THE EFFECT OF VIOLENT VIDEO GAME PLAY ON

EMOTION MODULATION OF STARTLE

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ABSTRACT

Previous research investigating the effects of violent video games have repeatedly demonstrated a connection with increased aggression. The General Aggression Model has incorporated many different theories of aggression into a unified model which suggests two routes (priming and desensitization) through which exposure to violent video games might increase aggression. The present research tests these routes using the emotion modulated startle technique. Startle was elicited while participants viewed a set of negative violent images before and after playing a violent or nonviolent video game. Competing hypotheses predict startle potentiation in support of priming, and startle attenuation in support of desensitization, while viewing violent negative images. The results indicate a differential attenuation of the startle response for game play conditions. Results ultimately support the desensitization hypothesis through a less negative

emotional reaction to the violent negative pictures for those playing the violent video game, but not those playing the nonviolent video game.

APPROVAL PAGE

The faculty listed below, appointed by the Dean of the College of Arts and Sciences have examined a thesis titled "The Effect of Violent Video Game Play on Emotion Modulation of Startle," presented by Wade R. Elmore, candidate for the Master of Arts degree, and certify that in their opinion it is worthy of acceptance.

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INTRODUCTION

The debate regarding the negative effects of violent video games has continued throughout the nearly forty years of their existence. Video games have become the dominant form of video based entertainment in the United States, and have evolved from two dimensional blocks and stick figures to extraordinarily life-like virtual characters and environments. Throughout this time scientists have consistently found support for a connection between violent video games and increased aggression, generating and applying several theories of aggression specifically to violent video games. However, despite an enormous amount of research supporting the connection between violent video games and increased aggression, the debate continues (Kent, 2001; Anderson & Bushman, 2001; Ferguson, 2007; Anderson et al., 2010; Ferguson & Kilburn, 2009). To understand the possible underlying mechanisms for this relationship, researchers on both sides are calling for the use of more standardized and validated measures. The present research employs emotion modulation of startle, an objective and well validated physiological measure of emotion, to assess the effects of violent video game play on emotion and the underlying causal mechanisms.

In the current study, participants were randomly assigned to play either a violent or nonviolent video game for 15 minutes. Participants were assessed using both self-report and physiological measures before and after game play. Self report data collected before game play included; demographic information, previous exposure to video games (violent and nonviolent), and a mood inventory. Self report data collected after game play included; a game play understanding and frustration index, and a mood inventory.

Startle eyeblink responses while viewing positive and negative (violent) images were recorded pre and post game play as a measure of emotional processing. The differences anticipated between groups will be in the pre-post comparison of mood inventory and startle eyeblink measure of emotional processing.

Review of the Literature

Introduction to Video Games

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.

The phenomenal growth and advancement in the video game industry over the last forty years has occurred amidst the controversy surrounding violence in video games. Within a few years of the first video game, the first controversial violent video game, Death Race, a driving game where points were awarded for running over zombies, was introduced (Kent, 2001). Although the graphics were little more than stick figures representing zombies and a blocky shape resembling a car, the goal of the game was

clearly to kill the zombies by running them over. The violence portrayed in this game, as figurative as it was, created the first media backlash against a video game based on its content, and set the stage for the decades long debate between the video game industry and scientists, politicians and parents, over the impact of violent video game play on America's youth. Despite the controversy over violence in video games, the industry has grown at an astounding rate with games containing violence consistently the most popular.

Video game's dominance of the entertainment industry

According to the Entertainment Software Association's 2006 report, between the years of 1996 and 2006 the annual sales of video games within the United States has almost tripled from $2.6 billion to $7.4 billion. The most recent estimate shows video game sales doubling again to $15 billion in 2010 (NPD Group, The, 2010). With nearly 70% of all American households having a video game console or a personal computer used for playing video games, it is clear that video games have become a part of American life (Association, 2010).

Although there are many genres of video game, such as sports, puzzle and racing games, the most popular games as assessed by sales are generally those of the first person shooter genre, particularly 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 2010 the release of Call of Duty: Black Ops, a cutting-edge highly realistic first person shooter video game, having record breaking single day sales of $360 million, and five day sales worldwide setting the

entertainment industry record of $650 million (Reisinger, 2010). 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 (Association, 2010).

Genres and popularity of video games

The two most popular genres of video game, according to the Entertainment Software Association, are "sports" and "action" games; each accounting for over 18% of the total game sales for 2009. Sports games include the games in which a sport is being played within the game, just as PONG was a video game analog to table tennis, almost every other sport now has video game analogs such as football, soccer, basketball, tennis, bowling and even curling. The majority of sports games are not rated violent, although the game play may include physical aggression. The intent of the physical aggression portrayed in sports games, is not to do harm, and therefore, is not rated as violent Action games are those that emphasize physical challenges to the player such as eye-hand coordination and reaction time. Action games include many different sub-genres most of which contain violence in one form or another. A few examples of these sub-genres are shooters, first person shooters, fighting games, real time strategy games, and racing games. A shooter or first person shooter is a game where the player typically controls an avatar (in game persona) whose goal is to shoot and kill in-game characters that may be monsters, aliens, or other humans. Examples of this genre include Doom, Halo, and Call of Duty. In a fighting game, the player's avatar (usually from the third person

perspective) fights against other non-player characters or another player in virtual hand-to-hand combat. Examples include Mortal Kombat, Street Fighter, and Tekken. Real time strategy games also most often involve violence, but unlike shooters and fighters the player does not control a single avatar, but instead directs large numbers of characters, typically armies and their support groups, with the end goal of destroying an enemy. Examples of this genre include Starcraft, Age of Empires, and Warcraft. Racing games also fall in the action game category, and usually involve driving various vehicles through different courses against both non-player characters, and other players. Exemplars of this genre are Grand Tourismo, Need for Speed, and PURE.

Advancement of video games

Not only has the size of the video game industry grow exponentially, the quality of video games has also increased by the same factor, becoming more realistic and immersive. Moore's Law specifically describes the doubling of transistors on an integrated circuit every two years, and has held true over the nearly 40 year history of video games(Moore, 1965; Moore, 1998). As video games exist exclusively within these transistors, the capacity for realism and complexity has also almost doubled every two years. To gain a sense of the growth, the Atari 2600, released in 1977, had a maximum screen resolution of 192 x 160 pixels, a color palate of 256 colors, and 128 bytes of RAM. In contrast, the Microsoft Xbox 360, has a screen resolution as high as 1280 x 1080 pixels, 16,777,216 different colors, and 512 megabytes (536,870,912 bytes) of RAM. The personal computer as a gaming device still has the most power with screen

resolutions as high as 2560 x 1600 pixels, 1,073,000,000 colors, and upwards of eight gigabytes (8,589,934,592 bytes) of RAM.

Following an almost identical trajectory as the development of the computer technology, the development of the Internet has recently changed the way video games are played. Beginning with PONG, the interpersonal aspects have been an integral part of playing video games. Playing both collaboratively and competitively, at home and in the arcade, video games have always been played with others. In fact, relatively few games have been developed that do not include a multiplayer option. The social aspect of video games has flourished with the availability of high speed internet access not only in computers, but all major video game consoles. The interconnectivity of video games has created online communities of players, both competing and collaborating with each other, from all around the world. There are many genres that take advantage of this interconnectivity, including first person shooters, shooters, and real time strategy games, but a new genre known as the Massive Multiplayer Online Role Playing Game (MMORPG) exists completely online. MMORPGs create a virtual environment in which players must cooperate and compete against other players as well as non-player characters. The majority of these games are violent and involve quests or missions to advance characters, but also involve instances or specific battles that require players to team up to overcome obstacles and defeat enemies. The interpersonal aspects of MMORPGs are unique, in that the game players are forced to rely on, and often befriend, other players most of which only know one another in this virtual environment. A few of the most popular MMORPGs are World of Warcraft, Guild Wars, and EVE Online. MMORPGs are now the most socially interactive video game genre with hundreds of

thousands of people playing together regularly, and creating meaningful relationships within a virtual environment that sometimes extend into real life (Cole & Griffiths, 2007).

One final technological advancement of recent years is the ability to capture the real life physical movements of the player. This is done either by tracking the movements of the game controller through space (Nintendo Wii, Sony Playstation Move), or by tracking the player's body in space (Microsoft Xbox 360 Kinect). By matching the real life movements of the player to those of their avatar, players experience a new connection with their avatar. This has been combined with creative control over the avatar itself giving the player the ability to design an avatar that mimics the physical characteristics of the player as well. In combination, movement control and graphic representations of the player, gives an unprecedented connection between the player and their in game avatar. Most popularly, this control style has been used in the sports genre, allowing players to mimic the movements necessary to play games such as tennis, bowling, fencing, and soccer. Now, as the technology has developed to detect finer movements, a new wave of video games fitting more closely into the action genre are being developed. This includes the shooter and fighting sub-genres, both are necessarily violent, and brings new concerns about the effects of violent video games.

As the technology underlying video games increases, so does the quality of the players' experience. One aspect of the players' experience that reflects many of the advances in video games is known as immersion, or presence, terms that are often used interchangeably concerning the video game experience. One of the more complete and understandable definitions of immersion was given by Janet Murray in 1997.

> Immersion is a metaphorical term derived from the physical experience of being submerged in water. We seek the same feeling from a psychologically immersive experience that we do from a plunge in the ocean or swimming pool: the sensation of being surrounded by a completely other reality, as different as water is from air, that takes over all of our attention, our whole perceptual apparatus . . . in a participatory medium, immersion implies learning to swim, to do the things that the new environment makes possible . . . the enjoyment of immersion as a participatory activity. (p. 98)

Many things can increase the level of immersion a player experiences. Some of these relate specifically to the sensory experience of the player, and others relate to the completeness of the experience. Increases in screen and video rendering allows for larger screens with higher resolutions, meaning players can encompass more of their field of vision in the virtual world. This combined with the 3D environments where players can move or look in any direction, and worlds to explore beyond the immediate goals or mission, gives a heightened level of immersion. Likewise more lifelike sounds allowed by more processing power, and surround sound environments allow players to experience the existence of a world off screen by hearing sounds beside and behind them. The use of movement tracking controllers, and realistic representations as avatars, puts the player into the game both visually and physically.

Technology is not behind all the increases in immersion found in modern video games. As a form of video based entertainment, the plot of video games become more complex and engaging. The narrative embedded within most modern video games rivals

or surpasses those of other forms of video based media, such as movies and television. The narratives of many games now include the creation of full universes where even the laws of physics are different, or may be altered. It is also common for there to be many different fully developed races and/or classes of character to be played and interacted with, many of which have a history and culture of their own. Game worlds often exist well beyond the limits of immediate goals, and missions of a particular level in a game. Indeed, many games host virtual communities of players replete with currency, trade, recreation, and libation, making the virtual world as participatory and immersive as possible. A huge cast of characters, often voiced by real world celebrities, also add to the level of immersion. The completeness of the virtual world is the hallmark of the modern video game, with ever higher levels of immersion being the goal.

As the video game industry has continued to grow exponentially, and the quality of video games continues to increase reaching ever higher levels of realism and immersion, the controversy surrounding violence in video games continues. Video games have evolved throughout their existence from PONG, where two rectangles bounce a virtual ball back and forth to Call of Duty, Black Ops, where the entire game is played as a series of flashbacks experienced by the protagonist while being interrogated. It is clear video games have evolved and fundamentally changed over the past four decades. This evolution must be considered along side the research into violent video game effects.

Violence in video games: controversies & reactions both public and private

Violence in video games has always been a controversy; politicians, parents, and scientists have warned of their dangers (Berkowitz, 1984; Dominick, 1984; Graybill, 1985; Kent, 2001; Senate Committee Commerce, 1999). The first controversial video game was Death Race, released in 1976. Although it was not the first violent game in an arcade and was not even the first video game to depict violence, it was the first video game to depict violence against an individual human shape. Other video games such as Sea Wolf, the most popular game in 1976, had the goal of sinking enemy ships (Kent, 2001), and Gunfight a game depicting a shoot-out between the two players, were both already in thousands of arcades before the release of Death Race. It was Death Race that first stirred public outrage, culminating in an episode of 60 Minutes examining the psychological impact of video games (Kent, 2001).

Over the next 15 years, the controversy over violence in video games was overshadowed by violence in other more popular forms of video entertainment, namely television and movies. In this period, thousands of papers demonstrating the effects of violent media exposure on aggression and real life violence prompted the American Medical Association, the National Institutes of Mental Health, the American Academy of Pediatrics, the American Psychological Association, and the Attorney General Task Force on Family Violence, as well as the Surgeon General of the United States, Dr. C. Everett Koop, to acknowledge and warn the public about the hazard of violent media exposure (Bushman & Anderson, 2002; Bushman, 1995; Freedman, 1984; Kent, 2001) . Except for a more descriptive ratings system used for movies, these warnings were widely ignored by the public and the television and movie industries(Kent, 2001). In this period, a relatively small amount of research was conducted looking for a similar

connection between violent video game exposure, aggression, and real world violence. This early violent video game research found small effects relative to those of television and movies, a difference explained by a lower level of realism, and actual violence portrayed in early video games (Dominick, 1984; Graybill, 1985; Price, 1985; Gentile & Anderson, 2003). This difference in realism quickly diminished in the early 1990s, with the next generation of video games.

In 1992, the release of two games ushered in the era of modern video games, and brought controversy back to the video game industry. One of these games, Mortal Kombat, was of the fighting genre, and was originally released only in arcades. Mortal Kombat was not the first violent fighting game of this era, in fact, it was developed to compete with other fighting games that were credited with reviving the arcade. The innovation Mortal Kombat brought to this genre, the thing that made it more successful than the other games at the time, and ultimately made it part of a congressional hearing, is the realism it brought to violence. Mortal Kombat introduced blood to the fighting genre, removing any illusions that what was being portrayed in the game did not constitute a violent act. Beyond the introduction of blood, the makers of Mortal Kombat went one step further and added "fatalities", which were special moves for each character that could only be done at the end of a fight, and were, to quote Ed Boom, one of the games creators, "Gruesome" (Kent, 2001).

The other seminal game of 1992, Wolfenstein 3D was a new take on the shooter genre, and only released for personal computers. While Mortal Kombat innovated on an existing genre, making it more realistic and violent than ever before, the innovations in Wolfenstein 3D created a new genre. Wolfenstein 3D was the first shooter to move from

the third person perspective to the first person perspective, therefore being the first, first-person shooter. Wolfenstein 3D like Mortal Kombat brought a new level of realism to video games through the use of blood, and gore, and a new graphics engine that rendered a 3D environment quickly and seamlessly (Kent, 2001). It was a new type of video game, one that would remain very popular, very remain very violent, and very controversial.

As Mortal Kombat, and Wolfenstein 3D ushered in the modern era of video games, they also brought parents, politicians, and scientists concerned with the effects of this suddenly realistic and gory violence. Following a decade of research and warnings about the hazards of violent media exposure in 1993, Senator Joseph Lieberman brought the violence in video games into the national spotlight. Soon after the release of Mortal Kombat, it was brought to the attention of Senator Lieberman who, as quoted in (Kent, 2001), said of his experience,

> I was startled. It was very violent and, as you know, rewarded violence. And at the end, if you really did well, you'd get to decide whether to decapitate ... How to kill the other guy, how to pull his head off. And there was all sorts of blood flying around. (p. 446)

Leiberman's experience prompted congressional hearings to evaluate the marketing of "R rated" material to children. In these hearings it was suggested that all games are not for children, and that there is a large adult contingent of video game players who should have the right to play whatever games they choose, an argument still used today. As a result of

these hearings, the video game industry agreed to create, and enforce, a rating system for video games to inform parents, and protect children from unintended content. This rating system would be akin to the standards created by the Motion Picture Association of America, giving games an age restriction based on several factors including violence, language, and sexual content. Furthermore there was a call for more independent federally funded research into the effects of video games. Although the requirement to rate, and restrict access, was an important step in regulating exposure to violent media, one unintended consequence was an increase in violence and realism in games rated for mature players.

Concerns about the level of violence in media, and exposure to high levels of violent media continued in subsequent years, while academic research continued to show significant positive correlations between violent media exposure, including violent video games, and aggressive behavior (Huesmann & Miller, 1994; Bushman, 1995; Felson, 1996; Zillmann & Weaver III, 1999). Only a few years after the first Congressional hearings on violence in video games, a series of horrific events caused public outcry, and focused the Senate's attention back on violent media.

Beginning in the fall of 1997, and ending less than two years later, there were five school shootings across the United States that resulted in 24 deaths and nearly one hundred wounded students and teachers. The most horrific and infamous was the massacre at Columbine High School, where two students armed with high powered weapons and explosives killed 13 people and injured 23 before killing themselves. This sparked a national outrage, and essential need for explanation and understanding as to how this could happen. It was discovered quickly that three of the shootings were linked

directly with violent media, and two specifically to violent video games (Bushman & Anderson, 2002).

Only two weeks after the Columbine massacre, Senator Sam Brownback led a second round of hearings investigating the marketing of violent media to children. Brownback and Congressional witnesses suggested that while the rating system was in place, the marketing of some of this media was directly targeting children younger than the rating intends. While the hearings were intended to discuss the marketing surrounding violent media, many of the witnesses who testified before Congress questioned the morality of creating such violent media, and its effects on society. Given the proximity of these hearings to the Columbine massacre and the connection between Columbine and violent video games in particular, several witnesses spoke directly about their concerns with how violent video games might be affecting children. One particularly scathing testimony by retired lieutenant colonel David Grossman called violent first person shooter video games "mass-murder simulators, that can truly teach you how to commit a mass murder, without having ever put your hands on a gun" (Senate Committee Commerce, 1999).

The Federal Trade Commission conducted further study into marketing violence to children and in 2000 brought representatives from the music, movie, and video game industries back in front of Congress to determine how they would address the problem of marketing to inappropriate audiences. Although the impact of these hearings on the video game industry was not as obvious, there were changes made by both the movie and video game industries to better enforce the age restrictions associated with their

respective ratings systems. The video game industry went further by restricting access to online demos of violent video games.

Nearly every year since this hearing there has been a report to Congress on the state of violent video games, with consistent concern and warnings about the effects of these games, and giving examples of the ever increasing realism and gore in video games each year. By 2005, the state of California passed a law that banned the sale of rental of violent video games to minors, which removed the regulation and enforcement of age restrictions from the industry and made it a legally punishable offense. While other countries such as Australia, Brasil, Germany, New Zeland, Saudi Arabia, and South Korea have made it illegal to sell, trade, or in some cases even own one of these games. California was quickly met with a lawsuit from Entertainment Merchants claiming that this law infringed on the first amendment rights to free speech of those companies who produce, sell and rent these games. California's argument is that banning this type of media is no different than banning the sale of pornography to minors. After several years of litigation, the Supreme Court found in favor of the Entertainment Merchants, and that the California law did violate the Constitution.

As the realism, immersion, and violence depicted in video games increases on a yearly bases, and the most popular games each year are consistently the most gory and violent, academia continues to research the effects of these games on the individual and society. In the next section I will review the literature to date, and the ongoing debate within academia about the effects of violent video games to illustrate the need for further research in this area.

Theories of Aggression

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; 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, and 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 contends that although disinhibition or permission granting may occur through violent media exposure, as proposed by Bandura, priming can also contribute to the observed differences in aggression after exposure to violent media (Berkowitz, 1984). 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 further elaborates 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 (Zillmann, 1979). 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, 1992).

Rowell Heusmann builds upon the previous work of Bandura, Berkowitz, and Zillmann with Script Theory (Huesmann, 1988). 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 observationally, 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-Associanistic Theory, and Script Theory, was developed by Craig Anderson and Brad Bushman (1992). The GAM encompasses a combination of variables brought by both

the individual and the situation, this interactive combination is known as an episode. Within an episode, the GAM describes three determinants that may lead to increased aggression: Inputs, Routes, and Outcomes (Anderson & Bushman, 2002).

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 can prime aggression related networks making them more accessible. For example, it has been demonstrated that exposure to weapon names primes aggression related words in a reaction time task, as compared to animal names, supporting Berkowitz's Cognitive Neo-Associanistic Model (Anderson, Benjamin, & Bartholow, 1998). The interaction of the slowly adapting personal factors and the highly dynamic situational variables set 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 such as 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 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 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 and Bushman, 2001; Anderson and Bushman, 2002; Bushman and Anderson, 2002; Gentile and Anderson, 2003; Kirsh, 2003; Funk et al., 2003; Anderson, 2004; Carnagey and Anderson, 2004; Gentile et al., 2004). As evidence supporting a connection between violent video game exposure and aggressive behavior increases, researchers have turned to understand what is happening within the

complex interaction of the person in 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 media 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). It was not

until the atrocities leading up to and including the Columbine massacre that the dangers of violent video games received the proper attention. 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 by Mark Griffiths (1999), examined the literature including both correlational and experimental studies. 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 from 1999, by Karen Dill and Jody Dill, 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. 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, while other forms of violent media are passive. Violent video games also require concentration by the player, while other forms of media can be followed without concentration. The relative lack of realism in video games 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, and again 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. Anderson and Bushman note that following atrocity at Columbine, the connection between violent video games and increased aggression needs to be understood. 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 examining and 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 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 goes on to apply 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 questions the assumption that violent video games have, or should have, the same effects on aggressive behavior. 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. Violent video games are an active versus passive experience, requiring more concentration, with less realistic visuals. Sherry goes on to discuss 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 continued to examine 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 increase 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 Neoassocianistic 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 number of aggression related information to be activated. Sherry concludes 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 with more extensive networks than in younger participants (Sherry, 2007).

Sherry proposed his own hypothesis of increased aggression as result of violent video game play, suggesting a combination of priming and arousal. The effects are 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, and also counters Anderson's view that video game violence exposure is a clear risk factor for aggressive behavior. Sherry finally concludes that more targeted testing of the mechanisms through which violent video game play can increase aggression offer 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 2007 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 violent video games. Ferguson removes the risk of conflating the findings of violent video game research with that of other forms of violent media. To better clarify the potential influence of violent video games on aggression, Ferguson's study excludes other forms of violent media and focuses solely on modern video games produced between 1995 and 2005. 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 (2007) finds a positive relationship between violent video game play aggression (pooled $r = 0.14$), similar to (Sherry, 2001), but slightly weaker than (Anderson & Bushman, 2001). Ferguson also found 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 concludes 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 (2007) about the relationship between violent video game exposure and aggression. Despite the assertions that video games are similar to, but different than other forms of violent media, Huesmann discusses them under the same umbrella, continuing to use the more robust violent television literature to bolster the violent video game research. 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, and similarly not every child exposed to violent media will acquire the affliction of violent behavior. 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 through 2005 to 1998 through 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 go on to 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 the recent statements by Huesmann comparing exposure to violent video games 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 on violent video games performed in both 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 & Bushman, 2001) for the full sample data (pooled $r = 0.189$), and found even stronger effects for the best practices data with a pooled $r = 0.244$.

Anderson et al. (2010) go on to delineate the data into the following six outcome variables into 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 of 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.

Despite the ever increasing evidence linking violent video game exposure to increased aggression several questions remain unanswered. In a meta-analysis of direct effects of violent video game exposure on brain activity, Anderson et al. (2010) suggest that arousal and emotional responses could be assessed via methods typically employed in social neuroscience and social psychophysiology. The level of experimental control afforded by methods such as electromyography allows for more precision in hypothesis testing. There are relatively few studies in the literature employing these techniques, 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).

More 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 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.

Another recent example of the application of psychophysiological measures in the investigation of the effects of violent video games is the recent work by Ravaja, Turpeinen, Saari, Puttonen, and Keltikangas-Jarvinen, 2008. In this experiment participants' real time emotional responses to playing violent video games were recorded using facial electromyography, as well as skin conductance level and heart rate. Recording electrical activity from the orbicularis occuli and zygomaticus major muscles allowed for the measure of positive emotion, while recordings from the corrugator supercilii measured negatively valenced emotional reactions while skin conductance and heart rate measure arousal during play. Ravaja et al. (2008) examined participants' real time emotional and arousal responses to the violence within the game they were playing.

They found that all violence within the game either perpetrated by their character or on their character resulted in an increase in arousal, but the emotional reaction to these two depictions of violence were different. When there was violence perpetrated against their character within the game, there was higher activation in the zygomaticus major and orbicularis occuli indicating positive emotion, and when there was violence perpetrated by their character against other characters in the game there was increased activation of the corrugator supercilii muscle indicating negative emotion. The authors conclude that these results suggest that the natural negative response to violence exists in video games, and that repeated exposure to this could lead to desensitization through habituation (Ravaja et al., 2008).

The use of functional magnetic resonance imaging (FMRI) to investigate the effects of violent video games has also identified differences in brain activation between participants playing violent and nonviolent video games, particularly those areas associated with emotion regulation and behavioral inhibition (Wang et al., 2009; Hummer et al., 2010). Wang et al. (2009) found differential activation and connectivity of the right amygdala , a part of the brain known to be involved in regulating emotional response, between those having played a violent versus nonviolent video game during an emotional stroop task. Hummer et al. (2010) found significantly less activation in the dorsolateral prefrontal cortex, an area of the brain involved in regulation of emotion and behavior, during a go no-go task, for participants having played a violent video game for 30 minutes, as compared to participants having played a nonviolent racing game for the same time period. 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. In the next section, I will specifically discuss emotion modulated startle (EMS), a psychophysiological index emotion.

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 occuli. Recording EMG of the orbicularis occuli is done with two small electrodes placed on orbicularis occuli 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 forms 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). Recently, EMS has detected 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 averse 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 bioamplifier 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 images that are equally positive and negative as compared to base line, and equally and sufficiently arousing to detect differences. 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.

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, 1992), 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 for increases related to short term exposure. According to the GAM a combination of personal and situational variables create the present internal state. On the one hand, personal variables such as trait hostility cannot be experimentally

controlled, 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. A combination of statistical and experimental controls should allow an accurate manipulation of the present internal state of the participants.

Departing from previous research, the present research will 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 can directly assess the effects of 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 either 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 games that induce the same levels of arousal, the method employed in the present research (Anderson et al., 2010). Affect, or the mood and emotion of the individual present internal state can be influenced by the situational variables, but this too 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 difference hypothesized in relation to violent video game exposure is through a process of 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 emotive pictures will be used to assess the effects of short term violent video game play on both priming and desensitization.

Hypotheses

Two competing hypotheses will determine if priming or desensitization are the primary route to increased aggression after violent video game play. On the one hand, if priming is the primary route towards aggression within the present internal state, the spreading activation to violent associations will be further activated 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 also diminishing the startle eyeblink response. By testing these hypotheses simultaneously using 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.

CHAPTER 2

METHODS

Participants

Based on a previous research investigating emotion modulated startle, a power analysis was conducted assuming a similar moderate effect size (d = 0.35), suggesting a sample size of 76 to adequately detect differences for our main hypotheses (Bradley et al., 1990). Seventy-seven students were recruited from the University of Missouri - Kansas City. Fifty-four participants (70%)were female with a mean age of 23.8 years (range 18-54; SD = 7.81). Of the sample, 51 (73%) indicated their ethnicity to be white, eight (11%) Black, three (4%) Asian, and the remainder (12%) indicated other, or declined to state their ethnicity. A gender and breakdown of the violent and nonviolent game play conditions can be found in Table 1. All participants were given extra credit in the class they were recruited from in exchange for their participation. Two participants were excluded from the data set due to data missing from the pre or post video game questionnaires.

Table 1

Demographics by game condition

	Age		**Gender**	
	Mean	SD	Male	Female
Violent game	23.49	7.58	11	28
Nonviolent game	24.20	8.214	7	23

Design

A three (positive, negative, neutral picture type) by two (violent, nonviolent video game type) by two (pre-gameplay, post gameplay) mixed design was used, with video game type as the randomly assigned between-subjects condition, and all other factors within subject.

Measures

The order of activities for all participants is as follows: informed consent, self report questionnaires, EMS measure one, video game play, EMS measure two, self report questionnaires, followed by a debriefing. To help control for non-experimentally controlled personal and situational variables, several self-report measures were used before and after violent video game exposure. The first of these was an estimate of violent video game exposure. Violent video game exposure was calculated based on the participant's self report data on how many hours per week they spend playing video games, hours per week spent watching video games, and the game reported to be most played and watched. A score for each game reported was generated based on the Entertainment Software Rating Board (ESRB) rating for each game, and the content analysis of 60 popular video games (Smith, Lachlan, & Tamborini, 2003). Smith et al. found that games with a rating for players age six years and up, as well as those rated for players over thirteen years and up often contain violence (57% and 90% respectively), but those rated for younger players had lower occurrences of violence, specifically 1.17 violent interactions per minute versus 4.59 for the higher age rated games. Based on this

difference, exposure to violent video games will be computed based on the ESRB rating. For games rated for players below thirteen and containing violence, the number of hours playing or watching was multiplied by 1.17. Games with a rating for players above thirteen and found to contain violence, the number of hours playing or watching was multiplied by 4.59.

Participants were also asked whether they had smoked a cigarette, consumed caffeine, or engaged in vigorous exercise in the 30 minutes prior to participating, to control for possible differences in arousal. A series of questions were also asked post video game play to investigate the participants' experience with the game controls and rules, as well as a self report on perceived difficulty and overall engagement.

The participant's mood was also measured pre and post video game play using the Multiple Affect Adjective Checklist - Revised (MAACL-R) (Lubin et al., 1986), a sixty-six item mood inventory checklist containing the five unipolar scales of anxiety, depression, hostility, positive affect, and sensation seeking. The use of the MAACL-R allowed for the assessment of changes in the present internal state that may not be measured via EMS responses. For example, a decrease in startle magnitude may indicate positive affect, or sensation seeking, and analysis of the MAACL-R could help to differentiate between the two.

Emotion modulation of startle eyeblink response was measured with electromyography (EMG) from the left orbicularis occuli muscle. Two Beckman-style subminiature electrodes were placed over the orbicularis occuli and another reference electrode was placed over the left mastoid bone. The EMG signal was amplified by a Coulbourn systems lablink 5 model v75-01 bioamplifier with a bandpass filter of 8 to

1000 Hz, and a gain of 10,000. The EMG signals were digitized in 500 ms epochs, centered at the startle probe, with 2048 samples per second. Data were rectified and integrated offline using custom software developed by Hoffman Computing Inc. Single-trial eyeblink onset latency, peak latency, and peak eyeblink amplitude were also quantified offline using the same custom software.

Stimuli

Based on pretesting, two video games were chosen to be similar in effort, engagement, frustration and elicited arousal, measured by heart rate, blood pressure and skin conductance (Elmore, Ayers, & Filion, 2001). The games chosen were Tetris and Perfect Dark, for the nonviolent and violent video game conditions, respectively. Tetris is a puzzle game in which pieces must be manipulated to fit in the appropriate spaces, and becomes progressively more difficult as game play continues, and is rated "E" for everyone. Perfect Dark is a first person shooter game, and a custom level was created to limit it's scope, making the goal to simply kill as many adversaries as possible while keeping the deaths of the player's character to a minimum, and is rated "M" for mature. Both video games were played on the Nintendo 64 game console connected to a thirteen-inch television approximately thirty inches from the participant.

The stimuli used to assess EMS were seven negative, neutral and positive rated images from the IAPS. The positive pictures set was selected to all contain flowers and be rated high on valence. The negative pictures were selected to all contain a gun, and be rated low on valence. Each picture was presented to the participant for seven-seconds with an inter-picture interval varying between five and nine-seconds, with a mean of

seven-seconds. Six of the seven images within each category were probed 3.5 seconds after picture onset using a 50 ms 100 dB SPL (A) white noise burst, with near instant onset and offset to elicit the startle eyeblink response.

Procedure

Upon arrival, participants were asked to read and sign an informed consent. After consenting, the participants were asked to complete the pre-game questionnaires. Participants were then taken into a sound attenuating room, where the EMG electrodes were attached, and headphones were placed over the participants' ears. The pre-game EMS was then collected, with pictures being presented in a pseudo-random order. After completion of the first EMS run, the headphones were removed and participants were randomly assigned to either the violent or nonviolent video game condition, and given instructions on game controls and rules. Participants were then asked to play the assigned game for fifteen minutes, while the researchers waited outside of the sound attenuating room. Participants were unobtrusively observed while playing to confirm that participants were following the rules and understood the controls of the game. Upon completion of the fifteen-minute game play the researcher entered the room and placed headphones on the participants again. The participants then went through the second EMS run, with the pictures presented in a different pseudo random order. After completing the second EMS run the participants were asked to complete the post-game questionnaire. Finally the participants were debriefed and given the opportunity to ask any questions regarding the study. The entire procedure took more than 45 minutes, but less than one hour for all participants.

CHAPTER 3

DATA ANALYSIS AND RESULTS

A chi-square analysis was performed comparing the violent game group to the control group on the variables of smoking, caffeine consumption, and/or performing vigorous exercise in the thirty minutes prior to beginning the experiment. All probabilities were > .05 (Table 2), suggesting no significant differences between groups for any of these variables and they were excluded from the remaining analyses. After calculating a violent video game exposure estimate, as described in the measures section, an independent samples t-test was performed determining no difference (t (1, 61) = -1.196, p. > .05) between violent (mean 3.8, SD 7.831) and non-violent gameplay conditions (mean 8.53, SD 21.699). A one-way ANOVA was performed to assess pre-game differences on the Multiple Affect Adjective Checklist - Revised (MAACL-R) determining no significant differences between game play condition groups with all probabilities greater than 0.05, with the means and standard deviations displayed in Table 3. As there were no differences found between game play conditions for smoking, caffeine consumption, recent exercise, violent video game exposure, or pre-game MAACL-R scores none of these will be included as covariates in the remaining analyses.

Table 2

Chi-Square values between game play conditions.

	Violent Game	**Nonviolent Game**	**Value**	**Probability**
Cigarette	8	7	0.079	0.778
Caffeine	12	7	0.470	0.493

	Violent Game	Nonviolent Game	Value	Probability
Exercise	2	3	0.599	0.439

Table 3

One-way ANOVA for pre-game MAACL-R scores.

	Mean		Standard Deviation		
	Violent Game Condition	Nonviolent Game Condition	Violent Game Condition	Nonviolent Game Condition	Probability
Anxiety	0.1921	0.1367	0.2888	0.1691	0.355
Sensation Seeking	0.3471	0.3381	0.2848	0.2071	0.885
Depression	0.0658	0.0667	0.1702	0.1391	0.748
Hostility	0.0641	0.0729	0.1111	0.1114	0.342
Positive Affect	0.5075	0.4429	0.2710	0.2833	0.982

After excluding potential covariates, a series of 2 (pre-game vs. post-game) x 2 (violent vs. nonviolent game play condition) ANOVAs were performed to determine game play related differences on the MAACL-R sub-scales. Looking at the individual sub-scales of the MAACL-R there was a significant main effect of time on positive affect (F (1,66) = 14.961, p. < .001, η^2 = .185), with positive affect decreasing after both gameplay conditions. Although it did not reach the statistical cutoff there was also a main effect for anxiety F = (1,66) = 3.146, p. = .081, η^2 = .045, suggesting that anxiety was higher for both game play conditions after game play. There were no statistically

significant interactions between game play condition and time (pre-post game play) with probabilities all > 0.05.

As startle eyeblink magnitude is the most reliable measure of the overall size of startle eyeblink responses, a 2 (time) x 2 (picture type) x 2 (play condition) repeated measures ANOVA was conducted as using eyeblink magnitude a manipulation check of the emotion eliciting images. Confirming emotion modulation of startle (F (1,67) = 60.056, p. < .001, η^2 = .473), with the startle response to negative pictures (mean 1985.002) greater than the positive pictures (mean 1724.951) shown in figure 1. This analysis also confirms the typical habituation to the startle stimulus (F (1,67) = 13.853, p. < .001, η^2 = .171), with startle responses at time one (mean 1930.654) higher than at time two (mean 1779.299) shown in figure 2. These results confirm the typical pattern for emotion modulated startle suggesting any further differences should be related to experimental manipulation (Bradley, Cuthbert, & Lang, 1999; Lang, Bradley, & Cuthbert, 1990; Vrana, Spence, & Lang, 1988).

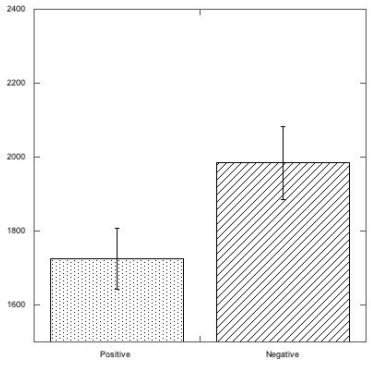

Figure 1. Startle eyeblink magnitude by picture type

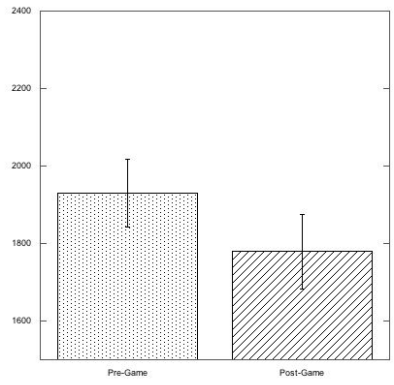

Figure 2. Startle eyeblink magnitude by time

In order to test the main competing hypotheses of priming versus desensitization startle eyeblink responses were standardized using the (((pre - post)/pre)*100) formula (Blumenthal et al., 2005), to account for differences in individual overall startle eyeblink response. To determine differences in emotion modulation of the startle response due to violent and nonviolent video game play a 2 (violent negative picture vs. positive picture) x 2 (violent vs. nonviolent game play condition) repeated measures ANOVA was performed for the calculated percent change scores. As hypothesized there was no main effect for either picture type or game play condition, p.'s > .1, and there was an interaction between these variables F (1,67) = 6.935, p. = .01, η^2 = .094. Reviewing the means contributing to this interaction shows that for those participants in the violent game condition startle eyeblink response was 28.475 (SE 7.101) percent smaller to the *violent negative pictures* versus only 11.189 (SE 6.456) percent smaller for the *positive*

pictures. Conversely, the startle eyeblink response was 26.515 (SE 8.097) percent smaller for the *positive pictures* versus 12.819 (SE 7.361) percent small for the *violent negative pictures* for those having played a nonviolent video game. This difference, illustrated in figure 3, supports the desensitization hypothesis through a diminished startle eyeblink response to the violent negative images post gameplay for the violent gameplay condition relative to the nonviolent gameplay condition.

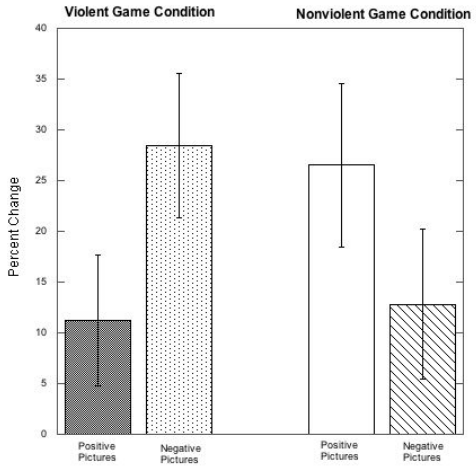

Figure 3. Startle eyeblink percent change score by picture type and game play condition

CHAPTER 4

DISCUSSION

The general aggression model (GAM) describes two routes through which violent video game play could lead to greater aggression: priming and desensitization. The current study was designed to test these two routes competitively using Emotion modulated startle (EMS). As a measure of emotion, EMS relies on the matching or mismatching of emotional state with the negative defensive startle reaction. After violent video game play, the priming route would predict a potentiated startle eyeblink response through a matching of primed state and emotional stimuli, while the desensitization route would predict attenuation of the startle eyeblink response by decreasing the emotional reaction to the negative violent images. Following these predictions it was hypothesized that if the startle response was attenuated, or reduced, after violent video game play this would demonstrate desensitization, while if the startle response were potentiated, or increased, after violent video game play this would demonstrate priming. The results revealed that the startle response was *attenuated* in participants who played the violent video game compared to participants assigned to the nonviolent game condition, a pattern of results that supports the desensitization hypothesis.

The desensitization hypothesis suggests that exposure to violent video games causes the natural negative reaction to violence to diminish through habituation (Anderson et al., 2010; Bartholow, Bushman, & Sestir, 2006; Bushman & Anderson, 2009; Carnagey, Anderson, & Bushman, 2007; Funk, Buchman, Jenks, & Bechtoldt,

2003). In the current study, we found further evidence to support the desensitization hypothesis by objectively measuring the emotional reaction to violent negative emotional images before and after playing a violent video game. The startle eyeblink response while viewing violent negative images was significantly smaller after playing a violent video game than a nonviolent video game, suggesting a reduction in the naturally negative emotional reaction to these images directly related to the exposure to a violent video game.

Previous work has demonstrated desensitization to violence in several ways, both through behavioral and self report measures, and more recently the connection between violent video games and aggression has been explored using psychophysiological measures. Barthalow, Bushman & Sestir (2005) found that violent video game players had reduced P300 event related potentials when viewing violent images, suggesting less activation of the aversive motivation system. Carnagey, Bushman & Anderson (2007), found diminished physiological arousal to violent video after violent video game play, suggesting a diminished autonomic response to violence after violent game play. Differences in cortical activation and functional connectivity have been imaged, showing both decreased activation in the dorsolateral prefrontal cortex and less functional connectivity between dorsolateral prefrontal cortex and the anterior cingulate cortex, and less functional connectivity between medial prefrontal cortex and the amygdala (Hummer et al., 2010; Wang et al., 2009), which suggests less functional connectivity between areas of the brain associated with emotion and behavioral inhibition.

Through the application of a physiological measure of emotion, the present research adds to the previous investigations of the effects of violent video games by

demonstrating a reduction in emotional reaction to violent images after violent video game play. This study is the first to objectively examine the effects of violent video game play on emotional reactivity toward violent negative images, and in doing so has revealed an emotional consequence of violent video game exposure. Even the relatively short-term violent video game exposure in this study led to a significant decrease in negative emotional reaction to violent images. This suggests that one of the mechanisms through which violent video game exposure may increase aggression is through desensitization, or a decrease in the natural emotional reaction to violence. Although this study did not directly examine the effect of this decrease in emotional reactivity on aggression it could be hypothesized based on these findings that a decrease in emotional response to violent images could lead to less inhibition of violent behavior. If the natural aversive emotional reaction to violent images is reduced it could be hypothesized that the natural inhibition to performing acts of violence could also be reduced creating a situation in which an individual is more likely to act violently.

There are limitations to these data, which should be addressed in future research. The subjective measure of emotion, the Multiple Affect Adjective Checklist - Revised, was under-powered, with a power analysis based on the obtained effect sizes suggesting a sample size between 156 and 494. A different measure of subjective emotion might add to the understanding emotion modulated startle brings to the effects of violent video games. The inclusion of an aggression measure could have strengthened these data by correlating the decrease in emotional response with an increase in aggression. Furthermore, the use of two sets of positive and negative images could have decreased the habituation to the emotional content of the images, and allowed for a subjective rating

of the images to be compared between game play conditions. Finally, these data only address the short-term effects of violent video game playing, and further investigation is necessary to determine any relationship between the desensitization demonstrated here, and any long-term effects of playing violent video games.

Overall, the current study was designed with competing hypotheses to either support the desensitization or priming hypothesis, and the desensitization hypothesis was supported. The current data did not support the priming cognitive route as described in the GAM. It was hypothesized that the EMS would be *potentiated* post game play, through a matching of startle response to primed negative emotional reaction to the negative violent images, if the priming route were supported. As EMS was *attenuated*, there is no support in the current data for the priming hypothesis. These data do not exclude the priming route, but suggest that the desensitization hypothesis may be stronger following short term violent video game play. Given the prior research suggesting a positive relationship between violent video game play and aggression, and the exponential increase in the popularity and realism of violent video games, a clear understanding of the negative consequences of playing these games is paramount. By applying well-established psychophysiological methods to the effects of violent video games we gain more power to break down and examine the mechanisms through which violent video games affect those who play them. Further understanding the mechanisms through which this occurs also allows for more direct research into ways to mitigate this relationship. For example, the current paradigm could be used with varying lengths of time between game play and the second emotion modulated startle block to examine the duration of the emotional desensitization. The current study is the first to describe

emotional desensitization related to violent video game play, and is an important step in understanding the underlying mechanism through which violent video game play can increase aggression.

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