violent video game exposure and the EMS to violent images indicates that as exposure increases, the negative reaction to violent negative images decreases.



*Figure 1 - Percent Change Differences by Exposure Group and Picture Valence*

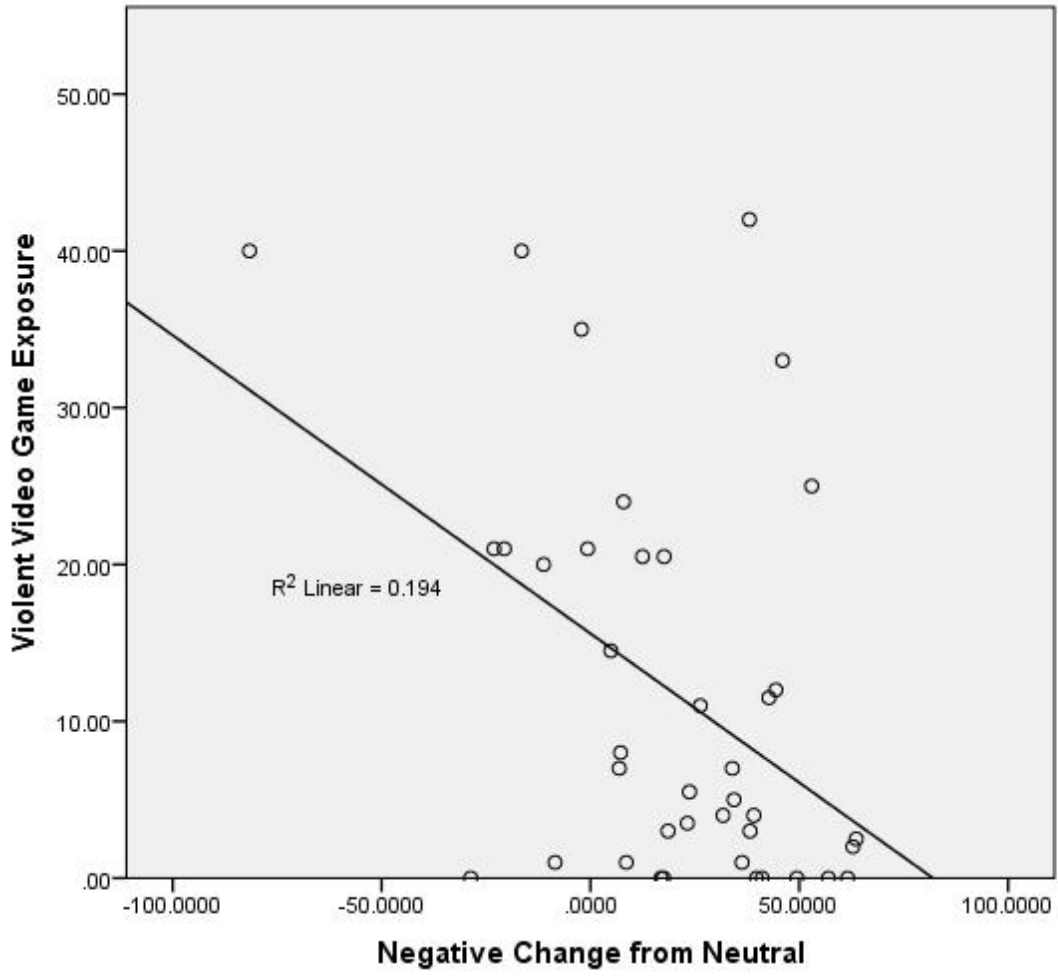


Figure 2 – Change score for Negative Images by Video Game Exposure

Hypothesis two focuses on the possible short-term effects of violent video game exposure, stating that if there are cognitive effects we should see differences in emotion modulated startle that support either priming or desensitization. To standardize the eyeblink responses, percent change scores were calculated for the responses to positive images, violent-negative images, and neutral responses using the following formula  $\left(\frac{\text{post-game response mean} - \text{pre-game response mean}}{\text{post-game response mean}}\right) * 100$ , which represents the response difference after gameplay relative to their pre-game response. A 2 (gameplay condition: violent gameplay condition, nonviolent gameplay condition) x 3 (image valence: violent-negative images, positive images, neutral responses) ANOVA was used to compare these percent-change scores between gameplay conditions. This analysis revealed no significant interaction between gameplay condition and image valence, but did reveal a significant difference between the change scores for the violent-negative images between gameplay conditions  $F(1,38) = 5.533$ ,  $p = .024$ ,  $d = .66$ , all other  $p$ s  $> .05$ . The means for the two gameplay conditions, depicted in Figure 3, support H2a in that those in the violent gameplay condition had a significantly greater decrease in response to the violent-negative images (-62.18%,  $SD = 59.85$ ) than those in the non-violent gameplay condition (-20.49%,  $SD = 51.33$ ).

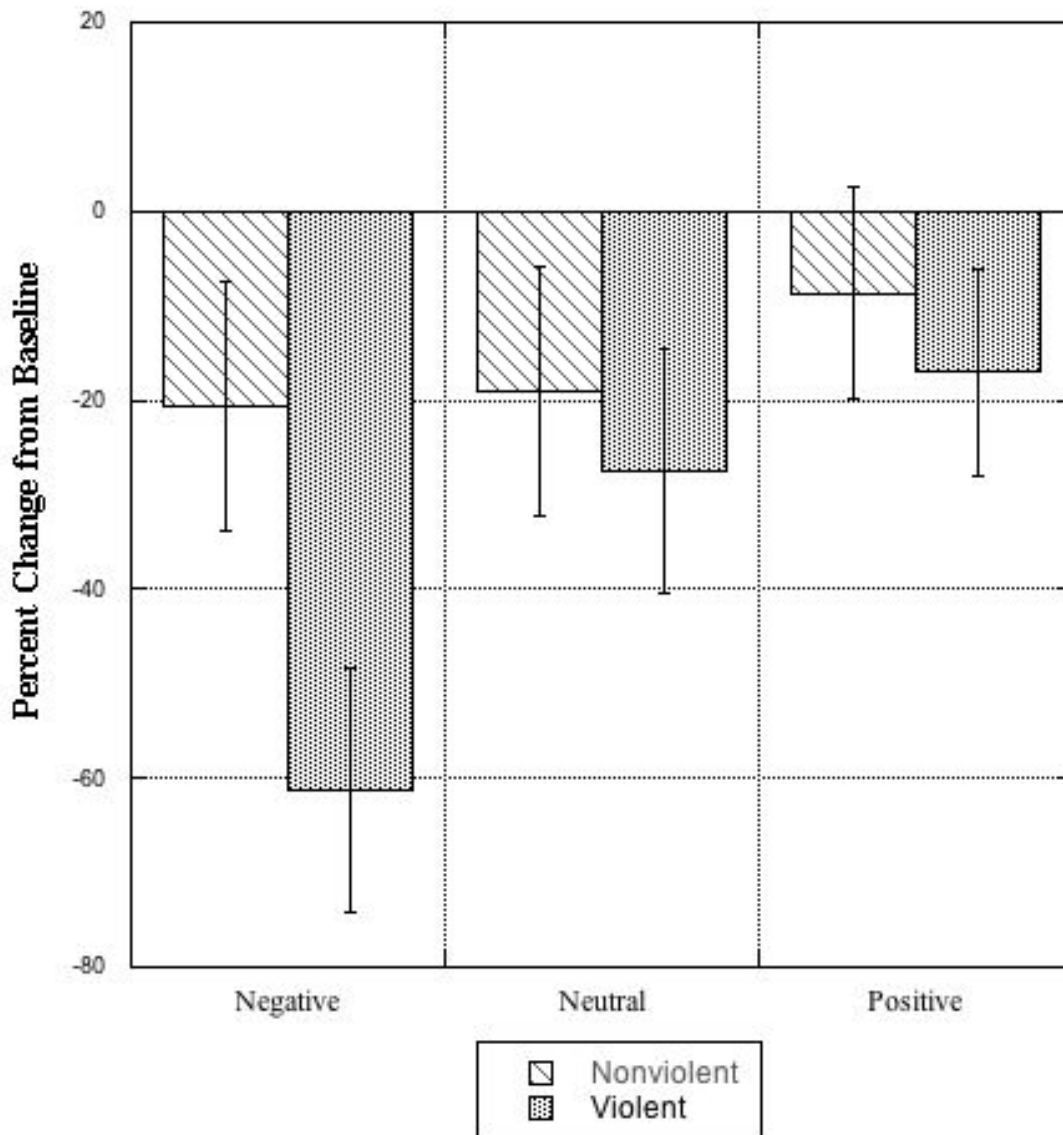


Figure 3 - Percent Change from Baseline by Gameplay Condition

The third hypothesis evaluates the relationship between violent video game exposure, and subsequent changes in the cognitive routes addressed in the first two hypotheses, and the laboratory measure of aggression (TCRTT). This hypothesis predicts that if there are changes in emotion modulated startle (EMS) related to violent video game exposure, there should be a related change in the amount of aggression demonstrated by the participants. All three measures of aggression were calculated for the TCRTT. Unprovoked aggression was calculated as the first

time assigned by the participants. Mean aggression was calculated as the mean time assigned by the participant across all trials won. Extreme aggression is the proportion of trials where the participant assigned the maximum amount of time to their opponent. These hypotheses were tested using 2 (high exposure group, low exposure group) x 2 (violent gameplay condition, nonviolent gameplay condition) full factorial MANOVA, comparing the means for unprovoked aggression, mean aggression, and extreme aggression. The overall interaction between gameplay condition and exposure groups was significant, Hotelling's Trace = .334,  $F(34) = 3.79$ ,  $p = .019$ ,  $\eta_p^2 = .251$ . The individual interactions for the three measures of aggression were also significant: unprovoked aggression ( $F(1,36) = 10.292$ ,  $p > .01$ ,  $\eta_p^2 = .222$ ), extreme aggression ( $F(1,36) = 6.720$ ,  $p = .014$ ,  $\eta_p^2 = .157$ ), and mean aggression ( $F(1,36) = 5.449$ ,  $p = .025$ ,  $\eta_p^2 = .131$ ). These interactions follow a similar pattern across measures as can be seen in Figure 3. For each measure, the pattern observed was the highest amount of aggression for the high exposure violent gameplay condition. The specific means by measure and group are shown in Table 3. After examining the means for all three measures of aggression the interaction seems to be driven by the high exposure violent gameplay condition group demonstrating the highest levels of aggression. To better understand the relationship between long-term violent video game exposure and increased aggression correlations were calculated between the previous violent video game exposure, and the three measures of aggression (unprovoked aggression, mean aggression, and extreme aggression), which can be found in Table 3. A positive correlation was found between previous video game exposure and the mean aggression ( $r = .375$ ,  $n = 41$ ,  $p = .008$ ), which is significant at the adjusted .05 alpha of .016, depicted in Figure 4. A positive correlation was also found for extreme aggression ( $r = .321$ ,  $n = 41$ ,  $p = .02$ ), but does not meet significance with the corrected .05 alpha of .016. Given the correlation found between previous

violent video game exposure, and decreased baseline EMS to negative pictures a series of correlations were calculated to investigate the relationship between baseline EMS to negative pictures, and aggression which can be seen in Table 4. A significant negative correlation was found for pre-game EMS for negative images and max aggression ( $r = -.360$ ,  $n = 40$ ,  $p = .011$ ), adjusted .05 alpha of .016, depicted in Figure 5. These findings considered together suggest that as long-term desensitization (greater decrease in emotional response) increases so does time assigned on the TCRTT.

*Table 2 – Aggression Measure Means for Gameplay Condition by Exposure Group*

		Nonviolent -Mean (SD)	Violent - Mean (SD)
Unprovoked Aggression	Low Exposure	11.78 (11.13)	6.46 (7.02)
	High Exposure	7.20 (6.51)	21.13 (12.93)
Mean Aggression	Low Exposure	13.33 (6.49)	9.12 (5.70)
	High Exposure	12.36 (6.24)	18.13 (8.58)
Extreme Aggression	Low Exposure	21.11 (28.92)	6.15 (11.93)
	High Exposure	13.00 (14.18)	38.75 (40.16)



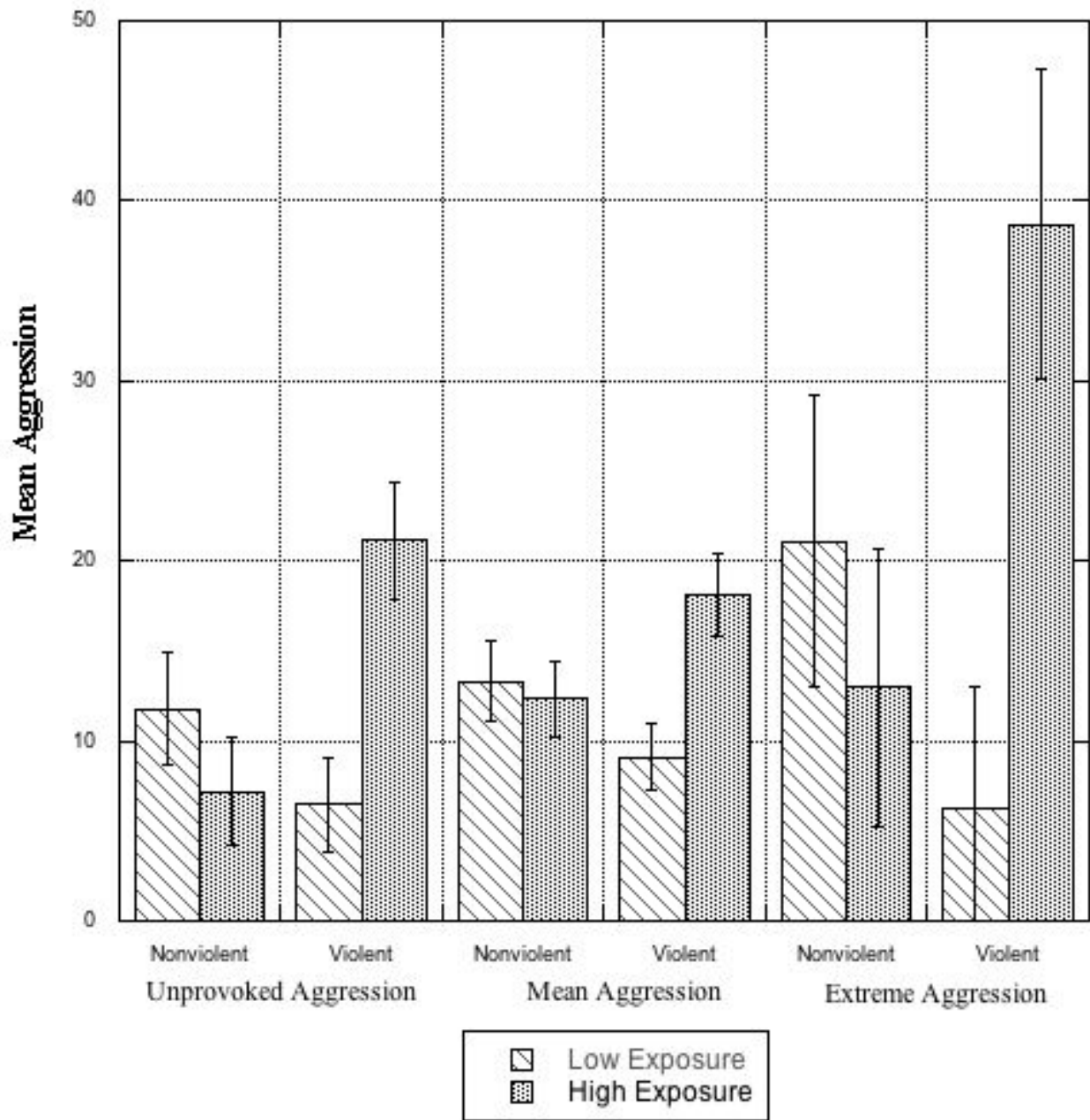


Figure 4 – Aggression Type by Gameplay Condition

Table 3 - Correlations between Violent Video Game Exposure and Three Measures of Aggression

		Unprovoked Aggression	Mean Aggression	Extreme Aggression
Violent Video Game Exposure	Pearson Correlation	.187	.375*	.321
	Sig. (1-tailed)	.121	.008	.020
	N	41	41	41

\*Correlation is significant at the adjusted 0.05 (0.017) alpha level (1-tailed).

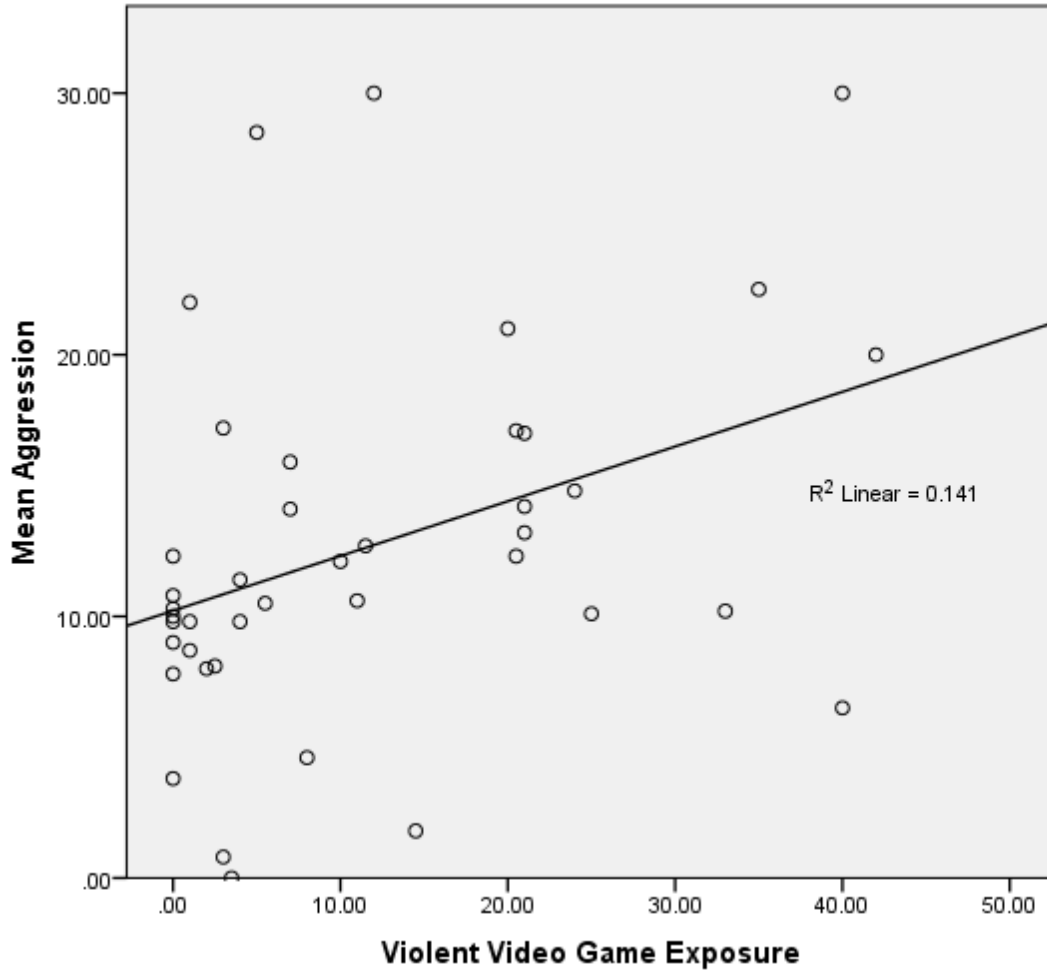


Figure 5 - Mean Aggression by Violent Video Game Exposure

Table 4 - Correlations between Baseline Negative EMS Change and Three Measures of Aggression

		Unprovoked Aggression	Mean Aggression	Extreme Aggression
Negative Change EMS	Pearson	-.272	-.248	-.360*
	Correlation			
	Sig. (1-tailed)	.045	.061	.011
	N	40	40	40

\*Correlation is significant at the adjusted 0.05 (0.017) alpha level (1-tailed).

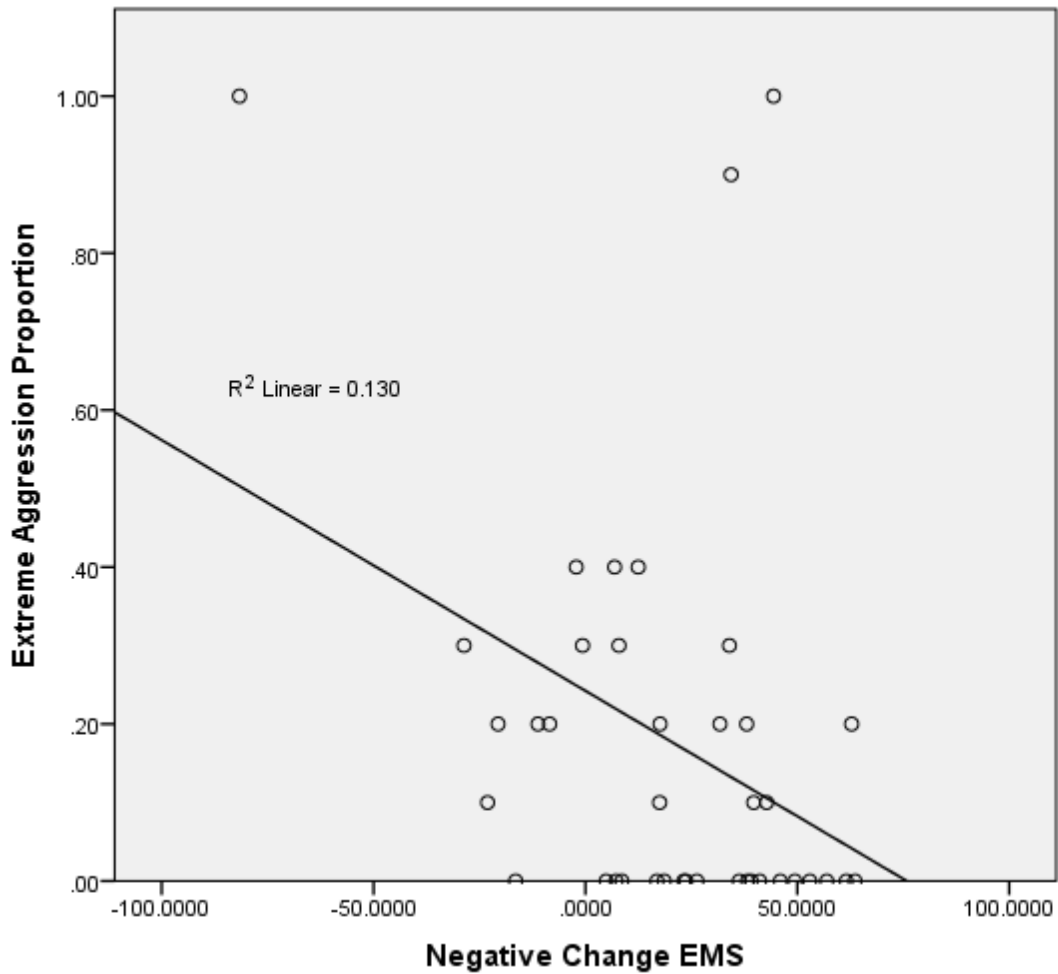


Figure 6 - Extreme Aggression by Negative Change EMS

## CHAPTER 5

### DISCUSSION

As the debate over the strength and scope of the effects of violent video game exposure on increased aggression continues in the literature, the appeal for more research comes from both sides (Bushman & Huesmann, 2014; Elson & Ferguson, 2014a; Krahé, 2014; Warburton, 2013). Specifically, research using well validated and controlled measures, which is also guided by theory to move beyond establishing the relationship between violent video game exposure and increased aggression toward an understanding of the mechanisms underlying this relationship. The present research sought to answer this call by combining the use of emotion modulated startle (EMS), a well validated and controllable measure of emotion, with traditional laboratory measures of aggression, to test the underlying mechanisms to increased aggression as described in the General Aggression Model (GAM).

The GAM describes two cognitive routes through which violent video game exposure could lead to greater aggression: priming and desensitization. The present study used EMS to competitively test these two routes in relation to both long-term, and short-term violent video game exposure. As a measure of emotion, EMS relies on the matching or mismatching of emotional state with the negative defensive startle response. If the effects of violent video game play increase aggression through the priming route a potentiated startle response was predicted through a matching of primed state and emotional stimuli. Conversely, if desensitization is the cognitive route to increased aggression an attenuated startle response was predicted, by a decrease in the emotional reaction to the negative violent images. By examining these routes to increased aggression via EMS in relation to both long-term, and short-term violent video game exposure, as well as laboratory measured aggression the present study is uniquely designed to provide a better understanding of contribution of the cognitive routes described in the GAM

towards increased aggression. Emotion Modulated Startle (EMS) to negative violent images was diminished in both those high in prior violent video game exposure, and those who were randomly assigned to play the violent video game. It was also found that there was an interaction between long-term and acute violent video game exposure and aggression with those high in violent video game exposure highest in aggression across all three measures of aggression. Overall, this pattern of results indicates a relationship between violent video game exposure, emotional desensitization to violence, and aggression. The results of each specific hypothesis will be discussed in detail below.

Hypothesis one predicted that if long-term violent video game exposure increases aggression through either priming (H1a) or desensitization (H1b), EMS responses should change in the predicted direction for those with higher violent video game exposure vs. those with lower violent video game exposure. The results revealed that the startle response while viewing violent negative images was *attenuated* in participants who were high in violent video game exposure as compared to those low in exposure in the pre-game EMS session. This difference supports the desensitization hypothesis (H1b), suggesting that long-term violent video game exposure may lead to emotional desensitization to violent negative images. These results lend support to the work of (Craig A. Anderson et al., 2003; Bartholow, Bushman, & Sestir, 2006; Engelhardt et al., 2011; Funk, Baldacci, Pasold, & Baumgardner, 2004; Krahé et al., 2011), all of whom describe long-term effects of violent video game exposure on desensitization to violence. While there has been growing support for desensitization to violence after violent video game exposure, the current study is the first to competitively test priming along with desensitization in relation to long-term violent video game exposure. The level of long-term exposure in the present research was not experimentally manipulated, meaning these results could easily be explained by other

uncontrolled variables such as a propensity for people who are less reactive to violent negative images to play more violent video games as suggested by Ferguson (2007), and Elson and Ferguson (2013). Despite the possible alternate explanations, this finding provides further support for desensitization as the cognitive route toward increased aggression as described by the GAM, and therefore provides further converging evidence to help in “triangulation” of effects of violent media exposure described by Warburton (2013, pg. 64).

Hypothesis two focused on the short-term, or acute, effects of violent video game exposure on the cognitive routes. Hypothesis two predicted that if short-term violent video game exposure increases aggression through either priming (H2a) or desensitization (H2b), EMS responses should change in the predicted direction for those playing a violent video game vs. those playing a nonviolent video game. The results of the analysis comparing pre-game and post-game EMS percent change scores again supports desensitization (H2a) as the cognitive route to increased aggression with a significant *attenuated* response to the violent negative images for those playing the violent video game as compared to those playing the nonviolent video game. This suggests that after 20 minutes of violent video game play, participants displayed a significant reduction in their natural negative emotional reaction to violent negative images. This result also supports earlier findings of desensitization after acute exposure to violent media: Carnagey, Anderson and Bushman (2007) finding decreased arousal; Fanti, Vanman, Henrich (2009) finding less sympathy for victims; Engelhardt, Bartholow, Kerr, and Bushman (2011) finding decreased P3 ERP component indicating decreased reaction to violence; Arriaga, Monteiro, and Esteves (2011) arousal and perceived emotional reaction desensitization. Although this result is consistent with previous findings related to violent video game exposure

and desensitization, this is the first study to competitively examine both cognitive routes described by the GAM, supporting desensitization over priming.

Building on these previous findings the present findings suggest that emotional reaction to violent images, as measured objectively via EMS, is also diminished after a relatively short period of exposure. Furthermore, considering the long-term and short-term exposure findings in the present study, a compelling case for desensitization begins to emerge. The short-term effects found here do not have the same limitations as the long-term findings, as the participants were randomly assigned to gameplay conditions, and these groups were not found to be different on trait aggression, positive or negative affect, previous exposure to violent video games, or arousal during gameplay, which leaves little doubt that the differences were the result of the content of the video games played. Given these findings it could be hypothesized that repeated acute exposure, and the associated emotional desensitization, could lead to long-term desensitization. It remains to be seen if either or both long-term and acute exposure to violent video games is associated with increased aggression in the laboratory.

Hypothesis three addresses the relationship between the desensitization found for long-term (H3a) and short-term (H3b) exposure and aggression in the laboratory. While there was no main effect for either long-term or short-term violent video game exposure on the three types of aggression measured, there was a significant interaction. The interaction between the exposure levels and video gameplay condition was that for each type of aggression measured, the high exposure violent gameplay condition demonstrated the highest aggression, while the low exposure violent gameplay condition demonstrated the least aggression. This interaction supports hypothesis three (neither H3a or H3b specifically), suggesting that there is a relationship between violent video game exposure and laboratory aggression. Coupling these

aggression findings with the findings that both the high violent video game exposure group, and the violent video gameplay condition exhibited significantly more emotional desensitization, clear support for the desensitization hypothesis begins to emerge. A relationship that is strengthened by the positive correlation between previous exposure and aggression, and a negative correlation between pre-gameplay EMS for negative pictures (more desensitization) and aggression. Together these findings suggest that people with higher long-term exposure to violent video games, and those with less emotional reaction to violent negative images, are more aggressive in the laboratory, and that this relationship is enhanced after acute exposure to violent video games.

Overall these findings support desensitization as the primary cognitive route contributing to increased aggression related to violent video game exposure. These findings directly support and build upon the work of Bartholow, et al., 2006, Engelhardt et al., 2011, and Arriaga et al., 2011, all of which found different types of desensitization related to violent video game exposure and increased aggression. Specifically, in those with high previous violent video game exposure Bartholow et al. 2006, and Engelhardt et al. 2011, found neural desensitization to violent images, and Arriaga et al. 2011, found desensitization of arousal and self report emotional reaction to violent negative images. These findings were replicated in the present research in that those with long-term exposure to violent video games show greater baseline desensitization to violent images. As the long-term exposure in all of these studies was naturalistic, and not experimentally manipulated, these findings provide support to the desensitization hypothesis, but cannot make a causal attribution. Engelhardt et al., 2011, and Arriaga et al., 2011 added an experimental manipulation, randomly assigning both high and low exposure groups to play a violent and nonviolent game in the laboratory. This addition allowed for the measure of acute



effects of violent video game play on desensitization, and aggression, while also accounting for previous exposure and pre-existing desensitization, a design very similar to that used in the present research. Engelhardt et al. (2011) found that acute violent video game exposure did increase neural desensitization, but only for those who were in the low previous exposure group, seemingly finding a floor effect on desensitization. Engelhardt et al. (2011) found that the violent video game condition exhibited more aggression than the nonviolent gameplay condition in the laboratory, with no differences within these conditions for high vs. low previous exposure. Arriaga et al. (2011) found similar long-term and acute effects of violent video game play for desensitization of arousal and self-report emotional ratings, although there was no floor effect on either measure of desensitization. Arriaga et al. (2011), found a different relationship between desensitization, video gameplay condition, and aggression than that found by Engelhardt et al. (2011). Arriaga et al. found that only those high in previous violent video game exposure were more aggressive in the violent video game condition. The findings of the present research, mirror the findings of Arriaga et al., (2011), in which emotional desensitization was found for both high and low previous exposure groups after violent video game play, but there was only increased aggression for those in the high previous exposure group. The differences in desensitization between Engelhardt et al. and the emotional desensitization may be related to a difference in neural versus emotional processing of negative violent images. Engelhardt et al. used the amplitude of the P300 component of the event-related brain potential as a metric of neural desensitization based on research linking this component to activation of the aversive motivational system (Delplanque, Silvert, Hot, Rigoulot, & Sequeira, 2006; Hajcak, Weinberg, MacNamara, & Foti, 2011; Nieuwenhuis, Aston-Jones, & Cohen, 2005). As this component is considered to be a part of the motivation evaluation system associated with emotional stimuli and

thought to be closely tied to arousal, it may vary from the emotional experience of the stimuli, which is being measured by EMS (Vrana, Spence, & Lang, 1988). As for the differences in aggression found between Engelhardt et al., and the present research could be due to a number of factors. One such factor is the use of the cold pressor as the form of aggression in the Taylor Competitive Reaction Time Task. By using a form of aggression that causes pain, as opposed to a loud noise, the operational definition of aggression in the present research more closely resembles the definition of aggression, as a behavior intended to cause harm to another individual. Perhaps this is a more sensitive measure of aggression and only those who are more aggressive chose to inflict pain on their competitor. Given that Arriaga et al., (2011) used the same form of aggression as Engelhardt et al. (2011), and found similar results to the current research this is unlikely the case. The inclusion of a zero aggression option in the TCRTT could also explain the differences between Engelhardt et al. (2011), and those of Arriaga et al. (2011) and the current research. Of these three, Engelhardt et al. (2011) is the only study to not include a no-aggression option in the TCRTT, which could set the expectation that the participant is expected to aggress, and therefore lead to more aggression from those who might otherwise not have aggressed. Despite the differences in aggression data, these studies seem to converge on a relationship between violent video game exposure and increased aggression.

Considering all of the current findings in the context of the recent findings by Engelhardt et al., (2011), and Arriaga et al., (2011), as Warburton (2013) suggests, leaves little doubt that there is a relationship between violent video game exposure, desensitization to violent images, and increased aggression in the laboratory. Despite the contribution of this research to the literature in providing further evidence to triangulate the effects of violent video game exposure there are limitations to this study and remaining questions. One such limitation of the current

research is its inability to generalize to women. The research presented here was conducted on an all male population, as a basic control for gender differences in aggression (Archer, 2004; Bettencourt & Miller, 1996; Hyde, 1984), there remains the question of whether these results would hold true for women. The findings of Arriaga et al., (2011) suggest that the relationship holds true across genders, as their sample was composed of half women and half men, half of each had high violent video game exposure, while Engelhardt et al. (2011) does not describe the distribution of high and low exposure by gender. Future research in this field should further investigate the relationship between gender, violent video game exposure, and aggression, to confirm the same relationship with emotional desensitization. Another major limitation of the current research is the lack of experimental manipulation of long-term violent video game exposure. In the current design, the relationship between short-term desensitization and long-term desensitization is inferred based on the relationship of both with violent video game exposure, but a causal relationship is not clearly described. While experimentally assigning people to play violent video games regularly, and measuring the decrease in emotional reactivity to violence, may be unethical, there may be room for creative experimental design to capture these changes in natural game play. Other related questions that remains unanswered, relate to the time course through which long-term desensitization may occur, we do not know how much exposure is necessary to create desensitization, and alternatively we do not know how quickly the desensitization may dissipate once exposure to violent video games ends. The answers to these questions will continue to build on the previous research and further clarify how exposure to violent video games increases aggression.

In conclusion, the present research provides further support that the cognitive route through which violent video game exposure increases aggression is desensitization, as described

in the General Aggression Model. Differences in emotional responses found here indicate that there are both long-term and short-term effects of violent video game exposure on desensitization, and that there is a relationship between this emotional desensitization and aggression. While the results of one study can never be considered conclusive, these findings considered in the context of the existing violent video game literature, suggest a clear path from exposure to violent video games to increased aggression, based in the theoretical General Aggression Model. It is also clear that through creative and careful experimental design research can begin to breakdown the relationship between violent video game exposure and increased aggression, and begin to understand the changes that are responsible for this relationship.

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## VITA

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