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Plugged in: The effects of electronic media use on attention problems, cognitive control, visual attention, and aggression

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ABSTRACT

The increasing use of electronic media increases the importance of the potential effects of those media (both positive and negative). A recent and growing body of research has focused on the potential for certain forms of electronic media, particularly television and video games, to increase attention problems and impulsiveness while decreasing self-control, executive function, proactive cognitive control, and also improving visual attention. These findings are also relevant to aggression as some of these outcomes have been associated with aggression in previous research and theory. In addition to replicating past findings relating some forms of electronic media use to greater attention problems and aggression, less proactive cognitive control, and superior visual attention, the present study produced several new findings. Watching videos on a computer, sending and receiving text messages by phone, and media multitasking are all associated with greater attention problems. Text messaging and media multitasking are also associated with lower reactive cognitive control. Both listening to music and playing music and party video games are associated with superior visual-spatial attention. Additionally, experimentally assigning participants to play an action video game for 10 sessions not only improved visual attention but also impaired proactive cognitive control, meaning positive and negative media effects can occur simultaneously.

CHAPTER 1. INTRODUCTION

An Internet search engine company has just contacted you by e-mail to express interest in buying your start-up company. The deal, if completed, would be worth over one million dollars. Surely a message this important would get your attention. Yet when Kord Campbell, a computer programmer, found himself in just that situation he did not notice the e-mail for 12 days (Richtel, 2010). This did not happen because Kord does not check his e-mail frequently. In fact, the opposite is true: Kord Campbell constantly immerses himself in technology, including e-mail, instant messaging, web browsing, video games, and a variety of other technological devices. Events such as the missed e-mail, which nearly cost him a major business deal, are not uncommon for Kord Campbell. He has forgotten about dinner plans, burned hamburgers on the grill, and forgotten to pick up his children. In the minutes before an online conference call that could determine the fate of his latest venture, he and his colleagues were desperately trying to figure out a way to share images with their potential business partners. Yet at that moment Kord found himself stopping to read an Internet news story titled “Man Found Dead Inside His Business.” The possibility that his media habits might be causing his apparent distractibility and forgetfulness, and the resulting negative consequences for both family and work, is not lost on Kord Campbell or his family.

Concern about potential negative consequences of electronic media use (i.e., films, television, video games, computers, cellular telephones, music players, and other electronic devices) is not new. Many parents and policymakers have worried about effects of screen media use on aggression, school performance, and various

cognitive abilities for decades (e.g., Kefauver, 1954; Steinfeld, 1972). Yet the stakes of the questions about negative effects have continued to grow higher as people in modernized countries use more types of electronic devices and spend more time with them (Rideout, Foehr, & Roberts, 2010; Link, 2009). Concern that the use of electronic media can result in undesirable effects may be needless worry about our changing lifestyles or a legitimate cause for concern. The truth of these two distinct possibilities constitutes an empirical question, or rather a number of related empirical questions about different forms of media and various potential negative effects. The present research is an attempt to further clarify some of the less studied aspects of electronic media effects. Of greatest interest are the effects of all forms of electronic media on the following related outcomes: executive function, cognitive control, self-control, impulsiveness, and attention problems. Also of interest is the potential for the well documented effects of electronic media on aggression to be mediated in part by these attention and control related abilities, traits, and processes. Additionally, there are some potential positive effects of electronic media use, such as electronic media effects on visual attention ability. This will also be examined in the present studies.

Trends in Electronic Media Use

Many forms of electronic media now exist, including films, television, computers, video games, cellular phones, and various music players. Trends in these forms of media have varied but overall use of electronic media has been increasing over time. Children and teens (ages 8-18) spent 10.75 hours per day using some form of electronic media in 2009, compared to 7.48 hours per day in

1999 (Rideout et , 2010).

Films

The first commercial films premiered in 1894 using Thomas Edison's Kinetoscope, making films perhaps the oldest form of electronic media (Musser, 2002). Films remain a popular form of entertainment in the US, with the domestic box office gross reaching $10.65 billion in 2009 (Boxofficemojo.com, 2010). Theater ticket sales in the US have generally increased over the past 30 years, rising from 1.02 billion in 1980 to 1.41 billion in 2009. However, this represents a more modest growth of 2.6% when adjusted for the US population growth over the same period (US Census Bureau, 2010a, 2010b). Growth based on box office trends may be an underestimate of the growth in film viewing, as a number of other ways of viewing films have grown substantially in the past thirty years: movies on television, home movie rentals/purchases, and movie viewing over the Internet. Americans increasingly prefer such methods of viewing films at home, rather than watching films in the theater (Taylor, Funk, & Craighill, 2006). Children and teens (ages 8-18) increased the total time they spent watching films from 18 minutes per day in 1999 to 25 minutes per day in 2009 (Rideout et al., 2010).

Television

Home television ownership in the US became common during the 1950s, with ownership by household growing from only 9% in 1950 to 87% in 1960 (TV Basics, 2010a). Television ownership has continued to increase more modestly since the 1950s, with ownership at 98.9% of US households as of 2009. Hours spent watching television (per household) have also grown consistently since the introduction of

Table 1. Trends over time in daily television viewing by household. Adapted from TV Basics (2010b).

Year	Daily Television Viewing	Percentage Growth over Previous Decade
1950	4 hours, 35 minutes	-
1960	5 hours, 6 minutes	11.3%
1970	5 hours, 56 minutes	16.3%
1980	6 hours, 36 minutes	11.2%
1990	6 hours, 53 minutes	4.3%
2000	7 hours, 35 minutes	10.2%
2009	8 hours, 21 minutes	10.1%*

*Because complete 2010 Nielsen data are not yet available, this calculation is based on the nine year change, rather than the 10 year intervals used for other measurements.

television (TV Basics, 2010b; see Table 1). Daily television viewing has also continued to increase per person from 1988 to 2009, growing from 3.98 hours to 4.90 hours for men (23% increase), 4.68 hours to 5.52 hours for women (18% increase), 3.30 hours to 3.43 hours for teens (4% increase), and 3.37 hours to 3.52 hours for children (4% increase).

Computers

Home computer access in the US has increased dramatically since the 1980s. In 1984, 15% of children (those under 18 years of age) had access to a computer at home (Child Trends Data Bank, 2010). In 2009, home computer access had increased to 93%. Even recently, time spent using a computer (not counting schoolwork) among youth has increased noticeably, from one hour per day in 2004 to 1.5 hours per day in 2009. Home Internet use showed similar growth among children since the 1990s, growing from 22% of children in 1997 to 84% in 2009. Internet use is also now common among adults over 50, with 63% considering

themselves “extremely” or “very” comfortable using the Internet (Koppen, 2010).

Video Games

Since the introduction of Pong in 1972, video games have also grown to be a ubiquitous form of entertainment (Alcorn, 1972). Computer and video game sales in the US have grown from $2.6 billion in 1996 to $10.5 billion in 2009 (Entertainment Software Association, 2010). As of 2008, 97% of teens (99% of boys and 94% of girls) ages 12-17 play some type of video game (Lenhart et al., 2008). The most common platform for video games among teens are video game consoles such as the Xbox, Playstation, or Wii (86% of teens), followed by computers (73% of teens), handheld gaming devices (60% of teens), and cellular phones (48% of teens). Recent data suggest that average Americans children/adolescents (ages 8-18) play video games for an average of 1.89 hours per day, with boys playing more (2.34 hours per day) than girls (1.31 hours per week; Gentile, 2009). Another study found that between 1999 and 2009, the average time 8-18 year olds spent playing video games increased from 0.43 hours per day to 1.22 hours per day (Rideout, Foehr, & Roberts, 2010). Many video game players are also adults, with 29% of adults over age 50 playing video games in 2011, up from 9% in 1999 (Entertainment Software Association, 2012).

Cellular Phones

Though the first mobile phone was invented in 1973, cellular phones did not gain widespread use until the 1990s and 2000s (Teixeira, 2010). In 1990, only 12 million people worldwide owned cellular phones (Worldmapper, 2010). By 2009, that number had risen to an estimated 4.6 billion (Heeks, 2008). In the US, 91% of the

total population owned cellular phones by 2009 (CTIA, 2010). Smartphones, a type of cellular phone capable of running a variety of applications and browsing the Internet, are also experiencing rapid growth with 21% of American cellphone subscribers using smartphones in 2009 (Privat, 2010). The market research firm Nielsen projects that smartphones will make up over half of all cellular phones in the US by the end of 2011. Children and adolescents ages 8-18 spend more time using their cellular phone to listen to music, play games, or watch television (49 minutes per day) than they do for talking (33 minutes per day; Rideout et al., 2010).

Music

Music is another popular form of electronic media, with American 8-18 year olds listening to music for 2.52 hours per day in 2009, up from 1.80 hours per day in 1999 (Rideout et al., 2010). In addition to using cellular phones, computers, and radios as music players, 76% of children and teens in this age range now own an mp3 player (compared to 18% owning an mp3 player five years ago). Though some of the time spent with mp3 players seems to have displaced time previously spent with CD players, it appears the newer forms of music players are also associated with more overall time listening to music. In 2004, 49 minutes per day were spent with CD players and MP3 players combined. In 2009, 41 minutes per day were spent with mp3 players, 17 minutes listening with CD players, and 17 minutes listening with cellular phones. Adults 18 and older also spent considerable time listening to music (2.75 hours per day; Link, 2009). More than 90% of American adults listened to music on an average day.

Media Multitasking

The considerable time spent with various forms of electronic media includes some time spent with more than one type of electronic media at a time, or media multitasking. In 2009, children and teens (ages 8-18) multitasked 29% of the time that they were using some form of media, compared to 16% of the time in 1999. This represents both a larger proportion of the time spent using media (16% to 29%) and an even larger increase in the absolute amount of multitasking (1.20 hours per day to 3.12 hours per day), due to the simultaneous increase in the overall time spent with electronic media (7.48 hours per day to 10.75 hours per day). Children and teens multitasked at similar rates for listening to music (43% of the time), using a computer (40% of the time) and watching television (39% of the time). Among adults (ages 18 and older), multitasking (in this case not necessarily combining two types of media, simply media and some other activity) was most common for listening to the radio (90% of the time), followed by using the Internet (46% of the time), and watching television (36% of the time; Link, 2009).

CHAPTER 2. LITERATURE REVIEW

Aggression Theory and Research Evidence

Aggression theories and violent media exposure

Among the potential negative effects of electronic media, the effects of violent electronic media on aggression has been researched the most. Most of this research has examined violent television, film, and video game effects, though there have also been some studies of violent music effects on aggression. Several theories have been applied to the prediction and explanation of media violence effects on aggression.

Social learning theory predicts that exposure to aggressive or violent behavior, whether in person or in the form of some type of electronic media, teaches a person to behave aggressively (Bandura, 1973, 1983). This is particularly true if the aggressive behavior is seen to be rewarded. According to social learning theory, one can learn a variety of different aggression related outcomes from violent media, such as when aggression is appropriate, aggression related beliefs and attitudes, as well as how to engage in specific forms of aggressive behavior.

Another theory that has contributed predictions about violent media effects on aggression is cognitive-neoassociation theory (Berkowitz, 1989, 1993). According to cognitive-neoassociation theory, stimuli present in aversive situations (even initially neutral stimuli) can become associated with aggressive feelings and thoughts. These stimuli are then capable of acting as cues for aggressive thoughts. This explains some of the violent media findings involving priming, as stimuli present in violent media can subsequently serve as cues for aggressive ideas.

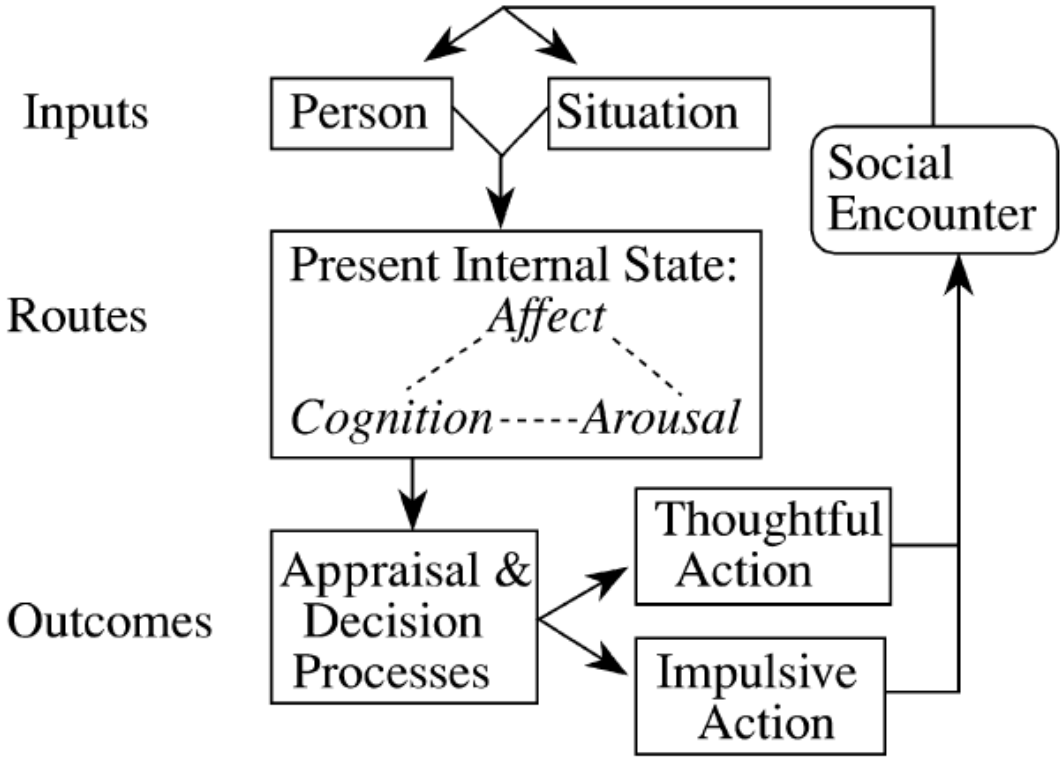
According to script theory, people develop highly associated concepts that guide subsequent behavior and social perceptions (Huesmann, 1998; Huesmann & Eron, 1986). When one part of a script is activated, the rest of the script is activated as well. In the context of violent media effects, script theory predicts that exposure to violent media should influence both the content of aggressive scripts and their accessibility, making it more likely that the individual will behave aggressively.

Excitation transfer theory predicts that when a person experiences arousal and is angered in a subsequent situation (before the arousal can dissipate) the arousal becomes misattributed to the source of the anger (Zillmann, 1983). As violent video games can increase arousal (heart rate, blood pressure), excitation transfer theory predicts that this will increase subsequent aggressive behavior when angered.

Though these theories are each useful for predicting and explaining a number of the findings in the violent media literature, they each have the limitation that they do not generate predictions or explanations about some of the other violent media findings. The General Aggression Model (GAM) was created to integrate the mechanisms from these and other specific theories of aggression in order to predict and explain a broader range of aggression effects (including, but not limited to, media violence findings) than each of these more specific aggression theories do individually (Anderson & Bushman, 2002a, DeWall, Anderson, & Bushman, 2011).

GAM includes both a model that describes the short term processes involved in each episode of aggressive behavior (see Figure 1) as well as the long term processes by which aggression related knowledge structures (i.e., aggressive

Figure 1. The general aggression model episodic processes. From Anderson and Bushman (2002a).



personality) develops over time (see Figure 3; Anderson & Bushman, 2002a). According to GAM, each individual brings a variety of relatively stable characteristics with them to any given aggression episode. These person inputs include innate characteristics such as sex or a genetic predisposition to aggression, as well as personality characteristics, long term goals, beliefs, attitudes, values, scripts, perceptual schemata, and expectation schemata that have the potential to influence aggression. These inputs combine with characteristics of the immediate situation to determine that individual's present internal state. Some situations increase the probability of aggression occurring, such as provocation, frustration, pain, and

discomfort.

The present internal state resulting from the combination of person and situational inputs consists of three interrelated parts: affect, cognition, and arousal (Anderson & Bushman, 2002a). In some episodes, aggression occurs primarily through a single route. For example, pain usually leads to aggression through the affective route, by increasing anger and state hostility (Berkowitz, 1993; K. B. Anderson, Anderson, Dill, & Deuser, 1998). In other cases, multiple routes may be involved. These three internal states are interrelated, such that they are influenced not only by the person and situational inputs, but also by the other internal state components.

An individual's present internal state may lead to an aggressive behavior, depending on the result of the appraisal and decision processes that occur (see

Figure 2. The general aggression model: expanded appraisal and decision processes. From Anderson and Bushman (2002a).

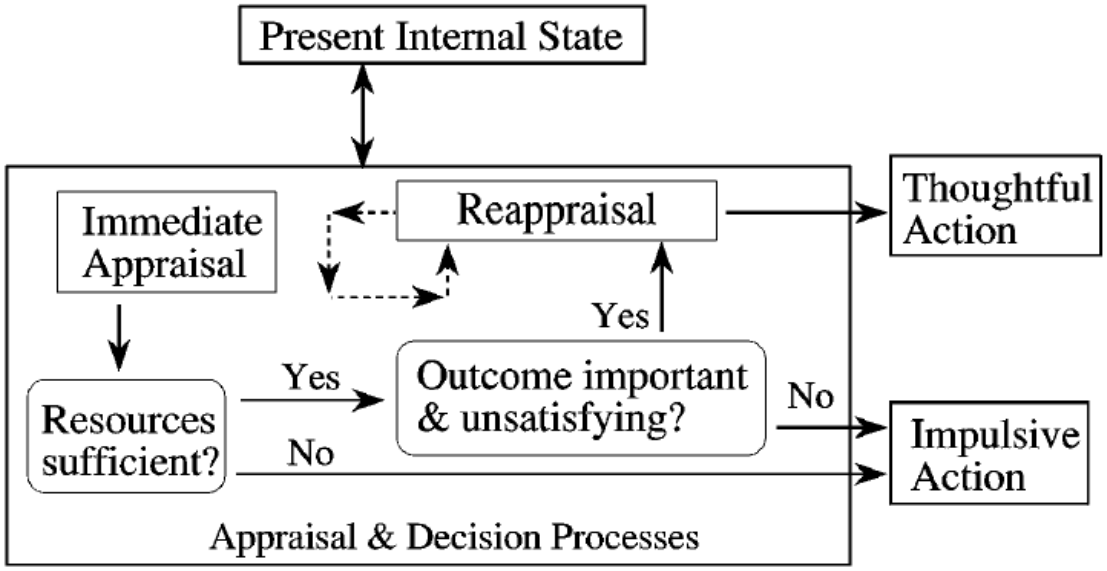
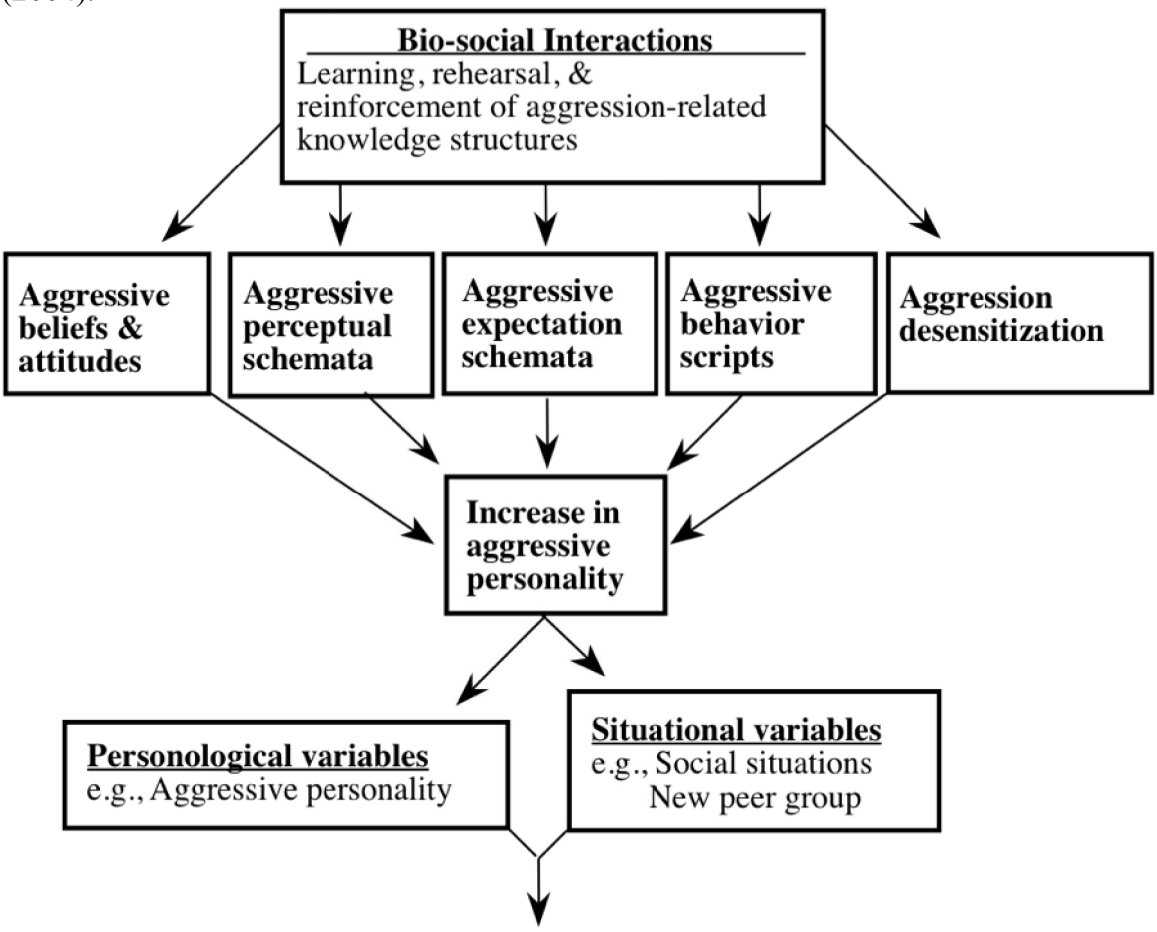


Figure 2; Anderson & Bushman, 2002a). An initial appraisal of the current situation occurs relatively automatically and effortlessly. Based on this initial appraisal, the individual might engage in an impulsive behavior. However, if they find the initial appraisal dissatisfying and have sufficient time and cognitive capacity they might reappraise the situation and engage in a more thoughtful behavior. An impulsive behavior is not necessarily the more aggressive response in every situation. However, because aggressive behavior generally has negative long term legal consequences, to the extent that impulsive behaviors are insensitive to long term consequences they should be more likely to be aggressive than thoughtful behaviors. This appraisal and decision making portion of GAM is particularly relevant to the present study, as many of the traits of greatest interest (attention problems, self-control, impulsiveness, executive function, and cognitive control) are associated with impulsive behavior and thus might influence aggression through the appraisal and decision making processes. The resulting thoughtful or impulsive behavior influences the current social encounter. If the behavior is aggressive, this episode may then influence the person and situational inputs of subsequent situations in ways that make aggression more likely to occur again.

The long term process model of GAM (Figure 3) describes how repeated short term episodes that lead to aggression can lead to lasting changes in aggression related knowledge structures (Anderson & Bushman, 2002a). Aggression related knowledge structures include aggressive beliefs, aggressive attitudes, aggressive perceptual schemata, aggressive expectation schemata, aggressive behavioral scripts, and desensitization to aggression. Together, these

Figure 3. The general aggression model personality processes. From Anderson and Carnagey, (2004).



knowledge structures constitute aggressive personality. Thus, repeated episodes of aggression can lead to the development of an aggressive personality over time. This change in personality can influence not only the person inputs but also the situational inputs of future episodes. For example, the individual might be more likely to associate with other aggressive individuals because less aggressive people tend to reject them as a consequence of their aggression.

Though non-violent media might be predicted to increase aggression

according to these aggression theories (e.g., by increasing arousal or inducing frustration), violent media is associated with some of the mechanisms in ways that non-violent media is not. For example, the development of aggressive behavioral scripts, positive beliefs about aggression, and desensitization to violence would all be expected to result from media with violent content but not media without violent content.

Empirical evidence of violent media effects on aggression

Many empirical studies have examined the effects of violent media on aggression. These include cross-sectional, experimental, and longitudinal studies. Meta-analyses have supported theoretical predictions of media violence effects on aggression. Paik and Comstock (1994) found that television violence was associated with aggression. This was particularly true for less serious forms of aggression (r = 0.38) though television violence was also significantly associated with criminal forms of violence (r = 0.13). Another meta-analysis of television, film, and video game violence found that all three forms of media violence were associated with greater aggression based on cross-sectional and longitudinal studies as well as laboratory and field experiments (Anderson & Bushman, 2002b). A recent meta-analysis found that violent video games increased aggressive behavior, aggressive cognition, aggressive affect, and arousal, decreased prosocial behavior, and caused desensitization to violence/decreased empathy (Anderson et al., 2010). These findings were true both in Western countries (e.g., the US) as well as Eastern countries (e.g., Japan).

Attention Problems and Control Processes and Traits

Definitions of attention problems and control processes and traits

Attention problems and the various control processes and traits discussed here are, at least in some cases, conceptually and empirically related even to the point of representing partially overlapping constructs. There are some important distinctions to be made between the definitions of these concepts but the research on these abilities and processes is examined at present because changes in these variables may represent a single effect, or at least a set of related effects, in the context of electronic media exposure.

Executive function. Executive function (or "executive control" or "executive attention") refers to a set of cognitive abilities, that regulate and control other abilities. Executive functions include inhibiting, restraining, or delaying responses, setting goals, planning, organizing, selectively attending, and maintaining and shifting sets (Singer & Bashir, 1999). Executive function is often assessed through tasks that require inhibiting some type of response, such as the Stroop task (Stroop, 1935). The Stroop task requires participants to identify the color of ink or font used for a particular word (e.g., red) while ignoring the meaning of the word (e.g., "green"). Because word meaning is processed faster than color, naming the color results in interference when color and word meaning are different. This interference results in slower reaction times, and is known as the Stroop interference effect.

Cognitive Control. According to the dual mechanisms of cognitive control theory (DMC), cognitive control over working memory operates via two distinct modes: proactive control and reactive control (Braver, Gray, & Burgess, 2007). Together, these types of cognitive control are responsible for selecting, maintaining,

and updating information in working memory as well as protecting that information from interference and using the information in working memory. Proactive control involves the activating and sustaining goal relevant information before the imperative stimulus. Proactive control occurs primarily in the lateral prefrontal cortex (PFC) and midbrain dopamine system. Reactive control, on the other hand, becomes active only after the imperative stimulus appears, functioning more as a late correction (as opposed to early selection). The context information in reactive control decays rapidly so that the information must be reactivated each time it is used (rather than remaining active). Reactive control is based in anterior cingulate cortex (ACC), lateral PFC (transient activation, unlike proactive control), and the medial temporal lobe (MTL). Proactive and reactive cognitive control can be measured through performance tasks, such as the AX-Continuous Performance task, Flanker task, or Stroop task. In these tasks, contextual cues must be actively maintained over a retention interval to bias later responses (demonstrating proactive cognitive control). However, one can also measure responding to immediate context information (i.e., last second adjustments) in these tasks, providing a measure of reactive cognitive control.

Self-control. Self-control is defined as altering oneself to meet the needs of the environment (Tangney, Baumeister, & Boone, 2004). Self-control is used by many researchers interchangeably with the concept of self-regulation, though some researchers use self-regulation to refer more broadly to goal-directed behavior (conscious or non-conscious) and use the term self-control only when describing conscious impulse control (Baumeister & Vohs, 2004). In this dissertation, both self-

control and self-regulation will refer to the same abilities and processes. Self-control, using this broad definition, involves exerting conscious or non-conscious control over ones' thoughts, feelings, or behaviors.

The ability to self-regulate varies for an individual from one point in time to another (Baumeister & Vohs, 2004). According to the strength model of self-control, self-regulatory ability acts like a resource that is depleted when used and returns over time, particularly after sleeping (Baumeister, Vohs, & Tice, 2007). This effect is called self-regulatory depletion or ego depletion. For example, participants who were forced to suppress a forbidden thought (relying on self-regulation) subsequently drank more alcohol (demonstrating less remaining self-regulatory strength) than participants who had simply solved math problems (Muraven, Collins, & Nienhaus, 2002). The level of glucose in the blood seems to be a physiological mechanism for this depleting self-regulatory strength (Gailliot et al., 2007).

Beyond these situational differences in the ability to self-regulate, there are also stable individual differences in self-control (Tangney et al., 2004). Trait differences in self-control appear to be important to a wide variety of consequences. Those with greater self-control tend to have better academic performance, psychological adjustment, perspective taking, and interpersonal relationships. Self-control is also associated with the ability to regulate anger in early childhood (Kochanska, Murray, & Harlan, 2000). Trait self-control can be assessed through self-report questionnaires, such as the Brief Self-Control Scale (BSCS; Tangney et al., 2004).

Impulsiveness. Impulsiveness (or “impulsivity”) is a personality trait

characterized by a lack of planning, sensation seeking, making up one's mind quickly, failure to persevere in difficult or boring tasks, and lack of forethought about the consequences of ones' actions (Whiteside & Lynam, 2001). Impulsiveness is associated with a number of behavior problems including pathological gambling and borderline personality disorder diagnosis (Whiteside, Lynam, Miller, & Reynolds, 2005). Impulsiveness is generally assessed with a self-report questionnaire, such as the Barratt Impulsiveness Scale-11 or the Impulsive Behavior Scale (Patton, Stanford, & Barratt, 1995; Whiteside & Lynam, 2001).

Attention problems. “Attention problems” is a term used to describe problems consistent with those characteristic of individuals diagnosed with attention disorders such as Attention Deficit Disorder (ADD) or Attention-Deficit/Hyperactivity Disorder (ADHD). Specifically, attention problems include inattentiveness, hyperactivity, and impulsiveness. Some authors (e.g., Barkley, 1997) have argued that poor impulse control is the defining characteristic of attention disorders, thus there is a clear theoretical association between attention problems or ADHD and constructs such as self-control and impulsiveness.

Measures of attention problems have at least two advantages over measuring clinical diagnoses of an attention disorder. Assessing attention problems (e.g., via questionnaire) is often more practical than obtaining clinical diagnoses for all participants in a study. Further, because questionnaire results (unlike diagnoses) are continuous measures, they typically have greater sensitivity to individual differences and changes over time. The Adult ADHD Self-Report Scale (ASRS) is an example of a measure of attention problems (Kessler et al., 2005). This scale was designed as a

clinical tool for screening adults for ADHD.

Visual attention. Another relevant, though more distinct, type of cognitive processing is visual attention. This includes abilities with respect to temporal and spatial aspects of visual attention (Green & Bavelier, 2003). Visual temporal processing includes such abilities as the number of targets that can be processed in a short period of time (enumeration task). Visual spatial processing includes the ability to process stimuli presented at varying degrees outside the point of fixation (useful field-of-view task).

Visual attention is only of secondary interest in the present research, however it is worth describing because research on video game effects on visual attention may seem to contradict the results of research on certain harmful effects of electronic media. In reality, the abilities addressed in these different areas of research are quite distinct, so it should not be surprising that a particular activity, such as video game playing, could have beneficial effects in one area and harmful effects in another (Anderson, Gentile, & Dill, 2012).

Specifically, whereas visual attention involves the ability to rapidly process multiple pieces of information (shifting focus between targets) or process information across a large spatial area, it does not involve biasing responses either before or after a trial is presented (as proactive and reactive cognitive control would) or any other form of goal oriented processing (as opposed to many types of executive function). Though both visual attention and attention problems research use the word “attention” the word could be defined in the context of visual attention research as the selection of information for further processing. In the context of attention

disorders, “attention” refers to the ability to sustain processing or behavior, particularly in difficult, effortful, goal-oriented contexts. As stated earlier, attention problems and attention disorders are primarily associated with poor impulse control rather than the speed or range of information selection (Barkley, 1997).

Attention problems and control processes as predictors of aggression

A variety of cognitive abilities and processes have been empirically associated with aggression. In some cases, the research focused on clinical psychological constructs such as conduct disorder, conduct problems, antisocial personality disorder, or psychopathy, rather than aggression per se (e.g., Seguin, Boulerice, Harden, Tremblay, & Pihl, 1999). Nonetheless, each of these constructs includes aggression as a prominent feature so this research provides valuable insights for research on aggression.

Executive function and aggression. A study found that boys diagnosed with Disruptive Behavior Disorder with aggressive symptoms had lower executive function, as measured by a counting Stroop task, than control boys (Mathews et al., 2005). A meta-analysis found that poorer executive function was associated with antisocial behavior diagnosis (i.e., conduct disorder, antisocial personality disorder, psychopathy; Morgan & Lilienfield, 2000). Individuals with an antisocial behavior diagnosis were 0.62 standard deviations lower in executive function than comparison participants.

Cognitive control and aggression. Though the dual mechanisms of cognitive control theory is relatively new, there is a small amount of evidence linking cognitive control with aggression or related measures. One study found that incarcerated male

adolescents and young adults were lower in proactive control (as assessed by the AX-CPT) than matched control participants (Iselin & DeCoster, 2009). Another study of university students found a small negative association between proactive control, as measured by a flanker task, and trait physical aggression, $r(185) = -0.15$, $p < 0.05$ (Swing, 2008, unpublished raw data).

Self-control and aggression. A number of studies have associated low self-control with aggression. Children with lower self-control had more conflicts with others and were more likely to react with hostility in response to anger in a role playing situation (Murphy & Eisenberg, 1997). People with lower self-control responded to situations designed to evoke anger with greater aggression (Tangney et al., 2004). The depletion of self-regulatory strength has also been linked with aggression. Participants whose self-regulatory strength was taxed were more aggressive when provoked (DeWall, Baumeister, Stillman, & Gailliot, 2007). People were also more aggressive towards intimate partners when self-regulatory strength was depleted (Finkel, DeWall, Slotter, Oaten, & Foshee, 2009). Those who had lower trait levels of self-control were also more aggressive towards their partners.

Impulsiveness and aggression. Impulsiveness has also been found to be related to aggression (Miller, Flory, Lynam, & Leukefeld, 2003). Negative urgency, the tendency to behave impulsively when experiencing negative emotions, showed the most robust relationship with aggression of the impulsiveness subtypes measured. Another study found that higher levels of trait impulsiveness was associated with a greater likelihood of choosing aggressive responses to interpersonal vignettes and making more hostile attributions (Lynam & Miller, 2004).

Attention problems and aggression. A number of studies have found ADHD diagnosis to be related to some form of aggression. A study of 6- to 12-year-old girls found that ADHD diagnosis was associated with higher levels of physical, verbal, and relational aggression (Zalecki & Hinshaw, 2004). The girls diagnosed as ADHD-combined were higher in aggression than those diagnosed as ADHD-inattentive, who in turn were more aggressive than non-diagnosed girls. Another longitudinal study found that both poor working memory and ADHD diagnosis were related to greater aggression (Seguin et al., 1999). A meta-analysis examining the co-occurrence of hyperactivity, impulsivity, and attention problems (HIA) found that HIA symptoms were associated with greater conduct problems, which include aggressive behaviors (Waschbusch, 2002).

Media effects on attention problems and control processes/abilities

A small but growing body of research has examined the possibility that exposure to electronic media can influence attention problems and various other control processes and abilities. The limited amount of work done on these topics so far is suggestive of negative effects on these abilities (see Table 2).

Media effects on executive function. A few studies have examined a possible link between exposure to media (specifically violent video games) and decreased executive function. One study found that participants who frequently played violent video games performed more poorly on a counting Stroop task than those who did not play violent video games (Mathews et al., 2005). Another study assigned participants to play either a violent or nonviolent video game and then complete an emotional Stroop task (Kirsh, Olczak, & Mounts, 2005). Participants who had played

Table 2. Electronic media effects on attention and control related outcomes.

Study	Design	Age	Media Type	Outcome	Sig
Kirsh, Olczak, & Mounts (2005)	Exp	Adult	VVGs	Exec. Func.	-
Mathews et al. (2005)	Corr	Adult	VVGs	Exec. Func.	-
Barr et al. (2010)	Corr	Child	TV	Exec. Func.	-
Beck (2010)	Corr	Child	TV	Exec. Func.	-
Lillard & Peterson (2011)	Exp	Child	TV	Exec. Func.	-
Swing (2008) unpublished data	Corr	Adult	FPS VGs	Cog. Control	-
Ophir, Nass, & Wagner (2009)	Corr	Adult	MT	Cog. Control	-
Bailey, West, & Anderson (2010)	Corr	Adult	VVGs	Cog. Control	-
Levine & Waite (2000)	Corr	Child	TV	Attention	+
Ozmert et al. (2002)	Corr	Child	TV	Attention	+
Christakis et al. (2004)	Long	Child	TV	Attention	+
Obel et al. (2004)	Long	Child	TV	Attention	X
Miller et al. (2006)	Corr	Child	TV	Attention	+
Stevens & Mulsow (2006)	Corr	Child	TV	Attention	X
Chan & Rabinowitz (2006)	Corr	Child	VGs	Attention	+
Acevedo-Polakovich et al. (2007)	Corr	Child	TV	Attention	+
Johnson et al. (2007)	Long	Adult	TV	Attention	+
Landhuis et al. (2007)	Long	Child	TV	Attention	+
Mistry et al. (2007)	Long	Child	TV	Attention	+
Zimmermann & Christakis (2007)	Long	Child	TV	Attention	+
Bioulac, Arfi, & Bouvard (2008)	Corr	Child	VGs	Attention	+
Hastings et al. (2009)	Corr	Child	VVGs	Attention	+
Swing et al. (2010) Study 1	Long	Child	TV, VGs	Attention	+
Swing et al. (2010) Study 2	Corr	Adult	TV, VGs	Attention	+
Tahiroglu et al. (2010)	Corr	Child	VGs	Attention	+
Ferguson (2011)	Corr	Adult	TV, VGs	Attention	+*
Gentile, Swing, Lim, & Khoo (2012)	Long	Child	VGs	Attention	+
Swing & Anderson (under review)	Corr	Adult	TMV	Attention	+

VVGs: Violent Video Games, VGs: Video games, FPS: First-Person Shooter, Sig: Significant effect on one or more outcome variable, +/- indicates the direction of the effect (X = null),
*Significant based on bivariate correlations.

a violent video game experienced greater interference from negatively valenced words (e.g., rage, murder) when trying to indicate the color of the font than those who had played the nonviolent video game.

Media effects on cognitive control. Relatively few studies have examined the effects of electronic media exposure on cognitive control. One study of male university students found that habitual action video game players had lower proactive cognitive control, as measured by a color Stroop task (Bailey, West, & Anderson, 2010). Similarly, a study of university students found that playing first-person shooter video games was associated with lower proactive cognitive control, $r(185) = -0.22$, $p < .01$ (Swing, 2008, unpublished raw data). This negative association between playing first person shooter video games and proactive control remained even when sex and other video game playing were statistically controlled, *partial* $r(173) = -0.20$, $p < 0.05$. Another study found that heavy media multitaskers were slower in responding in an AX-CPT when distractors were included and showed a greater false alarm rate for previously occurring letters in a three-back task compared with light media multitaskers (Ophir, Nass, & Wagner, 2009).

Media effects on attention problems, self-control, and impulsiveness. More studies have been conducted on the effects of electronic media on attention problems than other control variables but most of this research is still relatively recent and limited in target scope (most examining only television viewing) and methodology (most cross-sectional and longitudinal studies).

Several cross-sectional studies have examined the association between television viewing and attention problems. In one study, fourth and fifth grade

students completed a one week television diary (Levine & Waite, 2000). Time spent watching television was associated with lower teacher reported ability to pay attention in the classroom, but not parent ratings or Stroop task performance. A study of second and third grade students found television viewing to be associated with more attention problems, based on the Childhood Behavior Checklist (Achenbach, 1992; Ozmert, Toyran, & Yurdakok, 2002). Another study found that television viewing among preschool children was associated with teacher reports of inattentive and hyperactive behavior as well as behavioral measures of hyperactivity (Miller et al., 2006). A study of 4- to 9-year-old children found that those diagnosed with ADHD watched more television than controls who did not meet the criteria for ADHD diagnosis (Acevedo-Polakovich, Lorch, & Milich, 2007). Another cross-sectional study of kindergarten age children did not find television viewing to be related to attention problems (Stevens & Mulsow, 2006).

Several longitudinal studies of television viewing and attention problems have been published. One found that television viewing in the first three years of life predicted attention problems at ages 6-8 (Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004). Another longitudinal study found that television viewing at age 2-3 predicted attention problems, based on the Childhood Behavior Checklist, at age 5-6 (Mistry, Minkovitz, Strobino, & Borzekowski, 2007). Zimmerman and Christakis (2007) found that viewing entertainment television (but not educational television) in early childhood was associated with subsequent attention problems. One longitudinal study found that television viewing in childhood (ages 5-11) was associated with attention problems in adolescence (ages 13-15) based on self,

parent, and teacher reports (Landhuis, Poulton, Welch, & Handcox, 2007). This link remained significant even when sex and earlier attention problems were statistically controlled. Johnson, Cohen, Kasen, and Brook (2007) found that television viewing at ages 14-16 predicted greater attention problems and lower educational achievement at age 22 even when earlier cognitive difficulties and family characteristics were statistically controlled. A longitudinal study of a Danish sample of children did not find an association between television viewing and attention problems (Obel et al., 2004).

Considerably fewer studies of video game exposure and attention problems have been published. One cross-sectional study found that time spent playing console and Internet video games was associated with greater self-reported inattention and ADHD symptoms (Chan & Rabinowitz, 2006). A small scale cross-sectional study found that children with ADHD were higher in problem video game playing, though not significantly higher in total video game playing, compared to controls (Bioulac, Arfi, & Bouvard, 2008). Another study found that children who play video games regularly showed a bigger decline in Stroop task performance after playing a racing video game than those who do not play video games (Tahiroglu et al., 2010). A cross-sectional study of university students found television viewing and video game playing to be associated with greater attention problems, impulsiveness, and lower self-control (Swing, Gentile, Anderson, & Walsh, 2010). Swing et al. also examined a longitudinal sample of third, fourth, and fifth grade children and found television viewing and video game playing to be associated with later teacher reported attention problems, even when sex and earlier attention problems were

statistically controlled.

Media effects on visual attention. Several cross-sectional and experimental studies have found that playing action video games is associated with improved performance on visual attention tasks (see Table 3). Action video game players outperformed non-action video game players on visual attention as measured by the

Table 3. Electronic media effects on visual attention outcomes.

Study	**Design**	**Age**	**Media Type**	**Outcome**	**Sig**
Green & Bavelier (2003)	Corr/Exp	Adult	Action VGs	Visual Att.	+
Castel et al. (2005)	Corr	Adult	VG Playing	Visual Att.	X
Green & Bavelier (2006a,b)	Exp	Adult	Action VGs	Visual Att.	+
Feng, Spence, & Pratt (2007)	Exp	Adult	Action VGs	Visual Att.	+
Green & Bavelier (2007)	Exp	Adult	Action VGs	Visual Att.	+
Basak et al. (2008)	Exp	Adult	RTS VGs	Visual Att.	X
Boot et al. (2008)	Exp	Adult	Action VGs	Visual Att.	X
G. L. West et al. (2008)	Corr	Adult	Action VGs	Visual Att.	+
Dye, Green, & Bavelier (2009)	Exp	Adult	Action VGs	Visual Att.	+
Li et al. (2009)	Exp	Adult	Action VGs	Visual Att.	+
Murphy & Spencer (2009)	Corr	Adult	Action VGs	Visual Att.	X
Bailey (2010) unpublished data	Corr	Adult	Action VGs	Visual Att.	X
Chisolm et al. (2010)	Corr	Adult	VG Playing	Visual Att.	+
Donohue et al. (2010)	Corr	Adult	VG Playing	Vis/Aud Att	+
Durlach et al. (2010)	Corr	Adult	Action VGs	Visual Att.	+
Dye & Bavalier (2010)	Corr	Child/Adult	Action VGs	Visual Att.	+
Green et al. (2010)	Corr/Exp	Adult	Action VGs	Visual Att.	+
Lorant-Royer et al. (2010)	Exp	Child	Other VGs	Visual Att.	X
Irons et al. (2011)	Corr	Adult	Action VGs	Visual Att.	X

VGs: Video games, RTS: Real-Time Strategy, Other: Cognitive training/platform, Vis/Aud Att: Visual and auditory attention, Significant effect on one or more outcome variable, +/- indicates the direction of the effect (X = null)

flanker task, enumeration task, useful field-of-view task, and an attentional blink task (Green & Bavelier, 2003). Randomly assigning participants to play either Medal of Honor (an action video game) or Tetris (a non-action video game) for 10 hours over a 10 day period resulted in improvements in performance on the same visual attention tasks for the action video game condition but not the non-action video game condition. A follow up study revealed that the improvements in the enumeration task were due to faster serial counting of targets rather than immediately perceiving more targets (Green & Bavelier, 2006a). Another experimental study found that those assigned to play an action video game for 10 hours showed greater improvements on several visual attention tasks than participants assigned to a non-action video game (Feng, Spence, & Pratt, 2007).

Theoretical Explanations of Media Effects on Attention and Control Variables

There are as yet few theoretical explanations for potential media effects on attention problems or related variables. At a neural level, Christakis et al. (2004) suggest that television viewing in early childhood could result in excessive synaptic pruning (the process by which unused neural synapses are removed in early childhood), leading to subsequent attention problems. Four potential hypotheses have been suggested regarding the link between media exposure and attention problems (Gentile, Swing, Lim, & Khoo, 2012). The **excitement hypothesis** suggests that electronic media exposure might relate to attention problems because the fast pacing, rapid changes in focus, high excitement, and naturally attention grabbing cues (e.g., violence) found in many types of electronic media make paying attention in less stimulating contexts (e.g., a classroom) more difficult. The

displacement hypothesis suggests that time spent with media may simply displace time that might otherwise be spent on activities that lead to the development of self-control (e.g., every hour of video game playing is an hour not spent reading, exercising, or doing homework). Note that in this context, displacement simply means time spent on one activity taking up time that could have been or would have been spent on some other activity. Both of these explanations seem consistent with the strength model of self-control (Baumeister et al., 2007). According to this model, self-regulatory ability functions like a muscle in the sense that regularly using it leads to greater self-regulatory strength. To the extent that certain forms of electronic media rely on stimulus-driven attention and utilize very little self-controlled attention they might directly cause decreased self-control or displace time that could be spent on activities that would have improved self-control. The **attraction hypothesis** would mean that those with attention problems would tend to be more attracted to more exciting media and thus use them more frequently. These three hypotheses need not be mutually exclusive. For example, it is possible that media exposure increases attention problems (via excitement or time displacement) but that those with attention problems are also more attracted to certain forms of media (attraction). Only the excitement and displacement hypotheses would indicate causal effects of media exposure on attention problems, however.

Finally, the **third variable hypothesis** suggests that some other variable, such as sex, is correlated with both media exposure and attention problems and is in fact the true cause of higher attention problems among high media consumers (Gentile et al., 2012). Thus far, several third variables, including sex, age, race, and

socioeconomic status (SES), have been ruled out as third variable explanations. Many other potential third variables (e.g., genetic predisposition) have been largely ruled out by longitudinal designs that control for initial attention problems (e.g., Swing et al., 2010). Though there is little support for any individual third variable, more research controlling for additional third variables would be useful.

If electronic media exposure increases attention problems or negatively influences other control processes or abilities, it is not yet clear which types of media can have such an effect and which types are better or worse than others. Cross-sectional and longitudinal effects have been observed for television and video games, but there has been relatively little examination of content based differences. Zimmerman and Christakis (2007) found entertainment television (but not educational television) to be related to later attention problems. The effect was larger for violent television than non-violent entertainment television, but not significantly so. Some other studies (e.g., Bailey et al., 2010; Swing, 2008, unpublished raw data; Swing & Anderson, under review), have found evidence that action video games, first person shooter video games, or violent media (TV, films, and video games) are particularly associated with attention problems and/or lower proactive control. Another study found some evidence that both total hours of video game playing and violent video game playing are related to attention problems, but total hours was the more robust predictor – supporting the displacement hypothesis (Gentile et al., 2012). The most violent and fast paced video games are also the same ones used in most visual attention experimental studies. It seems plausible that the observed higher attention problems, lower proactive cognitive control, and improved visual

attention represent a single effect. Action video games might lead to a shift away from proactive, goal directed attention to more vigilant, rapid, stimulus-driven attention.

Current Studies: Purposes and Hypotheses

The current studies are intended to address several substantial gaps in the research literature on electronic media effects on attention. First, there is a need for research examining the associations of more types of electronic media in relation to attention problems and control processes/abilities. **Hypothesis 1a, 1b, & 1c:** In addition to replicating past findings of television, film, and video game effects on attention problems and related abilities even when third variables are statistically controlled (1a), similar effects will be found for other types of electronic media such as computers, music players, and cellular phones (1b). Further, it is predicted that media multitasking will be associated with more attention and control problems beyond the overall time spent with electronic media (1c).

A second need to be addressed by the present studies is the lack of information about the associations with certain types of electronic media and attention and control related outcomes. **Hypotheses 2a and 2b:** It is expected that electronic media that is violent (2a) and fast paced (2b) will be more strongly related to these outcomes compared to non-violent, slower paced media. **Hypothesis 2c:** Specifically, with respect to video games it is predicted that first person shooter video games are most strongly associated with attention problems and negative control process/ability outcomes (2c). Evidence for specificity of the electronic media

effects on attention and control related outcomes would support the excitement hypothesis. Evidence that total hours of electronic media use, but not content, drive these effects would support the displacement hypothesis.

A third need to be addressed by the current study is to clarify the association between the improvements to visual attention associated with action video game playing and the negative effects on attention problems, executive function, cognitive control, impulsiveness, and self-control identified in previous research. **Hypothesis 3a:** Because previous research has found that the same stimuli (violent, action video games) improve visual attention but are negatively associated with cognitive control and attention problems, it is predicted that visual attention will be negatively related to attention problems and related control processes/abilities, which will be positively associated with each other. **Hypothesis 3b:** Types of electronic media that are positively associated with visual attention (e.g., action video games) will be negatively associated with attention problems and related control processes/abilities.

A fourth need to be addressed by the current studies is the need for experimental evidence of electronic media effects on attention problems. This is particularly important for establishing the causality of the media-attention associations observed in previous cross-sectional and longitudinal studies. To date, there are two experimental studies (Lillard & Peterson, 2011; Tahiroglu et al., 2010) showing immediate effects of electronic media on executive function, but none showing effects of repeated exposure or effects beyond the immediate context have been published. **Hypothesis 4:** It is predicted that randomly assigning participants to play a first person shooter video game will result poorer performance on control and

attention related performance tasks.

A fifth need to be addressed by the present study is experimental evidence that the hypothesized video game effect on attention and control outcomes mediates the violent video game effect on aggression. Previous research has established the associations between video games and attention problems and control processes/abilities, violent video games and aggression, and attention problems, control processes/abilities and aggression (Swing & Anderson, under review). **Hypothesis 5:** It is predicted that changes in attention and control processes/abilities will partially mediate violent video game effects on aggression.

CHAPTER 3. CORRELATIONAL STUDY METHOD

Participants

Participants were 235 undergraduate students from a large Midwestern research university. This sample provided sufficient power (greater than 0.80) to detect medium and large effects. Participants were recruited from the research pool in introductory psychology and communications classes using the online sign-up system. Participants included 128 females and 107 males. The mean age of these participants was 19.51 (*SD* = 2.16).

Materials

Media habits questionnaire. Participants reported a number of aspects of their media habits using items similar to those used in previous studies (e.g., Anderson, Gentile, & Buckley, 2007; Gentile, Lynch, Linder, & Walsh, 2004; see Appendix A). They reported their three favorite television shows, films, and video games, including items for each about violent content and pacing to clarify Hypotheses 2a and 2b. Though these measures varied in their reliability (TV violence: *alpha* = .52, film violence: *alpha* = .62, video game violence: .82, total media violence: *alpha* = .75), this is not necessarily problematic. As noted by Anderson et al. (2007), this may simply reflect that some individuals prefer non-violent media, some prefer all violent media, and some prefer a mix of violent and non-violent media. Similarly, reliability was mixed for fast-pacing of favorite media (TV fast-pacing: *alpha* = .58, film fast-pacing: *alpha* = .69, video game fast-pacing: .83, total media fast-pacing: *alpha* = . 70).

Participants also reported the number of hours spent watching television on a

typical weekday during four time periods: 6 AM-Noon, Noon-6 PM, 6 PM-Midnight, and Midnight-6 AM and again during the same time periods on a typical weekend day. These items were used to calculate weekly time spent watching television. This measure showed good reliability in the present sample (*alpha* = .81). The same eight questions were repeated for video games to give the weekly time spent with video games. This measure also showed good reliability in the present sample (*alpha* = .87; for television and video game time combined [Total Screen Time], *alpha* = .86). Participants indicated how often they play 12 different genres of video games on a six point scale (1 – Never to 6 – Always).

Media multitasking index. Participants completed the media multitasking index (Ophir et al., 2009; see Appendix B). This included items assessing the number of hours spent weekly watching television, watching video content on a computer, listening to music, listening to non-musical audio, playing video games, talking on the phone, using an instant messenger, text messaging, reading/writing e-mails, reading web pages or other electronic documents, other computer applications (word processing, spreadsheets), and reading print media. Further, for each type of media, participants indicated how often they do it at the same time as each other type of media on a four point scale (1: Never to 4: Most of the time). Media multitasking was computed based on the multitasking frequency rating for each type of media, weighted by the amount of time spent with that type of media. This measure showed good reliability in the present sample (*alpha* = .89). Participants also completed three additional items assessing participants' perceptions of their multitasking effectiveness (*alpha* = .72).

Self-control. Trait self-control was assessed through the Brief Self-Control Scale (BSCS; Tangney et al., 2004; see Appendix C). This is a 13-item self-report measure including statements such as “I am able to work effectively toward long term goals”. Participants indicated their agreement or disagreement with each item on a five point scale (1: “Not at all” to 5: “Very much”). In past studies, this scale has demonstrated high inter-item reliability (coefficient alphas of .83 and .85 in the original studies) and a good three week test-retest reliability (r = 0.87). It also demonstrated good inter-item reliability in the present sample (*alpha* = .83).

Impulsiveness. Trait impulsiveness was assessed through the Barratt Impulsiveness Scale-11 (BIS-11; Patton et al., 1995; see Appendix D). The BIS-11 is a 30-item self-report scale. It is composed of a variety of statements, such as “I make up my mind quickly.” For each item participants must indicate “rarely/never,” “occasionally,” “often,” or “almost always/always.” This scale is composed of six subscales: attention, motor impulsiveness, self-control, cognitive complexity, perseverance, and cognitive instability. The coefficient alpha demonstrated among the original undergraduate sample was .82. In the present study, the inter-item reliability was similarly good (*alpha* = .80).

Attention problems. Attention problems were assessed using the Adult ADHD Self-Report Scale (ASRS, Kessler et al., 2005; see Appendix E). This is an 18-item self-report questionnaire, including nine items measuring inattention and nine items measuring hyperactivity. For example participants to respond to items such as “how often do you have difficulty keeping your attention when doing difficult or boring work?” using a five point scale ranging from very often to never. The overall scale

and both subscales have demonstrated good inter-item reliability (alphas > 0.80) and convergent validity with past diagnosis in previous research (Kessler et al., 2005; Swing et al., 2010). In the present study, this measure also showed good inter-item reliability (attention: *alpha* = .80, hyperactivity: *alpha* = .76, total scale: *alpha* = .84). Participants also reported past attention disorder diagnosis and current medication for attention disorder along with demographic questions (see Appendix H). These questions were intended primarily to validate the other measures of attention problems. Specifically, responses were scored so that those never diagnosed with an attention disorder received a 0, those diagnosed but currently medicated received a 1, and those diagnosed but currently unmedicated received a 2. This is based on the presumption that individuals who are diagnosed but medicated would experience a reduction in attention disorder symptoms, albeit not as low as non-diagnosed individuals.

Aggressiveness. Trait aggressiveness was assessed through the Aggression Questionnaire (BPAQ; Buss & Perry, 1992; see Appendix F). This 29-item self-report includes items such as “once in a while I can't control the urge to strike another person.” Participants must indicate how characteristic each statement is of them on a seven point scale (1: “Extremely uncharacteristic of me” to 7: “Extremely characteristic of me”). These items fall into four subscales: physical aggression, verbal aggression, anger, and hostility. The physical aggression subscale is of the greatest interest as this is the type of aggression most commonly depicted in electronic media. In the original study the BPAQ showed a strong test-retest correlation (r = 0.80) and good overall and subscale inter-item reliabilities (all alphas

greater than 0.80). In the present study, the scale, and all subscales, showed good reliability (physical: *alpha* = .88, verbal: *alpha* = .84, anger: *alpha* = .79, hostility: *alpha* = .86, total scale: *alpha* = .93).

Additionally, participants completed items from the National Youth Survey's delinquency items measuring violent behavior (Anderson & Dill, 2000; Elliot, Huizinga, & Ageton, 1985; see Appendix G). For example, participants indicate how often they “thrown objects (such as rocks or botttles) at cars or people” or “attacked someone with the idea of seriously hurting or killing him/her”. For each item, participants indicated how often they had done it in their life. Because standard deviations of responses varied widely and scores were skewed (with most responses being zero on each item), responses to each question were standardized, log-transformed and then combined. These items have demonstrated good inter-item reliability (alpha = 0.85) and strong associations with other measures of aggression in high school and university student samples (Anderson et al., 2007; Swing, 2008). In the present sample these items also demonstrated good reliability (*alpha* = .85).

Demographic and other questions. Participants completed a variety of demographic and other questions intended to measure several relevant variables (see Appendix H). These included sex, age, relevant past diagnoses and medication, parental education, parental involvement, and parental income. Some of these questions assess risk factors for attention disorders, such as family history of attention disorders, parental marital stability, and diet. These were intended to test third variable explanations for electronic media effects on attention problems.

Stroop task. A color naming Stroop task was completed on the computer in order to assess proactive and reactive cognitive control (see Appendix I). Participants first completed 40 non-word practice trials in which they indicated the color of the font used (red, yellow, blue, or green) for the letters “XXXXXXXXXX”. Between each trial there was a 1000 ms delay. These trials allowed participants to memorize the key mapping for each color. Participants then completed 24 practice trials in which a color word (red, yellow, blue, or green) appeared in a red, yellow, blue, or green font. For half of these trials (12), the word and font color were compatible (e.g., RED in red font) and for the other half the word and font color were incompatible (e.g., BLUE in yellow font). All participants received the same random order for these practice trials.

Next participants received a block of 48 test trials in which 36 were compatible font color/word and 12 were incompatible font color/word. Then participants received a block of 48 test trials in which 12 were compatible font color/word and 36 were incompatible font color/word (half of the participants were randomly assigned to receive these two blocks in the opposite order). Compatible stimuli and incompatible stimuli were balanced within blocks so that each color/word combination appeared the same number of times as other compatible/incompatible stimuli (respectively) within that block. Trials appeared in a random order within blocks.

Proactive cognitive control was based on the mean RT of incompatible trials in the compatible heavy block minus the mean RT of incompatible trials in the incompatible heavy block added to the mean RT of compatible trials in the

incompatible heavy block minus the mean RT of compatible trials in the compatible heavy block. This reflects the continuous use of context related information about the block of trials being completed, sustained in working memory. Reactive cognitive control was based on the standard Stroop interference effect (i.e., the mean RT of incompatible trials minus the mean RT of compatible trials). Conventionally, individual differences in this interference effect are simply described as “executive function”, however in the present studies it is described as reactive cognitive control to reflect the fact that it is based on cognitive control (i.e., processing font color while suppressing word meaning) without sustained activation of context information (thus it is not proactive). Scores on this measure were reversed (zero minus mean interference). This reflects the ability to focus on the relevant information while ignoring irrelevant information. For both proactive and reactive control, incorrect trials as well as trials with a reaction time of over 3000 ms or less than 300 ms were excluded. Any participant missing more than 25% of trials of one type (incompatible or compatible) in any one block (the 75% incompatible or 75% compatible blocks) were excluded from analyses. Nineteen participants were eliminated from analyses of this task on this basis.

Distractibility task. Participants read four short passages on the computer taken from previous GRE verbal examinations (see Appendix J). For the first two passages, participants had 90 seconds to read each passage before answering four multiple choice questions about that passage (the questions themselves were not timed). For the second two passages (which were longer) participants had 210 seconds to read each passage before answering the multiple choice questions.

During two of the four passages, clips from popular science fiction television shows (First Wave, 1998; Sliders, 1996) were played on a different part of the computer screen (with the sound on). Participants were told that they should focus on the essay and did not have to pay attention to the video. After this task, participants were asked if they recognized these shows. Only one participant was able to successfully identify one of these shows.

All participants completed the same four passages, but the passages that include the television distraction were counterbalanced across participants, such that half of the participants had the distracting video during the first and third essays and the other half had the distracting videos playing during the second and fourth videos. The difference in the number of correct responses between the no distraction and distraction passages was used as the participant's distractibility score. This task was intended to measure performance related to constructs including attention problems and self control.

In order to assess the amount of attention that was directed to the video clips (despite instructions not to) four unannounced multiple choice questions were included about each video. Participants correctly answered 3.47 out of the 8 multiple choice questions (*SD* = 1.86) about the video clips. For ten participants, data were not available for this task due to a computer error.

Useful field-of-view task. Participants completed a computerized useful field of view (UFOV) task similar to the one used by Green and Bavelier (2003; see Appendix K). This task was intended to assess the visual attention ability of participants. A visual display was presented for 17 ms displaying 23 squares (three

shapes at 10º, 20º, and 30º from the center in each of eight directions around the screen) as well as a target shape (a circle with a triangle inside it) in place of one of the squares. After the target screen appeared, a mask appeared for 500 ms containing circles and rectangles, with the positions of the targets and distractors covered. Then participants indicated which direction the target shape was in by pressing one of the eight directional keys on the keyboard number pad. After responding, there was a 1000 ms delay with only a fixation point in the center of the screen before the next target screen appeared. Participants were instructed to give their best guess when unsure of the location of the target.

This task included 24 practice trials (with the target shape appearing in each location once in a random order) for participants to familiarize themselves with the task. This was followed by 96 test trials, in which the target shape appeared in each of the 24 locations four times. The total number of accurate responses on this task serves as a measure of useful field-of-view (one form of visual attention). As would be expected, participants correctly identified the target shape more frequently at 10º (M = 43.9%, SD = 31.0%) than at 20º (M = 34.8%, SD = 24.8%), $t(229) = 10.52$, $p < .001$, $r = .570$, 95% C.I.: .476, .651. Also, participants correctly identified the target shape more frequently at 20º (M = 34.8%, SD = 24.8%) than at 30º (M = 24.3%, SD = 17.1%), $t(229) = 11.72$, $p < .001$, $r = .611$, 95% C.I.: .523, .686. Accuracy also showed strong between-distance reliability (*alpha* = .92). Five participants did not have usable data due to a computer error and were excluded from analyses of this task.

Procedure

Participants completed all measures in a single 60-90 minute laboratory session. After arriving at the laboratory and reading the informed consent document, participants were led to a cubicle where they completed the three computerized performance tasks first (Stroop task, Distractibility task, and Enumeration task). The order of these tasks was counterbalanced across participants. Next, participants completed the questionnaires in the following order to minimize the effects of suspicion: self-control (BSCS), impulsiveness (BIS-11), attention/hyperactivity problems (ASRS), Media Multitasking Index, Media Habits Questionnaire, trait aggression (BPAQ) and demographics. Participants then completed a short computerized debriefing questionnaire assessing their suspicion and read a full debriefing statement before leaving the lab.

CHAPTER 4. CORRELATIONAL STUDY RESULTS

Preliminary Analyses

Self-report measures of attention problems.

In order to validate the self-report measures of attention problems (ASRS, BIS-11, and BSCS), correlations between these variables and attention disorder diagnosis and attention disorder diagnosis (unmedicated) were calculated (see Table 4). As expected, ASRS (both inattention and hyperactivity subscales and the total score) were positively correlated with ADHD diagnosis (*r*s from .17 to .24, *p*s < .01). Impulsiveness was also positively correlated with ADHD diagnosis, *r*s of .20 and .22, *p*s < .01. Self-control was marginally negatively related to ADHD diagnosis, *r*s of -.11, *p* = .081 and .099. Thus, these measures appear to be consistent with past

Table 4. Bivariate correlations between measures of attention problems, cognitive control, distractibility, and attention disorder diagnoses. Reliability coefficient alphas are reported along the diagonal.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. $ASRS_1$ Attention	.80								
2. ASRS Hyperactivity	.48	.76							
3. ASRS Total	.86	.86	.84						
4. BIS_2 Impulsiveness	.56	.55	.64	.80					
5. $BSCS_3$ Self-control	-.54	-.42	-.55	-.68	.83				
6. Proactive Control	.02	-.04	-.01	-.04	.00	-			
7. Reactive Control	-.06	.03	-.01	-.01	-.04	-.22	-		
8. Distractibility	.06	-.03	.02	-.02	.01	-.09	.14	-	
9. ADHD Diagnosis	.17	.24	.24	.22	-.11	.04	.05	-.02	-
10. ADHD $Unmedicated_4$	.17	.24	.23	.20	-.11	.07	.07	-.03	.94

1: ASRS (Adult ADHD Self-Report Scale), **2:** BIS (Barratt Impulsiveness Scale), **3:** Brief Self-Control Scale, **4:** 0 = Undiagnosed, 1 = Diagnosed, medicated, 2 = Diagnosed, unmedicated. *N*=208-235. $p < .10$: $|r| = .11$ to .12; $p < .05$: $|r| = .13$ to .16; $p < .01$: $|r| = .17$ to .20; $p < .001$: $|r| > .21$

diagnoses of attention disorders. The correlations may be small to moderate in size due to most of those diagnosed with an attention disorder being treated with medication, presumably improving their symptoms. The continuous self-report measures of attention problems (Adult ADHD Self-Report Scale, Barratt Impulsiveness Scale-11, and Brief Self-Control Scale), rather than the yes/no question about past attention disorder diagnosis, was used as the measure of attention problems in subsequent analyses because (1) some individuals might suffer from an attention disorder yet never have been diagnosed and (2) continuous measures would tend to be more sensitive to variability in these variables than categorical measures (diagnosed or not). In order to combine these measures attention problems (ASRS total), impulsiveness (BIS-11), and self-control (BSCS) were standardized. Self-control was also reversed, so that higher scores indicated lower trait self-control. These three measures were then combined to form a composite measure of attention problems that was used in subsequent analyses.

Table 4 also shows that self-reported attention problems, cognitive control, and distractibility were not significantly correlated with each other (rs < .10, ps > .10), with the exception of distractibility and reactive cognitive control (r = .14, p < .05). This is relatively surprising given the conceptual links between these variables. For example, executive functions are generally disrupted in individuals with attention disorders. It may be that these measures tap somewhat distinct cognitive processes, some or all of which are influenced by electronic media use. The independence of these measures does suggest that effects on these outcomes are not part of a single effect and thus each of these variables could potentially be influenced independently

by different electronic media variables.

Validity of Distractibility Task

As expected, during the distractibility task participants answered more essay related questions correctly without the distracting videos (M = 3.51 out of 8, SD = 1.74) than with the distracting videos present (M = 2.88 out of 8, SD = 1.43), $t(224)$ = -5.128, $p < .001$, r = .32, 95% C.I.: .201, .435. This shows that the videos were distracting, as intended. Contrary to expectations, distractibility scores were not related to proactive cognitive control or self-reported attention problems, $r(209)$ = = -.09, p = .203, 95% C.I.: -.221, .046, and $r(224)$ = -.01, p = .934, 95% C.I.: -.136, .124, respectively. Distractibility scores were positively associated with executive functioning (reactive cognitive control) based on the Stroop task, $r(209)$ = .14, $p < .05$, 95% C.I.: .008, .273. This score was expected to relate negatively to reactive cognitive control. It may be that individuals who are easily distractible are forced to rely more on reactive control, though the lack of a correlation with proactive control and attention problems makes this interpretation less clear. Thus, the interpretation of distractibility scores is somewhat difficult.

Risk factors for Attention Disorders

A number of potential risk factors for attention disorders were correlated with self-reported attention problems (based on the composite of the ASRS, BIS-11, and BSCS) as well as past attention disorder diagnosis (see Table 5). These variables include genetic propensity for attention disorders (based on parental ADHD diagnosis, sibling ADHD diagnosis, and other family ADHD diagnosis). These

Table 5. The correlations of attention problems and attention disorder diagnosis with genetic, parent/home, and diet risk factors.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1. Attention Problems (composite)$_1$	.83															
2. ADHD Diagnosis	.22	-														
3. ADHD Unmedicated$_2$	.21	.94	-													
4. Family ADHD	.03	.21	.23	-												
5. Sibling ADHD$_3$	.10	.26	.28	.20	-											
6. Parental ADHD	.05	.47	.44	.38	.21	-										
7. Parental Marital Stability$_4$	.06	.03	.03	-.10	-.04	.01	-									
8. Parental Mental Disorder	.06	.26	.26	-.01	.03	.11	-.06	-								
9. Parental Arrest	.00	-.08	-.09	.11	.02	-.02	-.28	.03	-							
10. Parent Physical Conflict	.07	.00	.00	-.02	-.01	-.07	-.39	.02	.22	-						
11. Parent Verbal Conflict	-.01	-.12	-.11	-.05	-.16	-.09	-.34	-.04	.22	.54	-					
12. Foster Care	-.08	.03	.03	.03	.02	.02	-.04	.02	.03	.04	.04	-				
13. SES$_5$	-.01	.11	.11	-.03	.02	.10	.20	-.09	-.30	-.25	-.17	-.05	.67			
14. Candy	.13	.10	.08	-.01	-.02	.09	.07	-.06	-.08	-.11	.01	-.02	.06	-		
15. Chips	.15	.02	.00	-.03	-.01	.04	.06	-.05	.01	-.04	-.01	-.02	.04	.51	-	
16. Age	.02	.07	.04	.00	.01	.11	.06	-.05	-.05	-.01	-.08	.04	-.12	-.04	.02	-
17. Sex$_6$	.01	.09	.09	.03	-.02	-.02	.05	-.01	.00	-.04	-.02	-.01	.02	-.03	.11	.23

1: Composite measure of Adult ADHD Self-report scale, Barratt Impulsiveness scale, and Brief Self-Control Scale; **2**: 0 = Undiagnosed, 1 = Diagnosed, medicated, 2 = Diagnosed, unmedicated; **3**: Percentage of total siblings with ADD/ADHD diagnosis; **4**: 0 = Married, 1 = Divorced/separated/unmarried; **5**: SES is based on composite of parental education, parental income and number of toilets in parents' home; **6**: 0 = Female, 1 = Male.

N = 233-235. $p < .10$: $|r| = .11$ to .12; $p < .05$: $|r| = .13$ to .16; $p < .01$: $|r| = .17$ to .20; $p < .001$: $|r| > .21$

variables were all positively correlated with past attention disorder diagnosis for the participant, parent ADHD: $r(234) = .47$, $p < .001$; sibling ADHD: $r(234) = .26$, $p < .001$; other family ADHD: $r(232) = .21$, $p < .01$. Thus, genetic predisposition appears to be related to past attention disorder diagnosis. Each of these variables was standardized and combined to create a genetic attention disorder risk variable. Most family environment variables were not significantly related to either self-reported attention disorders or past attention disorder diagnoses (rs < .13, ps > .05). Only parental mental disorder diagnosis was significantly related to past attention disorder diagnosis, $r(234) = .26$, $p < .001$. Both diet variables (consumption of candy and chips/pretzels) were correlated with greater self-reported attention problems, $r(234) = .13$, $p < .05$, and $r(234) = .15$, $p < .05$, respectively. This is consistent with previous findings that foods high in carbohydrates, especially sugar, are risk factors for attention disorders (Blunden, Milte, & Sinn, 2011). These variables were standardized and combined to create a dietary risk factor variable. Neither age, nor sex were significantly related to attention problems or past diagnoses, rs < .10, ps > .10.

Media, Attention, and Control Variables as Predictors of Aggression

The findings of earlier studies (e.g., Miller et al., 2003; Seguin et al., 1999) that attention problems and control related variables predict aggression, were replicated by calculating correlations between aggression variables, attention problems, and proactive and reactive cognitive control (see Table 6). As would be expected, all Buss-Perry aggression subscales correlated highly with each other (rs

Table 6. Correlations of aggression, violence, attention problems, cognitive control, distractibility, and visual attention. Reliability coefficient alphas are reported along the diagonal, when relevant.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1. BPAQ[1]: Physical	.88												
2. BPAQ: Verbal	.52	.84											
3. BPAQ: Anger	.64	.56	.79										
4. BPAQ: Hostility	.46	.42	.56	.86									
5. BPAQ: Total	.84	.73	.84	.79	.93								
6. NYS[2]: Violence	.39	.22	.28	.22	.35	.85							
7. Attention Problems	.33	.17	.36	.33	.38	.21	.83						
8. Proactive Control	.03	.07	-.01	-.05	.00	-.08	-.02	-					
9. Reactive Control	.05	-.05	-.02	.01	.00	.08	.01	-.22	-				
10. Distractibility	.03	.08	.00	.02	.04	.04	-.01	-.09	.14	-			
11. Video Recall	.08	.11	.06	.11	.11	.09	.09	.02	.05	.09	-		
12. UFOV[3] (Total)	.07	.08	-.07	.02	.03	-.02	-.08	-.04	.03	.07	.15	.92	
13. Age	.18	.05	.01	.01	.09	.21	.02	.01	.08	-.01	-.06	-.10	-
14. Sex	.48	.28	.20	.13	.35	.23	.01	-.01	.13	.15	.18	.21	.23

1: BPAQ (Buss-Perry Aggression Questionnaire), **2:** NYS (National Youth Survey), **3:** UFOV (Useful Field-of-View)
N = 216-235, $p < .10$: $|r| = .11$ to .12; $p < .05$: $|r| = .13$ to .16; $p < .01$: $|r| = .17$ to .20; $p < .001$: $|r| > .21$

from .42 to .64, *p*s < .001) and with violent behavior (*r*s from .26 to .47, *p*s < .001). Attention problems were positively correlated with trait aggression (*r* = .38, *p* < .001), including physical aggression (*r* = .33, *p* < .001), and violence (*r* = .26, *p* < .001). Thus, consistent with previous research, individuals with greater attention problems (including impulsiveness and lower self-control) tend to be more aggressive. Cognitive control (both proactive and reactive), visual attention (based on UFOV), and distractibility were not related to aggression (*r*s < .11, *p*s >.10).

In order to replicate previous findings of an association between media violence and aggression, correlations were computed between various media variables, aggression, and violence (see Tables 7 and 13). Television violence, film violence, video game violence, and total media violence were all related to greater physical aggression (*r*s from .20 to .45, *p*s < .05) and violence (*r*s from .18 to .28, *p*s < .05). These findings are consistent with previous research.

Accurate Recall of Distraction Videos

Accurate recall of the videos from the distractibility task was greater for males (*r* = .18, *p* < .01) and for those with greater useful field-of-view (*r* = .15, *p* < .05). A number of forms of electronic media use were also positively associated with recall from the distraction videos (see Tables 7 and 13). Males also tended to have a larger useful field-of-view, *r* = .21, *p* < .001, which is also consistent with males tendency to more frequently play video games that are believed to improve visual attention. These findings may indicate that individuals who spend more time with electronic media (disproportionately males) had their attention drawn more to the

Table 7. Correlations of attention, cognitive control, and media exposure variables. Coefficient alphas are reported along the diagonal.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1. Attention Problems	.83																			
2. $BPAQ_1$: Physical	.33	.88																		
3. NYS_2: Violence	.21	.39	.85																	
4. Proactive Control	-.02	.03	-.08	-																
5. Reactive Control	.01	.05	.08	-.22	-															
6. Distractibility	-.01	.03	.04	-.09	.14	-														
7. Video Recall	.09	.08	.09	.02	.05	.09	-													
8. $UFOV_3$ (Total)	-.08	.07	-.02	-.04	.03	.07	.15	.92												
9. TVT_4	.19	.14	.09	-.04	-.02	-.01	.01	-.03	.81											
10. VGT_5	.10	.34	.15	-.05	-.03	.07	.11	.08	.39	.87										
11. TST_6	.18	.28	.14	-.05	-.03	.03	.07	.03	.87	.79	.86									
12. TVV_7	.16	.20	.15	-.14	.07	.05	.09	.05	.21	.13	.20	.51								
13. FV_8	.19	.36	.15	-.02	-.02	.09	.11	.08	.04	.17	.12	.31	.62							
14. VGV_9	.12	.39	.16	-.14	.15	.07	.19	.23	.11	.63	.41	.27	.37	.82						
15. TMV_{10}	.21	.45	.20	-.13	.09	.10	.18	.17	.15	.45	.34	.63	.78	.79	.75					
16. $TVFP_{11}$	.15	.04	.04	-.11	.01	-.09	.05	-.05	.30	-.04	.18	.68	.13	.12	.36	.58				
17. FFP_{12}	.12	.13	.03	.04	-.03	.00	.18	.03	.05	.07	.07	.22	.72	.20	.52	.25	.69			
18. $VGFP_{13}$	.13	.40	.18	-.13	.17	.07	.15	.20	.13	.64	.43	.25	.35	.93	.74	.11	.19	.83		
19. $TMFP_{14}$	.19	.32	.14	-.10	.10	.01	.20	.12	.22	.41	.36	.51	.61	.71	.84	.57	.69	.74	.70	
20. Media Multitasking	.18	.06	.02	.02	-.16	-.19	-.12	-.05	.20	.09	.18	.12	-.08	-.04	-.01	.12	-.05	-.02	.01	.89

1: BPAQ (Buss-Perry Aggression Questionnaire), **2:** NYS (National Youth Survey), **3:** UFOV (Useful Field-of-View), **4:** TV (TV Time), **5:** VGE (Video Game Time), **6:** TST (Total Screen Time), **7:** TVV (TV Violence), **8:** FV (Film Violence), **9:** VGV (Video Game Violence), **10:** TMV (Total Media Violence), **11:** TVFP (TV Fast-Paced), **12:** FFP (Film Fast-Paced), **13:** VGFP (Video Game Fast-Paced), **14:** TMFP (Total Media Fast-Paced

N = 216-235, $p < .10$: $|r| = .11$ to .12; $p < .05$: $|r| = .13$ to .16; $p < .01$: $|r| = .17$ to .20; $p < .001$: $|r| > .21$

video clips out of habit. Those with greater useful field-of-view were able to get more information from the videos even when they were visually focused on the essay.

Primary Analyses

Television, Film, and Video Game Effects on Attention Problems

In order to replicate the past findings of television, film, and video game exposure on attention problems and cognitive control (Hypothesis 1a), correlations between these variables were computed (see Table 7). Television time and total screen time are significantly correlated with attention problems, $r(234) = .19$, $p < .01$, 95% C.I.: .063, .309; $r(234) = .18$, $p < .01$, 95% C.I.: .054, .301. In order to test and rule out some third variable explanations for these findings, general linear models were calculated testing the effects of television time (Table 8), video game time (Table 9), and total screen time (i.e., television and video game time combined; Table 10) on attention problems. These models included variables identified earlier as risk factors for attention problems: genetic attention disorder risk, parental mental

Table 8. General linear model of television time, parental mental health, genetic and dietary risk, sex, and age on attention problems. $N = 233$.

	B	***t***	***df***	***p***	***Partial r***	**95% C.I.**
Television time	.188	2.942	226	.004	.192	.064, .314
Parental mental health	.082	1.288	226	.199	.085	-.045, .212
Genetic ADHD risk	.084	1.319	226	.189	.087	-.043, .214
Dietary ADHD risk	.175	2.732	226	.007	.178	.049, .301
Sex	-.028	-.430	226	.668	-.029	-.158, .101
Age	.019	.294	226	.769	.020	-.110, .149

Table 9. General Linear Model of video game time, parental mental health, genetic and dietary risk, sex, and age on attention problems. *N* = 233.

	B	***t***	***df***	***p***	***Partial r***	**95% C.I.**
Video game time	.128	1.798	226	.074	.119	-.011, .245
Parental mental health	.072	1.121	226	.264	.074	-.056, .202
Genetic ADHD risk	.074	1.148	226	.252	.076	-.054, .204
Dietary ADHD risk	.184	2.844	226	.005	.185	.057, .307
Sex	-.073	-.994	226	.321	-.066	-.194, .064
Age	.031	.474	226	.636	.031	-.099, .160

health history, dietary attention disorder risk. Sex and age were also included as covariates, though these variables were not significantly related to attention problems. All variables were standardized to reduce multicollinearity. Television time continued to uniquely predict attention problems, even with genetic attention disorder risk, parental mental health history, dietary attention disorder risk, age and sex statistically controlled, $t(226) = 2.94$, $p = .004$, $r = .192$, 95% C.I.: .064, .314. Video game time was marginally uniquely related to attention problems with these covariates included, $t(226) = 1.80$, $p = .074$, $r = .119$, 95% C.I.: -.011, .245. Total screen time was uniquely associated with attention problems with these covariates included, $t(226) = 2.934$, $p = .004$, $r = .191$, 95% C.I.: .063, .313.

Overall, these results are generally consistent with earlier research findings. Exposure to television and video games (both separately and combined) are associated with attention problems even when a number of third variables are statistically controlled, though the video game time link is only marginally significant. Of particular relevance, two additional risk factors were tested and ruled

Table 10. General Linear Model of total screen time, parental mental health, genetic and dietary risk, sex, and age on attention problems. *N* = 233.

	B	***t***	***df***	***p***	***Partial r***	**95% C.I.**
Total screen time	.194	2.934	226	.004	.191	.063, .313
Parental mental health	.082	1.286	226	.200	.085	-.045, .212
Genetic ADHD risk	.080	1.255	226	.211	.083	-.047, .210
Dietary ADHD risk	.178	2.781	226	.006	.182	.045, .304
Sex	-.070	-1.032	226	.303	-.068	-.196, .062
Age	.026	.403	226	.687	.027	-.103, .156

out as alternative explanations for this finding. Statistically controlling for genetic risk of attention disorders (based on parent, sibling, and other family member diagnosis) and dietary risk of attention disorders (based on consumption of chips/pretzels and candy) does not eliminate the link between television and video game time and attention problems.

Additional Media Use Variables and Attention Problems

In order to expand the types of electronic media that are potentially related to attention problems, correlations were computed between the media use variables from the Media Multitasking Index (watching videos on a computer, internet use, e-mailing, instant messaging, other computer use, music, non-musical audio, talking on the phone, text messaging, and reading print media) in relation to attention problems and related measures (see Table 11). Given the lack of previous research testing these media in relation to attention problems, these analyses are relatively exploratory.

Table 11. Correlations between additional media variables and attention problems, aggression, cognitive control, and useful field-of-view.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
1. Attention Problems	.83																
2. BPAQ: Physical	.33	.88															
3. NYS: Violence	.21	.39	.85														
4. Proactive Control	-.02	.03	-.08	-													
5. Reactive Control	.01	.05	.08	-.22	-												
6. Distractibility	-.01	.03	.04	-.09	.14	-											
7. Video Recall	.09	.08	.09	.02	.05	.09	-										
8. UFOV	-.08	.07	-.02	-.04	.03	.07	.15	.92									
9. Computer Video	.13	.17	.15	-.09	-.08	.00	.10	.02	-								
10. Internet Use	.04	.12	.03	-.07	-.05	-.03	.03	.03	.21	-							
11. E-mailing	.05	.06	.01	-.02	-.07	-.09	-.08	-.15	.22	.39	-						
12. Instant Messaging	.11	.10	.01	.05	-.05	-.02	-.02	.02	.06	.50	.30	-					
13. Other Computer Use	-.12	.02	.01	.02	.06	-.03	.08	.03	.20	.39	.32	.28	-				
14. Music	.03	.01	-.06	.04	-.05	.02	.08	.20	.24	.21	.07	.08	.15	-			
15. Non-musical Audio	-.04	.04	.02	-.05	.00	.11	.06	-.09	.10	.19	.08	.04	.13	.04	-		
16. Phone (Calling)	.05	.11	-.01	-.03	-.07	-.02	-.05	-.02	.28	.34	.28	.38	.22	.35	.06	-	
17. Phone (Texting)	.16	.00	-.05	.02	-.17	-.15	-.08	.00	-.02	.14	.02	.15	-.08	.10	-.07	.29	-
18. Print Media	.01	.16	.10	.11	.03	.09	.12	.01	.31	.04	.07	.06	.15	.20	-.01	.24	.06

N = 208-235, $p < .10$: $|r| = .11$ to .12; $p < .05$: $|r| = .13$ to .16; $p < .01$: $|r| = .17$ to .20; $p < .001$: $|r| > .21$

Watching videos on a computer is marginally related to greater attention problems, $r(234) = .125$, $p = .056$, 95% C.I.: -.003, .248. Other computer use is marginally related to fewer attention problems, $r(234) = -.122$, $p = .062$, 95% C.I.: -.246, .006. Texting is related to greater attention problems, $r(234) = .156$, $p < .05$, 95% C.I.: .029, .278. Texting is also related to lower reactive cognitive control and less distractibility, $r(215) = -.167$, $p < .05$, 95% C.I.: -.293, -.035, and $r(224) = -.149$, $p < .05$, 95% C.I.: -.274, -.019, respectively. Non-musical audio use is related to marginally greater distractibility, $r(224) = .114$, $p = .087$, 95% C.I.: -.017, .241. E-mailing is negatively related to useful field-of-view, $r(229) = -.146$, $p < .05$, 95% C.I.: -.270, -.017. Music use is related to greater useful field-of-view, $r(229) = .197$, $p < .01$, 95% C.I.: .070, .318.

It is surprising that texting is associated with greater attention problems and lower reactive cognitive control, yet also less distractibility. Though cross-sectional data cannot causal provide strong causal evidence, this association might reflect improvements in some aspects of attention (e.g., filtering out irrelevant information in the environment in the Distractibility task) but decrements in other aspects (e.g., sustaining focus, task persistence) that are assessed by self-report measures of attention problems or Stroop task. This may also simply reflect that the distractibility task is not measuring what it was expected to measure.

Correlations between media multitasking and attention and control variables were also computed (see Table 7). As predicted, media multitasking was related to greater attention problems, $r(234) = .178$, $p < .01$, 95% C.I.: .052, .299. More surprisingly, media multitasking was related to greater reactive cognitive control and

Table 12. General linear model of the unique effects of media multitasking, media use, and sex on attention problems. $N = 235$.

	B	***t***	***df***	***p***	***Partial r***	**95% C.I.**
Media multitasking	.166	2.379	231	.018	.153	.026, .275
MMI Media use	.055	.803	231	.423	.052	-.076. .178
Sex	.035	.536	231	.593	.035	-.093, .201

less distractibility, $r(215) = .158$, $p < .05$, 95% C.I.: .026, .285, and $r(224) = -.190$, $p < .01$, 95% C.I.: -.313, -.061, respectively. A general linear model was computed relating media multitasking to attention problems, with sex and overall media use (based on the use of media assessed in the Media Multitasking Index) was computed (see Table 12). As hypothesized, media multitasking is uniquely related to greater attention problems even when overall media use and sex are statistically controlled.

In order to further explore the link between multitasking and distractibility, high and low multitaskers (those greater than one standard deviation above the mean or less than one standard deviation below the mean) were compared in their accuracy in answering questions about the essays in the distractibility task using independent samples t-tests. When the distracting videos were present, high and low multitaskers made a similar number of correct answers (high multitaskers: $M = 2.81$, $SD = 1.35$; low multitaskers: $M = 2.67$, $SD = 1.63$), $t(64) = -.379$, $p = .706$, $r = -.047$, 95% C.I.: -.287, .199. When the distracting videos were not present, low multitaskers correctly answered more questions ($M = 3.67$, $SD = 1.83$) than high multitaskers ($M = 2.81$, $SD = 1.26$), $t(64) = 2.258$, $p < .05$, $r = .270$, 95% C.I.: .030, .480. Thus, the negative

Table 13. Correlations of attention, cognitive control, and video game genres. Coefficient alphas are reported along the diagonal.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1. Attention Problems	.83																			
2. BPAQ: Physical	.33	.88																		
3. NYS: Violence	.21	.39	.85																	
4. Proactive Control	-.02	.03	-.08	-																
5. Reactive Control	.01	.05	.08	-.22	-															
6. Distractibility	-.01	.03	.04	-.09	.14	-														
7. Video Recall	.09	.08	.09	.02	.05	.09	-													
8. UFOV	-.08	.07	-.02	-.04	.03	.07	.15	.92												
9. Action Games$_1$	.08	.47	.20	-.03	.05	.02	.21	.26	-											
10. First-person Shooter	.04	.44	.14	-.05	.11	.06	.21	.29	.87	-										
11. Third-Person Shooter	.12	.44	.20	.01	.01	-.03	.07	.15	.87	.66	-									
12. Action/Adventure	.05	.31	.17	-.04	.02	.02	.25	.22	.83	.55	.56	-								
13. Fighting Games	.18	.44	.22	-.08	.05	-.03	.06	.06	.61	.56	.50	.50	-							
14. Strategy Games	-.01	.34	.19	-.03	.04	.04	.23	.16	.61	.50	.48	.57	.44	-						
15. Single Player RPG$_2$	.00	.26	.13	-.09	.11	-.06	.21	.18	.58	.39	.45	.64	.40	.67	-					
16. MMORPG$_3$	.06	.23	.12	.02	.06	.06	.12	.10	.33	.23	.29	.31	.26	.49	.48	-				
17. Sports Games	.08	.33	.16	.04	.05	-.02	.05	.08	.47	.45	.46	.29	.21	.23	.13	.06	-			
18. Puzzle Games	.05	-.02	.04	-.05	.01	-.05	.08	.09	.19	.06	.10	.33	.27	.19	.21	.06	.03	-		
19. Simulation	.01	.13	.03	-.03	-.01	.01	.06	.02	.23	.07	.22	.30	.23	.32	.29	.23	.03	.34	-	
20. Real World MMO$_4$	.06	.29	.18	-.09	.01	-.02	.08	.13	.34	.28	.27	.31	.36	.44	.39	.58	.05	.04	.35	-
21. Music & Party Game	.05	-.03	-.03	-.05	.03	-.04	-.07	.18	.08	-.02	.10	.12	.23	.07	.14	.12	.01	.36	.43	.21

1: Composite of First-person shooter, Third-person shooter, and Action/Adventure Games. **2:** RPG (Role-Playing Game)
3: MMORPG (Massively Multiplayer Online Role-Playing Game). **4:** Real World MMO (Massively Multiplayer Online game).
N = 216-235, $p < .10$: $|r| = .11$ to .12; $p < .05$: $|r| = .13$ to .16; $p < .01$: $|r| = .17$ to .20; $p < .001$: $|r| > .21$

association between multitasking and distractibility appears to be due to low multitaskers doing better in the absence of distractions, rather than high multitaskers doing better with distractions. It may indicate that high multi-taskers experience distraction even in the absence of an explicit distractor (the video). This is, nonetheless, an unexpected finding.

Media Content Effects on Attention and Control Variables

To test the link between specific aspects of media (violent content, fast pacing, video game genres) and attention problems, cognitive control, distractibility, and useful field-of-view, correlations were computed between these variables (see

Table 14. General linear models of violent content, screen time, sex, and age on attention problems. Unique effects of sex are not reported to conserve space. In all models except Model 4, sex was not uniquely significant. $N = 235$.

	B	***t***	***df***	***p***	***Partial r***	**95% C.I.**
Model 1						
TV Violence	.130	1.974	231	.050	.178	.001, .251
TV Time	.163	2.494	231	.013	.161	.034, .283
Model 2						
Film Violence	.199	2.964	231	.003	.190	.064, .310
Total Screen Time	.187	2.832	231	.005	.182	.056, .302
Model 3						
Video Game Violence	.153	1.594	231	.112	.103	-.016, .236
Video Game Time	.055	.655	231	.513	.043	-.085, .170
Model 4						
Total Media Violence	.241	3.155	231	.002	.202	.076, .321
Total Screen Time	.143	2.109	231	.036	.136	.009, .259

Table 15. General linear models of fast-pacing, screen time, sex, and age on attention problems. Unique effects of sex are not reported to conserve space, but were, in all cases, non-significant. *N* = 235.

	B	***t***	***df***	***p***	***Partial r***	**95% C.I.**
Model 5						
TV Fast-pacing	.097	1.441	231	.151	.094	-.034, .219
TV Time	.159	2.351	231	.020	.152	.025, .274
Model 6						
Film Fast-pacing	.110	1.711	231	.088	.111	-.017, .235
Total Screen Time	.187	2.786	231	.006	.179	.053, .300
Model 7						
Video Game Fast-pacing	.164	1.705	231	.089	.111	-.017, .235
Video Game Time	.047	.556	231	.579	.036	-.092, .163
Model 8						
Total Media Fast-pacing	.176	2.434	231	.016	.157	.030, .279
Total Screen Time	.144	2.080	231	.039	.134	.007, .257

Tables 7 and 13). For effects that are significant or marginally significant additional analyses were conducted.

Attention problems. Exposure to most forms of violent media, based on participants' rating of their three favorite television shows, films and video games,were related to greater attention problems (for television, film, and total media violence: *r*s from .16 to .21, *p*s < .05). Video game violence exposure was only marginally related to attention problems, $r(234) = .120$, $p = .067$, 95% C.I.: -.008, .244. Similarly, fast pacing was generally positively related to attention problems, television fast-pacing, $r(234) = .145$, $p < .05$, 95% C.I.: .018, .267; total media fast-pacing: $r(234) = .190$, $p < .01$, 95% C.I.: .064, .310. Film and video game

Table 16. General linear models of the unique effects of fighting games and third person shooter games on attention problems with sex and video game time as covariates. Unique sex effects are not reported in tables but were in all cases non-significant, *B*s < .10, *p*s > .10. *N* = 235.

	B	***t***	***df***	***p***	***Partial r***	**95% C.I.**
Model 9						
Fighting games	.175	2.375	231	.018	.153	.026, .275
Video game time	.050	.637	231	.525	.042	-.086, .169
Model 10						
Third person shooter games	.112	1.447	231	.149	.094	-.034, .219
Video game time	.087	1.148	231	.252	.075	-.053, .201

fast-pacing were only marginally related to greater attention problems, $r(234) = .121$, $p = .065$, 95% C.I.: -.007, .245, and $r(234) = .126$, $p = .054$, 95% C.I.: -.002, .249, respectively.

The specificity of the media-attention problems links were further tested using general linear models including each of the media violence/fast pacing variables separately, along with the relevant form of screen time, and sex as covariates (see Tables 14 and 15). Though included as a covariate in all models, the unique effects of sex are not reported in the Table, but in all cases except Model 4, sex was not uniquely significant (|*B*s| < -.12, *p*s > .10; Model 4: Sex: $B = -.158$, $t(231) = -2.114$, $p < .05$, $r = -.137$, 95% C.I.: -.260, -.010).

Video game effects on attention problems were examined in greater detail by computing correlations between experience with different video game genres and attention problems and related measures. Playing fighting games was associated with greater attention problems, $r(234) = .18$, $p < .01$, 95% C.I.: .053, .300. Playing

third person shooter games was marginally associated with greater attention problems, $r(234) = .12$, $p = .079$, 95% C.I.: -.013, .239. General linear models were computed testing the associations of these genres with attention problems, controlling for sex and overall video game time (see Table 16). Of these genres, only fighting games were uniquely associated with attention problems when controlling for hours spent playing video games.

Television violence, film violence, and total media violence were uniquely significant predictors of attention problems, even when sex and overall media use were statistically controlled. Only video game violence was not significant, and at $t(231) = 1.594$, $p = .112$, $r = .103$, it was not substantially smaller than the other media violence variables. Total media fast pacing was related to attention problems even when total screen time and sex were statistically controlled. Film and video game fast-pacing were marginally related to greater attention problems when overall media use and sex were statistically controlled. Though television fast-pacing was non-significant, $B = .097$, $t(231) = 1.441$, $p = .155$, $r = .094$, it was also only slightly smaller than the other unique media fast-pacing effects. It should also be noted that in six of the eight models (all except Models 3 and 7), measures of screen time (television, video games, or total screen time) were also a uniquely significant predictors of attention problems. Additional analyses of genres reveals that playing fighting games, which tend to be both fast paced and violent, may also contribute unique variance to predicting attention problems. Though the evidence is somewhat mixed, overall it appears that violent/fast paced content and total hours of at least some forms of media exposure both uniquely predict attention problems.

Attention problems as a mediator for media violence and aggression. It is possible that media violence increases aggression in part by increasing attention problems. Attention problems are characterized by poor impulse control, which may lead to acting out on aggressive impulses that other individuals would have been able to restrain. In order to test this possibility, a latent variable model was computed testing the effects of total screen time and total media violence on attention problems and aggression (see Figure 4). This model showed good fit to the data, *Chi-square*(27) = 41.47, *p* = .037, *CFI* = .979, *TLI* = .965, *RMSEA* = .048, 90% CI: .012, .075. When total screen time was included as a latent variable, video game playing had a standardized beta to the total screen time latent variable of greater than 1. Thus, in this model, total screen time was used as an observed (rather than latent) variable. In this model, both total screen time and media violence predicted attention problems, but only media violence predicted aggression. However, as predicted, there was a significant indirect effect of media violence on aggression through attention problems, *b* = .11, *p* < .05. This is consistent with partial mediation.

Cognitive control and distractibility. Exposure to television violence, video game violence, and total media violence were related to lower proactive cognitive control, *r*s from -.13 to -.14, *p*s < .05. Video game violence is related to greater reactive cognitive control, r(215) = .150, p < .05, 95% C.I.: .017, .277. Video game fast pacing was marginally related to lower proactive cognitive control and significantly related to greater reactive cognitive control, *r*(215) = -.125, *p* = .066, 95% C.I.: -.254, .008, and *r*(215) = .167, *p* < .05, 95% C.I.: .035, .293, respectively. In order to further test the strength of these associations, general linear models were

Figure 4. Latent variable model of screen time and media violence effects on attention problems aggression. All reported paths are significant. *N* = 235.

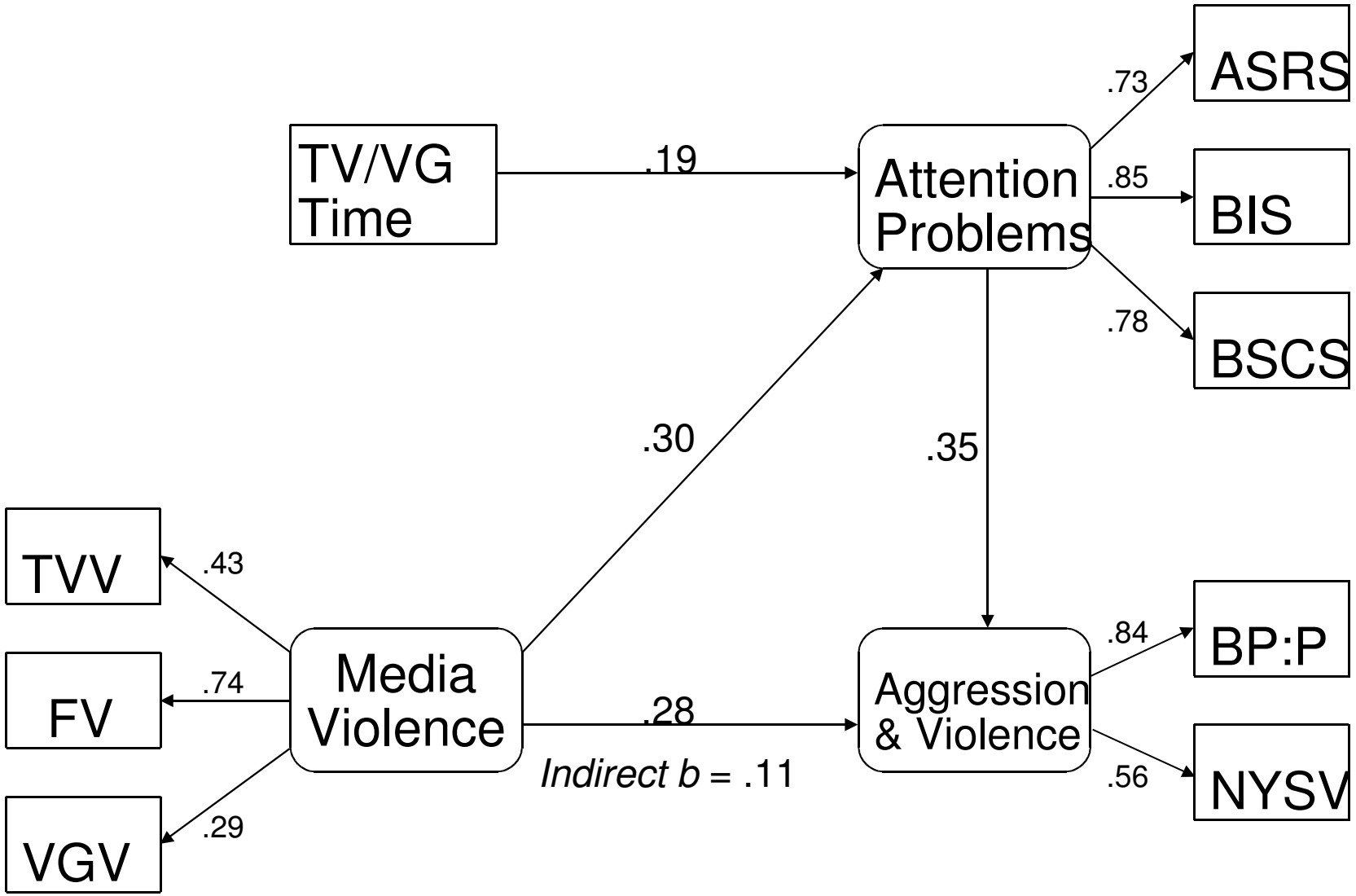


Table 17. General linear models of media violence and fast pacing, screen time, and sex on proactive cognitive control. Unique sex effects not reported, but all are non-significant, $B < .14$, $p > .10$. $N = 216$.

	B	***t***	***df***	***p***	***Partial r***	**95% C.I.**
Model 11						
Television violence	-.136	-1.927	212	.055	-.130	-.258, .003
Television time	-.012	-.166	212	.868	-.011	-.144, .122
Model 12						
Video game violence	-.259	-2.587	212	.010	-.173	-.299, -.041
Video game time	.054	.606	212	.545	.041	-.093, .173
Model 13						
Total media violence	-.175	-2.122	212	.035	-.143	-.271, -.010
Total screen time	-.022	-.294	212	.769	-.020	-.153, .113
Model 14						
Video game fast pacing	-.230	-2.245	212	.026	-.151	-.278, -.018
Video game time	.045	.498	212	.619	.034	-.099, .166

computed including each media violence/fast-pacing variable separately, along with overall media use and sex (see Tables 17 and 18).

Video game violence, total media violence, video game fast-pacing were all uniquely negatively related to proactive cognitive control, *partial r*s from -.143 to -.173, *p*s < .05. Television violence was marginally negatively related to proactive cognitive control, $B = -.136$, $t(212) = -1.927$, $p = 055$, *partial r* = -.130, 95% C.I.: -.258, .003. Video game violence and video game fast pacing were also uniquely positively related to reactive cognitive control, partial *r*s of .158 and .188, *p*s < .05, respectively. In these models, video game time was negatively related to reactive cognitive control, *partial r*s of -.165 and -.183, *p*s < .05, respectively. With the exception of film violence, only violent media use was related to lower proactive

Table 18. General linear models of media violence and fast pacing, screen time, and sex on reactive cognitive control. Unique sex effects not reported, but all are non-significant, $B < .12$, $p > .10$. $N = 216$.

	B	***t***	***df***	***p***	***Partial r***	**95% C.I.**
Model 15						
Video game violence	.234	2.353	212	.020	.158	.026, .283
Video game time	-.218	-2.459	212	.015	-.165	-.292, -.033
Model 16						
Video game fast pacing	.283	2.820	212	.005	.188	.056, .313
Video game time	-.244	-2.734	212	.007	-.183	-.308, -.051

cognitive control. Reactive cognitive control was only related to video game time, with violence and fast-pacing related positively and video game time was related negatively. Individual genres of video games were not significantly related to cognitive control, with the exception of single player role-playing games, which were marginally associated with higher reactive cognitive control, $r(234) = .114$, $p = .094$, 95% C.I.: .014, .238.

As Tables 7 and 13 show, none of the media violence or media fast pacing variables or specific video game genres were significantly related to distractibility, rs $< .11$, $p > .10$. Though media multitasking is negatively related to distractibility, other aspects such as violence, fast-pacing, or total time spent with television and video games are not related. Given the lack of correlation between distractibility and attention problems/proactive, it may be that these reflect different cognitive abilities that are influenced by or associated with different types of electronic media.

Visual attention. Exposure to video game violence and video game fast

Table 19. Effects of video game violence, video game fast pacing, and total media violence as predictors of UFOV, with screen time and sex included as covariates. $N = 230$.

	B	***t***	***df***	***p***	***Partial r***	**95% C.I.**
Model 17						
Video game violence	.222	2.338	226	.020	.152	.024, .275
Video game time	-.106	-1.292	226	.198	-.085	-.212, .044
Model 18						
Video game fast pacing	.177	1.774	226	.077	.116	-.013, .241
Video game time	-.086	-1.026	226	.306	-.068	-.195, .061
Model 19						
Total media violence	.105	1.353	226	.177	.089	-.040, .215
Total screen time	-.057	-.822	226	.412	-.054	-.182, .075

pacing were associated with a larger useful field-of-view, $r(229) = .230$, $p < .01$, and $r(229) = .202$, $p < .01$. Total media violence was also significantly associated with a larger useful field-of-view. General linear models were computed to further test the link between these media variables and visual attention (see Table 19). When screen time and sex were statistically controlled, only video game violence was significantly related to a greater useful field of view. Video game fast pacing was marginally related to a larger useful field-of-view. Video game violence appears to be the most robust media exposure predictor of useful field-of-view.

In order to examine the association between video game playing and visual attention in greater detail, correlations between video game genres and useful field-of-view were computed (see Table 13). This revealed that several genres of games were related to greater useful field-of-view: action games (including all three game genres within the “action game” category: first-person shooter, third-person shooter,

and action/adventure games), stategy games, single player role-playing games, and music/party games, *r*s from .15 to .26, *p*s < .05. Additionally, real world massively multiplayer online games were marginally related to greater useful field-of-view, r(229) = .127, p = .055.

Given the large number of video game genres associated with greater useful field-of-view, a general linear model was calculated including all genres, along with video game time and sex as covariates, in a single model (see Table 20). This is a very conservative test, given the substantial multicollinearity of these video game measures. However, it is hoped that this will reveal the game genres that have the most robust association with visual attention. Of these genres, only first-person shooter games and music/party games remained uniquely significant in this model, *partial r* = .253, 95% C.I.: .124, .373, and *partial r* = .251, 95% C.I.: .122, .372, respectively. Fighting games actually became uniquely negatively associated with useful field-of-view, however this finding seems likely to be a result of the high multi-collinearity between video game genres, given the lack of a zero order correlation between fighting games and UFOV, *r*(229) = .064, *p* = .355. The finding that first-person shooter games are particularly associated with UFOV is not surprising given the earlier findings linking violent and fast-paced video games to UFOV as well as previous research on visual attention, which has generally used first-person shooter games in experimental studies. Interestingly, music/party video games are uniquely related to greater UFOV, even in a very conservative model. To date, no previous studies have identified a link between such games and visual attention.

Table 20. General linear model of unique video game effects (by genre), as well as video game time and sex, on useful field-of-view. *N* = 230.

	B	***t***	***df***	***p***	***Partial r***	**95% C.I.**
1. First-person Shooter	.403	3.843	215	.000	.253	.124, .373
2. Third-Person Shooter	-.086	-.927	215	.355	-.063	-.194, .071
3. Action/Adventure	.107	1.117	215	.265	.076	-.058, .207
4. Fighting Games	-.269	-3.133	215	.002	-.208	-.332, -.077
5. Strategy Games	-.037	-.386	215	.700	-.026	-.158, .107
6. Single Player RPG_1	.050	.520	215	.604	.035	-.098, .167
7. $MMORPG_2$	.018	.211	215	.833	.014	-.119, .147
8. Sports Games	-.112	-1.428	215	.155	-.097	-.227, .036
9. Puzzle Games	.056	.754	215	.452	.051	-.083, .183
10. Simulation	-.115	-1.501	215	.135	-.102	-.232, .031
11. Real World MMO_3	.046	.567	215	.572	.039	-.094, .171
12. Music & Party Game	.288	3.808	215	.000	.251	.122, .372
13. VGT_4	-.027	-.329	215	.743	-.022	-.155, .111
14. Sex	.153	1.648	215	.101	.111	-.022, .240

1: RPG (Role-Playing Game). **2:** MMORPG (Massively Multiplayer Online Role-Playing Game). **3:** Real World MMO (Massively Multiplayer Online game). **4:** VGT (Video Game Time)

Attention Problems, Cognitive Control, Distractibility, and Visual Attention

In order to test the prediction (Hypothesis 3a) that attention problems, cognitive control, and distractibility are inversely related to visual attention, correlations between these measures were computed (see Table 7). Contrary to this prediction, none of these measures were significantly related to UFOV, $|rs| < .10$, $ps > .10$. As noted earlier, these appear to be relatively distinct traits or abilities. An examination of the media characteristics related to each of these variables (Hypothesis 3b; see Tables 7 and 13) reveals some overlap. Violent and fast paced video games, in particular showed some evidence of associations with attention

problems, proactive and reactive cognitive control, and UFOV. Even here, the associations between video game variables and attention problems are somewhat weaker and more inconsistent than some previous studies (Swing et al., 2010; Gentile et al., 2012). Nevertheless, there were notable differences in which media variables related to each ability and trait. Overall television and video game use was uniquely associated with attention problems, but not the other abilities. Various video game genres, particularly action games, related to UFOV, but not to attention problems or cognitive control. However this finding is inconsistent with some previous studies (e.g., Bailey et al., 2010; Swing, 2008, unpublished data). Additionally, television and film variables appear to be more related to attention problems than they are to cognitive control or UFOV. Media multitasking relates to attention problems, reactive cognitive control, and distractibility, albeit in seemingly inconsistent ways (possibly due to lack of validity of the distractibility measure).

CHAPTER 5. PILOT STUDY METHOD

Purpose

Video games were identified for the experimental study based on previous research: Unreal Tournament 2004 and Sims 2. Unreal Tournament 2004 is a first-person shooter video game (it is also considered an "action game" within the visual attention literature). Sims 2 is a social simulation video game. These video games were used by previous researchers and produced visual attention improvements for the Unreal Tournament 2004 group (Green & Bavelier, 2006b; Green, Pouget, and Bavelier; 2010). The present pilot study is a small scale study intended to identify aspects on which these games differ. Using a within-subjects design (all participants playing both games) gives greater power to these comparisons. Additionally, this study involved the measurement of screen change, which would have been more difficult and intrusive to measure in the experimental study.

Participants

Participants in this study were 11 undergraduate students from a large Midwestern research university. Of these participants, 6 were female and 5 were male.

Materials

Video game genre experience. Participants completed items from the general media habits questionnaire indicating for each of 11 genres how often they play it on a seven point scale (1 – Never to 7 – Every day).

Video game playing. Each participants played two PC video games (Unreal Tournament 2004 and Sims 2). The order in which participants played these games

was counterbalanced to balance any potential order effects. After each game, the participant rated the game on a variety of dimensions including “fun”, “difficult”, “violent”, and “fast paced” on a 1 to 10 scale (see Appendix L).

Screen change. While the participant was playing each video game, a computer program running on the same computer measured the rate of change in color for a subset of the pixels on the screen (1 pixel out of every 1000) at intervals of 100 ms. Note that these games were played at a resolution that displayed a total of 480,000 and 786,432 pixels for Unreal Tournament and Sims 2, respectively. Over the course of the 10 minutes, this program produced an average rate of screen change (as a percentage of the possible change) to be used as a measure of the pace of the game in addition to the pace as reported by the participants.

Procedures

Participants first completed the video game genre portion of the media habits questionnaire. Then participants played the Unreal Tournament 2004 and Sims 2. Each game was be played for 10 minutes. After each game participants completed a video game evaluation (see Appendix L). Participants were thanked for their time.

CHAPTER 6. PILOT STUDY RESULTS

Video game ratings

Participant ratings of Unreal Tournament 2004 and Sims 2 were compared using a series of paired samples t-tests. Unreal Tournament 2004 was rated (in descending order of effect size) as significantly more violent, fast-paced, action-packed, stimulating, arousing, involving, exciting, addicting, boring (reversed), and absorbing than Sims 2 (see Table 21). A follow up analysis revealed that the difference in ratings of how "boring" each game was significant among males, $t(4)$ -4.54, $p = .01$, $r(4) = .90$, but not females, $t(5) = -1.05$, $p = .34$, $r(5) = .39$. The two games did not significantly differ in participant ratings of how enjoyable, entertaining, fun, difficult, or frustrating each game was, ps $> .05$.

Screen change

A paired samples t-test of the average screen change (as a percentage) was conducted between Unreal Tournament 2004 and Sims 2. Unreal Tournament 2004 had a significantly higher rate of change in the pixels than Sims 2, $t(10) = 43.19$, $p < .001$, $r(10) = .997$. The rate of screen change in Unreal Tournament 2004 ($M = 84.15\%$, $SD = 6.41\%$) was much higher than the rate of screen change in Sims 2 ($M = 11.00\%$, $SD = 4.22\%$; see Table 21). The measure of screen change was most strongly correlated with participant ratings of how violent ($r = .89$, $p < .001$), action-packed ($r = .89$, $p < .001$), fast-paced ($r = .88$, $p < .001$), stimulating ($r = .78$, $p < .001$, exciting ($r = .65$, $p = .001$), and arousing ($r = .63$, $p = .002$) each game was.

Table 21. Differences between Unreal Tournament 2004 and Sims 2 based on participant ratings and screen change analysis. Positive values reflect dimensions on which Unreal Tournament 2004 was rated higher than Sims 2. $N = 11$.

	t	***df***	***p***	**Mean difference[1]**	***r***
Screen Change	43.19	10	<.001	69.38	.997
Violent	23.62	10	<.001	8.09	.991
Fast-paced	8.17	10	<.001	5.55	.933
Action-packed	8.08	10	<.001	5.91	.931
Stimulating	5.24	10	<.001	4.00	.856
Arousing	3.91	10	0.003	2.91	.778
Involving	3.61	10	.005	2.45	.752
Exciting	3.19	10	.010	3.36	.710
Addicting	3.03	10	.013	1.82	.692
Boring	-2.73	10	.021	-2.36	-.653
Absorbing	2.42	10	.036	1.55	.608

1. Mean difference is measured on a 1-10 scale, except for Screen Change, which was measured on a 0-100 percentage scale.

CHAPTER 7. EXPERIMENTAL STUDY METHOD

Overview

In order to provide stronger evidence of long term causal media effects on several outcome variables (cognitive control, distractibility, visual attention and aggression) a multisession experimental study was conducted. To date, few such experimental studies of long term effects on variables such as cognitive control have been published, and those published have not identified significant changes (e.g., Boot et al., 2008) leaving the number of sessions necessary to find such an effect (if it exists) undetermined. Thus, the procedures used in visual attention studies (e.g., Green & Bavelier, 2003) were the basis for the present study. This involves initial measurements of task performance before any manipulation, followed by separate video game play sessions based on the assigned condition, and then a final session in which the tasks used in the baseline are repeated.

Participants

Participants were 22 undergraduate students from a large Midwestern research university. The mean age of participants was 19.08 years (*SD* = 1.38). Participants were recruited from the research pool in introductory psychology classes by phone. Twenty-eight students were originally recruited by phone after being screened for regular video game playing (those who reported playing video games for four or more hours in an average week were excluded). Of the 28 students (9 males and 19 females) who began the study, 25 completed the study (89.3%). Of the three who discontinued participation, one was from each condition (one Unreal Tournament 2004, one Sims 2, and one no game participant) and these

included two females and one male. Three more participants were dropped from analyses due to high habitual video game playing (despite efforts to screen out such participants) giving a final sample of 22 (8 males, 14 females).

Materials

Participants completed the same questionnaires and performance measures used in the Correlational Study (i.e., media habits, media multitasking, self-control, impulsiveness, attention problems, trait aggression, violence, demographic questions, the Stroop task, the Distractibility task, and the UFOV task (see Appendices A-K). Additionally, participants completed a single video game evaluation using the same form used in the Pilot Study (see Appendix L). Participants also completed a recent media use summary at the end of the study (see Appendix M).

Ice water aggression paradigm. Participants were told that another participant in the next cubicle was completing a different version of the distractibility task in which they must submerge one's hand in a bucket of ice water while reading one of the passages instead of having the television clip play (based on Vasquez, Denson, Pedersen, Stenstrom, & Miller, 2005). The bucket of ice water was shown to the participants and they were asked to briefly submerge their hand in it in order to see how distracting it is. Previous research has revealed that briefly submerging their hand in a bucket of ice water reveals it to be painful, thus this measure actually captures the extent to which participants aggress against their ostensible partner (there was, in fact, no other participant receiving the ice water assignment). They were told that participants are assigned to different conditions of the Distractibility

Task (one in which the distraction is a video clip, another in which it consists of ice water submersion) and each must determine the length of the distractor for the other participant. They were then told that we need to determine how much distraction another participant should receive on an 11 point scale (0: “no distraction/0 seconds” to “very strong distraction/120 seconds” in 12 second intervals). Immediately before receiving the opportunity to assign an amount of distraction, participants will learn that the alleged opponent selected the length of the video clip distractor that they were exposed to (the number “210 seconds”, which represented the 8th of 11 increments, was circled on the form on which they indicated their partner's ice water assignment).

Video games. Participants were randomly assigned prior to recruitment to one of three conditions: the action video game condition (Unreal Tournament 2004), a control game condition (Sims 2), or a no game condition. Unreal Tournament 2004 is a violent, fast-paced video game, whereas Sims 2 is a non-violent social simulation video game. The no game condition allowed an additional test to show that the control game was not having an effect. However, because this comparison was of secondary interest, random assignment was made such that 50% of participants were assigned to play Unreal Tournament 2004, 25% were assigned to play Sims 2, and 25% were assigned to the no game control condition. Assuming there are no differences between the Sims 2 and no game control conditions, this assignment pattern gives the maximum statistical power to the Unreal Tournament 2004 vs. Control comparison that is of primary interest.

Procedures

Experimental procedures. Participants were randomly selected from the course list of Psychology 101, which offers required and extra course credit through research participation. Before being contacted, potential participants were randomly assigned to be recruited for the action game condition, the control game condition, or the no game control condition. After being screened for habitual video game playing (less than 4 hours per week), participants were invited to participate in a 12 session (50 minutes each), 12 credit study if they had been assigned to the action game or control game conditions or a two session (50 minutes each), two credit

Table 22. Comparison of session activities for action game, control game and no game control participants.

Ssn.	Action Game	Control Game	No Game Control
1	Questionnaires, Pretest: Stroop, Distractibility, and UFOV	Questionnaires, Pretest: Stroop, Distractibility, and UFOV	Questionnaires, Pretest: Stroop, Distractibility, and Enumeration
2	50 minutes of UT2004	50 minutes of Sims 2	No session
3	50 minutes of UT2004	50 minutes of Sims 2	No session
4	50 minutes of UT2004	50 minutes of Sims 2	No session
5	50 minutes of UT2004	50 minutes of Sims 2	No session
6	50 minutes of UT2004	50 minutes of Sims 2	No session
7	50 minutes of UT2004	50 minutes of Sims 2	No session
8	50 minutes of UT2004	50 minutes of Sims 2	No session
9	50 minutes of UT2004	50 minutes of Sims 2	No session
10	50 minutes of UT2004	50 minutes of Sims 2	No session
11	50 minutes of UT2004	50 minutes of Sims 2	No session
12	Post-test measures: Stroop, Distractibility, UFOV; Video game eval.; Recent media summary; Ice Water Paradigm; Debrief	Post-test measures: Stroop, Distractibility, UFOV; Video game eval.; Recent media summary; Ice Water Paradigm; Debrief	Post-test measures: Stroop, Distractibility, UFOV; Recent media summary; Ice Water Paradigm; Debrief

study if they had been assigned to the no game condition. The schedule of sessions is listed in Table 22. When participants in either condition came to the laboratory for the first session, they completed the Informed Consent Document and then the same computer performance tasks (Stroop, Distractibility, and UFOV) and questionnaires (media habits, media multitasking, self-control, impulsiveness, attention problems, aggression, and demographics) used in the Correlational Study. Participants scheduled their remaining sessions before they left. Efforts were made to complete all sessions within 28 days of beginning the study, though in practice participants often took longer (mean length of participation = 41.32 days, *SD* = 15.68). Length of time to complete the study did not differ significantly by condition based on a one-way ANOVA, $F(2,19) = .851$, $p = .443$.

The next 10 sessions (for those in the two game conditions) consisted entirely of arriving and playing the assigned video game for 50 minutes. For participants in all conditions, the last session was identical. Participants completed post-test measures of the Stroop task, Distractibility task, UFOV task, before completing the video game evaluation (see Appendix L), recent media summary (see Appendix M), and then the ice water aggression paradigm. Participants were then debriefed for suspicion and receive a full debriefing statement before leaving.

Ethical concerns. This study raised some ethical concerns due to the potential to exert an undesirable effect on attention, control, and aggression related variables. These concerns should be put into perspective and the steps to be taken to reduce harm discussed. Though the study briefly increased video game playing for participants, it did so by only approximately 85 minutes per week over the course of

the study. Given the low baseline of video game playing due to selection of individuals who play video games for fewer than 4 hours per week, these participants remained well below the mean for this population (7.49 hours per week in a similar sample; Swing et al., 2010). Further, a number of previous studies (e.g., Green & Bavelier, 2003) have assigned participants to similar manipulations without apparent recognition of risk. Researchers are likely to continue using such manipulations if no evidence of harmful effects is obtained. If electronic media such as action video games can exert harmful effects, then the stronger evidence of causality this study can potentially provide would have a substantial benefit for reducing harmful electronic media exposure. This potential benefit helps to justify the risk posed by this study, though this risk was reduced as much as possible without undermining the value of the study.

The risk was addressed in the following ways. Before beginning the study participants were be encouraged to do so at a time in the academic semester when it will pose the least disruption to their academic work. Participants were warned before consenting to participate that because the study involves playing a video game for a substantial amount of time, it may interfere with their school work. Finally, after debriefing in the final session, participants in all conditions were given an information sheet briefly describing techniques for improving self-regulatory ability (e.g., mindfulness meditation, exercise) and encouraged to seek out further information about these techniques if they fear their abilities were impaired.

CHAPTER 8. EXPERIMENTAL STUDY RESULTS

Preliminary Analyses

Selection Criterion Check

Participants were selected to participate in the study based on their response to the question “do you play video games for four or more hours in a typical week?” At the time they were asked, participants did not know the nature of the study or which response would disqualify them from participating. Nonetheless, it is possible that some participants gave incorrect answers to this question. Of particular concern are those who indicated that they were below the video game playing threshold, but did in fact play video games more. Because the video game training depends on relatively inexperienced players (those with more experience may have already had their abilities shifted as far as is possible from their prior game play), a preliminary analysis were done to verify that all participants were below the video game playing threshold.

Weekly video game playing hours was calculated based on the average from the questions about video game playing hours per week in the Media Habits Questionnaire, Media Multi-tasking Index, and the Recent Media Summary (the question about video game playing from the past three weeks). Three participants averaged four or more hours per week according to this composite. These participants were dropped from subsequent analyses. The remaining sample of 22 participants averaged 1.24 hours of video game playing per week (SD = 1.35) based on the composite measure. These participants include 14 females and 8 males.

Control Group Comparisons

In order to test the possibility that the video game control group (Sims 2) caused changes in the outcome measures, independent samples t-tests were calculated comparing the Sims 2 control group and no game control group on proactive cognitive control, reactive cognitive control, distractibility, useful field-of-view and aggression (see Table 23). For all measures, change scores (last session score minus first session score) were used as the outcome variable (see Appendices N and P for first and last session means and standard deviations as well as Appendices O and Q for means, standard deviations and confidence intervals for the correlational study, for comparison). The Sims 2 and no game conditions did not significantly differ in changes in proactive cognitive control, useful field-of-view, or

Table 23. Independent samples t-tests comparing Sims 2 condition control participants to no game control participants on cognitive control, distractibility, UFOV, and aggression. Positive values reflect Sims 2 being associated with more positive changes than no game. *N* = 10-11.

	t	***df***	***p***	***r***	***Sims 2 Change***	***No Game Change***
Model 20: Proactive Control						
	1.592	9	.146	.450	37.83	173.59
Model 21: Reactive Control						
	-2.478	9	.035	-.617	-104.47	43.66
Model 22: Distractibility						
	2.179	9	.054	.567	-1.43	.80
Model 23: UFOV						
	.415	10	.687	.130	1.71	6.20
Model 24: Aggression						
	.291	10	.777	.092	52.80	48.00

aggression (*t*s < 1.6, *p*s > .10). Subsequent analyses of these variables will combine Sims 2 and no game participants and analyses compared Unreal Tournament 2004 vs. Control participants. Sims 2 and control participants did differ in changes to reactive cognitive control, $t(9) = -2.478$, $p < .05$ and were marginally different in changes to distractibility, $t(9) = 2.179$, $p = .054$. Though these differences were not expected, subsequent analyses of reactive cognitive control and distractibility compared all three groups (without combining the Sims 2 and no game control groups).

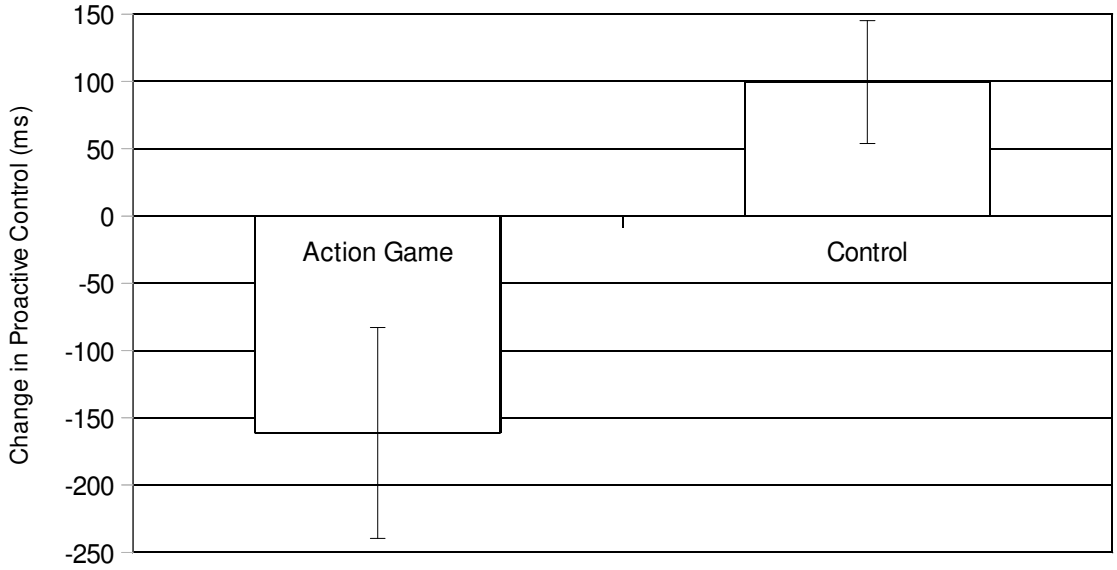
Primary Analyses

Proactive and Reactive Cognitive Control

In order to test the effect of action video game playing on proactive cognitive control, an independent samples t-test was computed. Change in proactive cognitive control (from the first to the final session) was used as the dependent variable. Because group differences were not found between Sims 2 and no game, these groups were combined for this analysis. Action game training differed from the control conditions in changes in proactive cognitive control, $t(19) = -2.942$, $p < .01$, $r = -.550$, 95% C.I.: -.793, -.156. Specifically, action video game training decreased proactive cognitive control based on the Stroop task (see Figure 5).

In order to test the effect of group assignment (action game, Sims 2, or no game) on reactive cognitive control, a one-way ANOVA was calculated. This revealed no significant group differences, $F(2,18) = 2.012$, $p = .163$ (see Figure 6). Though the preliminary analysis had revealed a difference between Sims 2 and the

Figure 5. Action video game training effects on proactive cognitive control. Standard error bars are displayed for each group mean. $N = 21$.

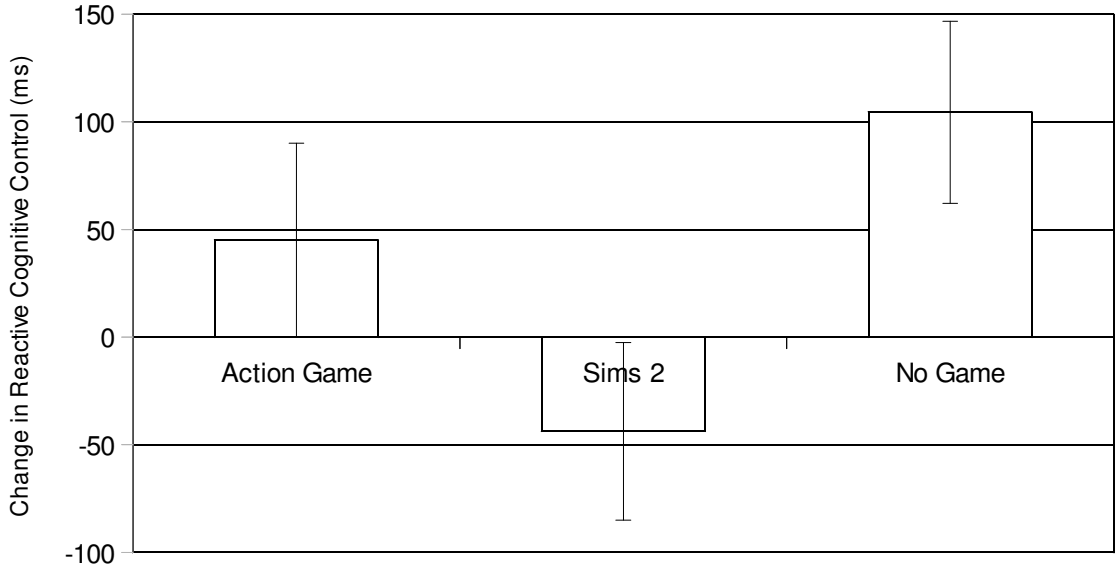


no game control condition, a Bonferroni corrected post-hoc test revealed that this comparison was not significant, Sims 2 (M = -43.66 ms, SD = 92.26), no game (M = 104.47 ms, SD = 103.59), p = .182. It should be noted, however, that the assignment pattern used (50% action game, 25% control game, 25% no game) reduced the power for this comparison. Post-hoc comparisons of the action game condition to Sims 2 and action game condition to the no game condition were non-significant, ps > .60. Group assignment did not appear to affect reactive cognitive control. This result is consistent with the finding of Bailey et al. (2010) that high and low action gamers did not differ in reactive cognitive control.

Distractibility

In order to test the effects of group assignment on distractibility, a one-way ANOVA was computed comparing the action game, control game, and no game

Figure 6. Group assignment differences in changes in reactive cognitive control. Standard error bars are displayed for each mean. $N = 21$.

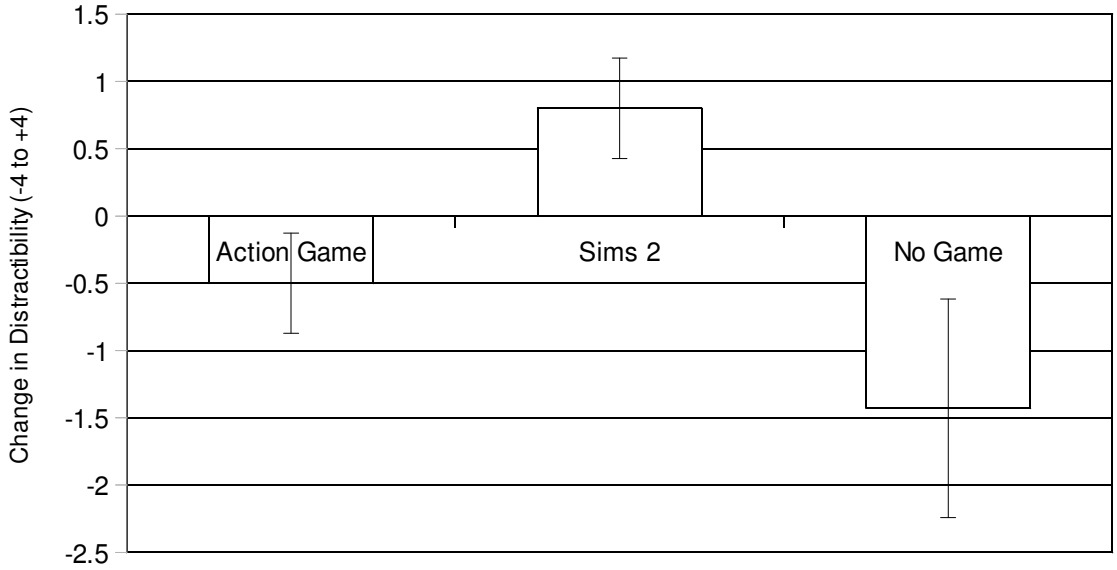


conditions (see Figure 7). The control game and no game conditions were not combined given the marginally significant difference between these groups found in preliminary analyses. This ANOVA revealed marginally significant differences between groups, $F(2,19) = 3.20$, $p = .063$. Bonferroni post-hoc comparisons revealed a marginally significant difference between the Sims 2 condition ($M = .80$, $SD = .84$) and no game condition ($M = -1.42$, $SD = 2.15$) on changes in distractibility, $p = .061$. This provides some evidence that Sims 2 increased participants' distractibility. The action game condition did not significantly differ from either the Sims 2 or no game conditions, ps > .30.

Useful Field-of-View

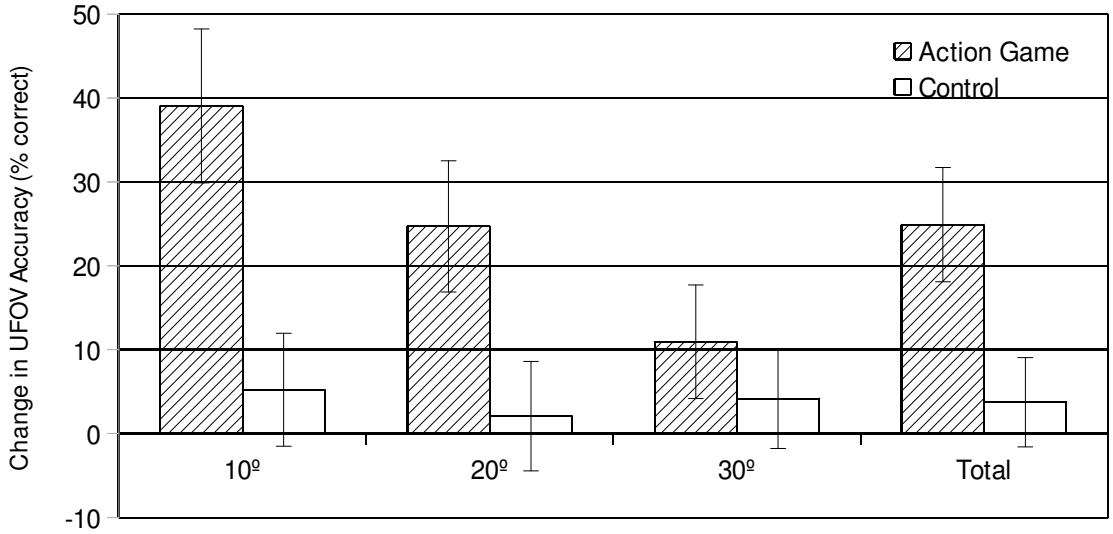
An independent samples t-test was computed comparing the action game and

Figure 7. Group assignment differences in changes in distractibility. Standard error bars are displayed for each mean. $N = 21$.



control conditions on useful field-of-view (see Figure 8). Given the lack of a significant difference between the Sims 2 and no game conditions, these were combined as a single "control" condition. There was a significant difference between conditions, $t(20) = 2.481$, $p < .05$, $r = .476$, 95% C.I.: .069, .747. In order to specify where this change in UFOV occurred, additional independent samples t-tests were computed at the 10º, 20º, and 30º positions. These analyses revealed significant differences at 10º and 20º, $t(20) = 3.036$, $p < .001$, $r = .552$, 95% C.I.: .170, .789, and $t(20) = 2.236$, $p < .05$, $r = .439$, 95% C.I.: .022, .726, respectively. The difference at 30º was not significant, $t(20) = .753$, $p = .460$, $r = .162$, 95% C.I.: -.278, .546. Action game training appears to increase participants' useful field-of-view, though this improvement appears to be limited to the 10º to 20º range.

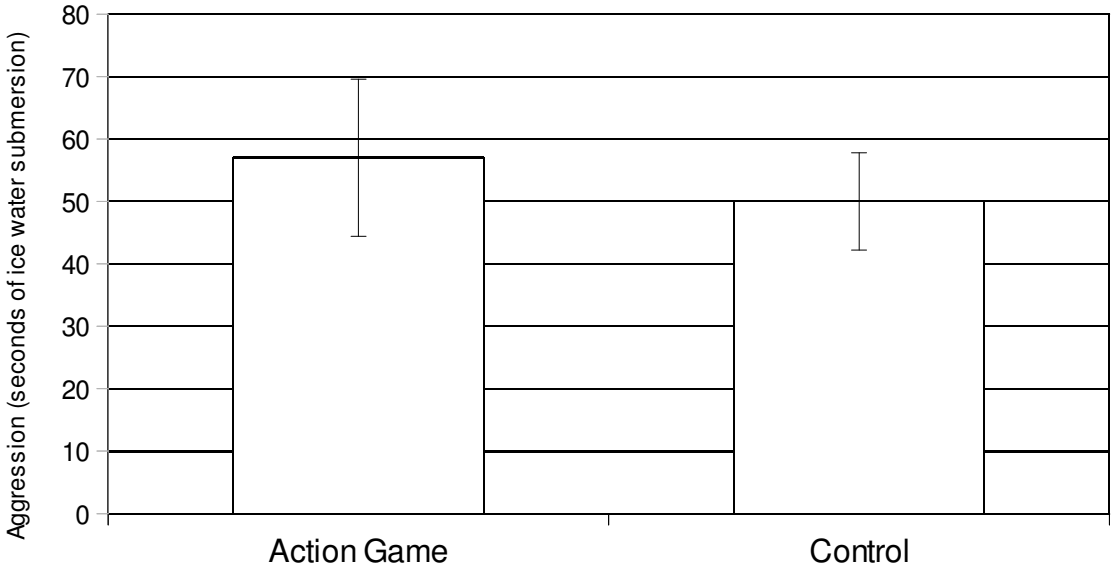
Figure 8. Action video game training effects on useful field-of-view. Standard error bars are displayed for each group mean. $N = 22$.



Aggression

Before comparing groups for aggression, two participants were removed from analyses due to reporting suspicion of the aggression measure during debriefing. An independent samples t-test compared those in the action game condition to participants in the control conditions (see Figure 9). Because no difference was found in preliminary analyses, Sims 2 and no game participants were combined in a single "control" condition. No significant difference was found in aggression based on the ice water task, $t(18) = .501$, $p = .622$, $r = .114$, 95% C.I.: -.345, .529. Group assignment did not significantly affect aggression.

Figure 9. Action video game training effects on aggression. Standard error bars are displayed for each group mean. $N = 22$.



CHAPTER 9. DISCUSSION

Attention Problems

The present correlational study examined a broad range of media variables in relation to attention problems. As hypothesized (Hypothesis 1a), higher levels of television and video game time were associated with more attention problems. These associations remained significant (albeit only marginally for video game time) even when sex, age, and a number of other significant predictors of attention problems were statistically controlled. These included controls for parental mental health problems, genetic risk (based on family attention disorder diagnosis), and dietary risk. Though, like all cross-sectional research, the support for a causal link is limited, the list of alternative explanations ruled out for the media exposure-attention problems link has expanded. Between the correlational study and previous studies, most known risk factors for attention problems have been statistically controlled without eliminating this link, which is useful evidence in favor of a causal interpretation. The third variable hypothesis has not generated much support, though it remains possible that some plausible alternative explanation will emerge. Specific aspects of these media also appear to be particularly associated with attention problems (Hypotheses 2a and 2b). Violent and fast-paced television, films, and video games are associated with greater attention problems. This link goes beyond simply the amount of time spent on these media, suggesting (if this is a causal link) that media which are violent and fast-paced may especially increase attention problems.

Of the types of media use not previously tested in relation to attention

problems (various forms of computer use, musical and non-musical audio, phone use, and print media reading), only watching videos on the computer and text messaging were related to attention problems (Hypothesis 1b). That watching videos on a computer is positively related to attention problems is not surprising – this activity is not substantively different from television viewing. The finding that the frequency of sending and receiving text messages (but not actual phone conversations) relates positively to attention problems is interesting. Future research should attempt to replicate this finding, ideally using longitudinal designs that could eliminate the possibility that attention problems predispose a person to texting. The fact that several other forms of media use (e.g., listening to music or non-musical audio, reading print media, instant messaging) were unrelated to attention problems is itself a noteworthy finding. It may be that specific aspects of electronic media are required to influence attention problems and that some media lack those aspects. For example, music and non-musical audio do not involve a screen. Similarly, print media require much more self-directed (as opposed to stimulus driven) attention.

As hypothesized (Hypothesis 1c), media multitasking is related to greater attention problems. This is true even when the overall amount of time spent on those media is statistically controlled. This suggests that at least some aspects of context matter for media effects. That is, it is not just a issue of which media are used, but how they are used. As this is the first evidence of a link between media multitasking and attention problems, more studies (including studies using longitudinal designs) will be needed to support a causal interpretation. If this link is causal, one possibility is that using more than one form of media at a time is more stimulating than using

only one, leading a person to become accustomed to a very high level of stimulation that is not present in other activities.

Cognitive Control

The link between media use and cognitive control (both proactive and reactive) was examined in both the correlational and experimental studies. As hypothesized (Hypotheses 2a and 2b), violent television, violent video games, and fast-paced video games were associated with lower proactive cognitive control. This remained true for violent and fast-paced video games (marginally significant for violent television) even with overall time spent on video games statistically controlled. Reactive cognitive control, on the other hand was uniquely positively related to violent and fast-paced video games, even when overall video game use was controlled. This may indicate that violent and fast paced video games lead individuals to shift the form of cognitive control they habitually use (less proactive, more reactive).

Evidence from the experimental study showed that assignment to an action game (Unreal Tournament 2004), which is both violent and fast-paced, decreased proactive cognitive control (Hypothesis 4). This assignment did not, however, lead to differences in reactive cognitive control. The evidence of an experimental effect of action game playing on proactive cognitive control is significant. This provides important evidence of a causal negative effect of certain video games on proactive cognitive control. Future research should attempt to replicate this finding. It would also be particularly useful in future studies to include other types of video games. It

remains an open question whether the essential element is video game violence, video game fast-pacing, the combination of the two, or perhaps some other characteristic found in action games but not other games such as Sims 2. Using games that are fast-paced, but not violent, might help answer this question.

Correlations between other media variables and cognitive control (Hypotheses 1b and 1c) revealed few associations. Reading print media was marginally positively related to proactive cognitive control. This association makes some sense – reading print media would seem to involve retaining information in working memory (presumably to a greater extent than many other forms of media such as television or video games). Text messaging and media multitasking were associated with lower reactive cognitive control. It is possible that text messaging and media multitasking are causing decreased reactive cognitive control as well increased attention problems. Given that reactive control was measured in this study as the Stroop interference effect (reversed), this might mean that frequent text messagers and multitaskers have greater difficulty filtering out irrelevant information in a reactive manner as the Stroop task requires.

Distractibility

The measure of distractibility was intended to measure executive functioning in a way that is ecologically valid for university students. Students often try to study course material while a television is on in the same room, requiring them to protect their goal related processing (studying) from interference. The measure did not relate as would be expected to attention problems or cognitive control. It was

expected to relate positively to proactive cognitive control. In this study, however, it was unrelated to proactive control but negatively associated with reactive cognitive control. Distractibility also was expected to relate to trait (self-report) measures of attention problems, but it did not. Given that distractibility did not relate to these measures in the way one would expect, it is not clear if it was measuring the intended construct. This may be due to low validity (possibly due to poor psychometric properties) or could be due to this task measuring an ability that is not empirically related to executive functioning as measured by the Stroop task (even if they would seem to be conceptually related). Furthermore, the Stroop task only measures some aspects of executive function. Future research might attempt further variations in measuring distractibility in order to clarify what, if anything, this task is measuring.

Visual Attention

Consistent with previous research and Hypothesis 3b, playing violent and fast paced video games was associated with greater visual attention. Specifically, those who played such video games more frequently showed a larger useful field-of-view. Experimental assignment to Unreal Tournament 2004, which is both violent and fast-paced, led to improvements on the UFOV task. Based on the correlational study, this association appears to be quite specific: television and film exposure were unrelated to UFOV performance.

Though violent and fast-paced video games were particularly associated with a larger useful field-of-view, one surprising finding was that music and party games

were robustly correlated to larger UFOV. These games are certainly not violent and do not seem to be considered fast-paced (playing music and party games was unrelated to fast-paced video game playing, $r = .01$, $p > .10$). They do seem to require allocating attention to more than one location on the screen simultaneously, though. For example, in games such as Guitar Hero or Rock Band, notes are displayed cascading down the screen. The notes the player must play at a given moment appear near the bottom of the screen, while the notes to be played next appear higher up on the screen. Thus, a player who wants to track upcoming notes would presumably distribute their visual attention across space. Future experimental studies should test the effects of music and party video game training on visual attention. If they do improve visual attention, this would be quite noteworthy given the lack of an association between these games and the various negative video game effects (aggression, attention problems, and proactive cognitive control) and thus might have practical benefits (e.g., recommending these games as an alternative to other types of games that are associated with these negative effects).

Additional associations were found between listening to music and greater UFOV performance as well as e-mail use and poorer UFOV performance. If these represent causal effects, the reason is not clear. Listening to music is, by nature, an auditory (rather than visual) task. Controlling for sex and action video game playing did not eliminate either of these effects. One possible explanation for the positive association with listening to music and UFOV is that, similar to the Music and Party game playing and UFOV finding, those who listen to music may also sing or play musical instruments more frequently. To the extent that this performance involves

reading sheet music, it might be expected to lead to improvements in visual attention due to visual attention demands similar to those hypothesized for music and party video games.

Aggression

The correlational study found a link between violent media and aggression, as well violent media and violent behavior, consistent with previous research. There was evidence from the correlational study that attention problems are a plausible partial mediator for this media violence to aggression link. In the experimental study, however, contrary to Hypothesis 5, no effect was found between the violent game playing and aggression. Thus, no mediation analyses were conducted testing attention, cognitive control, or distractibility as mediators.

There are several possible explanations for the lack of an experimental video game effect on aggression. One possibility is that 10 sessions is not long enough for long term violent media effects to emerge. This length of time was based on visual attention studies. Most experimental violent media effects have involved a single laboratory session and measured short term effects within 30 minutes of the exposure to violent media. The present study measured aggression in a different session on a different day, thus depending on longer term effects. Long term media violence effects are typically assessed through longitudinal studies measuring periods of time much longer than 42 days and levels of exposure much greater than 10 hours.

Another possibility is that the small sample in the present training study (N =

20 for the aggression analysis) did not provide adequate power to detect this effect. Meta-analyses (e.g., Anderson et al., 2010) have indicated an effect size of approximately $r = .20$ for violent video games on aggression, which would require a much larger sample size in order to reliably find an effect. Power could be especially problematic for aggression in this study because, unlike cognitive control, distractibility, and useful field-of-view, aggression was not measured in a pretest/posttest design that takes into account individual differences. This might leave more error variance (from individual differences) in the measurement of the experimental effect.

Finally, it is also possible that the sample did not show long term effects clearly because some of these participants have already been affected by exposure to media violence. Participants were screened for overall video game playing, which would have kept video game violence exposure relatively low in this sample, but other forms of violent media (e.g., violent television and violent films) were not used in screening. Thus, it is possible that the sample had previously been exposed to a considerable amount of these other forms of violent media. Cumulative violent media effects would be theoretically less likely to be found among those previously exposed to violent media. Once aggressive scripts and beliefs have been formed, for example, there is a limit to what further media violence exposure could do. An ideal sample with respect to the aggression measure would thus have been screened to produce a sample low in past violent media exposure, rather than low total time with a particular form of media (e.g., video games).

Relations Between Attention Problems, Cognitive Control, & Visual Attention

It was hypothesized (Hypothesis 3a) that attention problems and cognitive control would be positively correlated. This was not the case in the correlational study, with these measures appearing to be uncorrelated. This is surprising, given the conceptual link between attention disorders and executive functions. Both proactive and reactive cognitive control are types of executive functions. It is possible that attention disorders are associated with disruptions in other forms of executive functions that are not well captured by this task.

Alternatively, this impairment may be less apparent in an undergraduate sample, which may well be less impaired in executive function due to maturation (younger individuals may not yet have developed these abilities as well) and selection (highly impaired individuals may not enter or remain in a university setting). Such maturation and/or selection effects might make it less likely to find an association between attention problems and cognitive control, as the extreme end of the distribution of each variable has been truncated.

Additionally, contrary to expectations (Hypothesis 3a) attention problems and cognitive control were unrelated to visual attention. There was, however, some support for the hypothesis (Hypothesis 3b) that the same media that negatively influenced attention problems and cognitive control would positively influence visual attention. Visual attention appeared to be associated mostly with violent and fast-paced video games (with the exception of music and party games). These games were also associated with proactive cognitive control (negatively) and attention problems (positively).

However, despite this overlap on violent/fast-paced video games, there were asymmetries in the media associated with attention problems, cognitive control, and visual attention. Total hours of television and video game time seem to be uniquely associated with attention problems but not the other outcomes. This suggests that the displacement hypothesis may apply to attention problems but not other outcomes (proactive cognitive control, visual attention). Television and film variables were also largely unrelated to cognitive control and visual attention, though they were related to attention problems. The specific genres of video games were related to visual attention but generally not to attention problems or cognitive control, in the current correlational sample. This was not the case in other studies (e.g., Bailey et al., 2010; Swing, 2008, unpublished data), though, and given that some of the broader characteristics of such genres (violence, fast-pacing) *were* related to attention problems and cognitive control, caution is probably warranted in interpreting this finding (it may simply be chance). Finally, text messaging and media multitasking were related to greater attention problems and lower reactive cognitive control but not proactive cognitive control or visual attention.

Some of these differences in which media variables predict each outcome might be due to chance. Yet given the consistency between these findings and the media used in previous studies (i.e., proactive cognitive control and visual attention studies typically use video games but not television or films, whereas attention problems and aggression research uses all three) they may in fact reflect actual differences in which types of media variables affect each of these outcomes.

The small correlations between attention problems and visual attention, as

well as differences in the associations of each variable with media exposure suggests that, despite the shared use of the word “attention”, these reflect very different dimensions. Theoretically, this is to be expected. Attention problems reflect difficulty in impulse control, whereas visual attention reflects efficacy in the processing of visual information.

General Conclusions

Given the prominent role that electronic media play in our lives – collectively occupying perhaps one-fourth to one-third of the hours Americans spend from cradle to grave – it is not surprising that these media would influence our thinking and behavior. The research evidence of media effects on different outcomes varies considerably in strength, with some effects (e.g., media violence on aggression) being very well established and others (e.g., action video games on proactive cognitive control) being quite new. As psychological research progresses, the evidence for the newer areas will become clearer and additional outcomes may gain scientific consideration as well. What has become clear so far, and is advanced to some extent in the current studies, is not only that some of these effects are causal, but also that they depend on somewhat distinct mental processes and different media variables.

Aggression and violence are causally increased specifically by violent media content (i.e., depictions of characters harming or attempting to harm other characters). Attention problems are associated, perhaps also causally, with overall hours spent watching television and playing video games. There is some evidence

that violent and fast-paced media content also make a unique contribution to attention problems (beyond total hours). Proactive and reactive cognitive control seem to be associated primarily with violent, action video games. The present experimental study provides some early evidence that this association is causal. Visual attention is improved by violent, action video games as well.

It is possible that other non-violent video games (i.e., music and party video games) also improve visual attention, though that possibility has yet to be experimentally tested. Music listening is also associated with superior visual attention. Other media use variables, such as text messaging and media multitasking, also correlate with attention problems and reactive cognitive control. These associations need further replication and extension using more rigorous designs (cross-sectional studies with control variables relevant to plausible alternative explanations, as well as longitudinal and experimental studies).

Rather than viewing on media effects as generally good or generally bad, researchers and the general public should understand that media effects include both positive and negative consequences (Saleem & Anderson, 2012). In some cases, a particular type of media will cause both positive and negative consequences simultaneously, whereas other types of media might produce mostly positive or mostly negative consequences. Only by understanding the circumstances in which electronic media produce each effect can we find ways to deliberately minimize the negative effects and maximize the positive effects.

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APPENDIX A: MEDIA HABITS QUESTIONNAIRE

I. What are your three most frequently watched television shows?

a. Title #1:_____

1. How often do you watch this show?

- ❑ Once a month or less
- ❑ 2-3 times a month
- ❑ Once a week
- ❑ 2-4 times a week
- ❑ 5 or more times a week

2. How often do characters try to physically injure each other in this show? **Never:**1 2 3 4 5 6 7**:All the time**

3. How fast paced is this show? **Extremely slow:** 1 2 3 4 5 6 7**:Extremely fast**

b. Title #2:_____

4. How often do you watch this show?

- ❑ Once a month or less
- ❑ 2-3 times a month
- ❑ Once a week
- ❑ 2-4 times a week
- ❑ 5 or more times a week

5. How often do characters try to physically injure each other in this show? **Never:**1 2 3 4 5 6 7**:All the time**

6. How fast paced is this show? **Extremely slow:** 1 2 3 4 5 6 7**:Extremely fast**

c. Title #3:_____

7. How often do you watch this show?

- ❑ Once a month or less
- ❑ 2-3 times a month
- ❑ Once a week
- ❑ 2-4 times a week
- ❑ 5 or more times a week

8. How often do characters try to physically injure each other in this show? **Never:**1 2 3 4 5 6 7**:All the time**

9. How fast paced is this show? **Extremely slow:** 1 2 3 4 5 6 7**:Extremely fast**

II. What are your three most frequently watched movies/videos/DVDs?

a. Title #1:_____

10. How many times have you watched this movie?

- ❑ Once
- ❑ Twice
- ❑ Three times
- ❑ Four times
- ❑ Five or more times

11. How often do characters try to physically injure each other in this film? **Never:**1 2 3 4 5 6 7**:All the time**

12. How fast paced is this film? **Extremely slow:** 1 2 3 4 5 6 7**:Extremely fast**

b. Title #2:_____

13. How many times have you watched this movie?

- ❑ Once
- ❑ Twice
- ❑ Three times
- ❑ Four times
- ❑ Five or more times

14. How often do characters try to physically injure each other in this film? **Never:**1 2 3 4 5 6 7**:All the time**

15. How fast paced is this film? **Extremely slow:** 1 2 3 4 5 6 7**:Extremely fast**

c. Title #3:_____

16. How many times have you watched this movie?

- ❑ Once
- ❑ Twice
- ❑ Three times
- ❑ Four times
- ❑ Five or more times

17. How often do characters try to physically injure each other in this film? **Never:**1 2 3 4 5 6 7**:All the time**

18. How fast paced is this film? **Extremely slow:** 1 2 3 4 5 6 7**:Extremely fast**

III. What are your three most frequently played video games?

a. Title #1:_____

19. How often do you play this game?

- ❑ Once a month or less
- ❑ 2-3 times a month
- ❑ Once a week
- ❑ 2-4 times a week
- ❑ 5 or more times a week

20. How often do characters try to physically injure each other in this video game? **Never:** 1 2 3 4 5 6 7**:All the time**

21. How fast paced is this video game? **Extremely slow:** 1 2 3 4 5 6 7**:Extremely fast**

b. Title #2:_____

22. How often do you play this game?

- ❑ Once a month or less
- ❑ 2-3 times a month
- ❑ Once a week
- ❑ 2-4 times a week
- ❑ 5 or more times a week

23. How often do characters try to physically injure each

other in this video game? **Never:** 1 2 3 4 5 6 7**:All the time**

24. How fast paced is this video game? **Extremely slow:** 1 2 3 4 5 6 7**:Extremely fast**

c. Title #3:_____

25. How often do you play this game?

- ❑ Once a month or less
- ❑ 2-3 times a month
- ❑ Once a week
- ❑ 2-4 times a week
- ❑ 5 or more times a week

26. How often do characters try to physically injure each other in this video game? **Never:** 1 2 3 4 5 6 7**:All the time**

27. How fast paced is this video game? **Extremely slow:** 1 2 3 4 5 6 7**:Extremely fast**

28. On a typical <u>school day</u> (Monday through Friday), for how many *<u>hours</u>* do you **<u>play video games</u>** during each of the following times?

6 am - Noon	**Noon - 6 pm**	**6 pm - Midnight**	**Midnight - 6 am**
_____ hours/day	_____ hours/day	_____ hours/day	_____ hours/day

29. On a typical <u>weekend day</u> (Saturday or Sunday), for how many *<u>hours</u>* do you **<u>play video games</u>** during each of the following times?

6 am - Noon	**Noon - 6 pm**	**6 pm - Midnight**	**Midnight - 6 am**
_____ hours/day	_____ hours/day	_____ hours/day	_____ hours/day

30. On a typical <u>week day</u> (Monday through Friday), for how many *<u>hours</u>* do you **<u>watch TV/movies</u>** during each of the following times?

6 am - Noon	**Noon - 6 pm**	**6 pm - Midnight**	**Midnight - 6 am**
_____ hours/day	_____ hours/day	_____ hours/day	_____ hours/day

31. On a typical <u>weekend day</u> (Saturday or Sunday), for how many *<u>hours</u>* do you **<u>watch TV/movies</u>** during each of the following times?

6 am - Noon	**Noon - 6 pm**	**6 pm - Midnight**	**Midnight - 6 am**
_____ hours/day	**_____ hours/day**	**_____ hours/day**	**_____ hours/day**

How often do you play each of the following genres of video games? (Examples listed after)

1: I **never** play it
2: I **rarely** play it
3: I **occasionally** play it
4: I **sometimes** play it
5: I **often** play it
6: I **always** play it

_____ Sports (Madden NFL 09, NBA 2K9)
_____ Action/adventure (Prince of Persia, Tomb Raider)
_____ Puzzle games (Super Monkey Ball, Tetris)
_____ Fighting games (Street Fighter IV)
_____ First-Person Shooters (Halo, Unreal Tournament, Far Cry 2)
_____ Third-Person Shooters (Gears of War, Grand Theft Auto)
_____ Strategy (Starcraft II, Civilization)
_____ Simulation (Flight Simulator, Sim City)
_____ Music & Party (Dance Dance Revolution, Guitar Hero)
_____ Single-player Roleplaying Game (Diablo 2, Final Fantasy XII)
_____ Real World Massively Multiplayer Online Game (Second Life)
_____ Massively Multiplayer Online Roleplaying Game (World of Warcraft, Guild Wars)

APPENDIX B: MEDIA MULTITASKING INDEX

Please indicate your agreement or disagreement with the following three statements on a seven point scale.
1=strongly disagree 2=disagree 3=neither agree nor disagree 4=agree 5=strongly agree

1. I am able to do two things at the same time without hurting my performance on either of them.
2. I can multi-task more effectively than the average person.
3. Having a TV, radio, or video game system on in the same room does not harm my concentration on other activities.

4. Do you read print media (for either work or pleasure)? This would include books, newspapers, magazines, traditional mail, etc.
5. Approximately how many hours a week do you spend doing this activity? (please count all hours spent doing this activity, whether you are doing this activity only, or whether you are doing additional things at the same time)
6. When you are reading print media, how often are you also doing the following at the same time:

Never A little of the time Some of the time Most of the time

Watching television, video, and/or DVDs (on a TV)
Watching video content on a computer
Listening to music
Listening to non-musical audio (news radio, podcasts, etc…)
Playing video or computer games
Talking on the phone
Instant messaging (chat)
Mobile phone text-messaging
Reading/writing e-mails
Reading web pages, pdfs, and/or other electronic documents
Using other computer applications (word processing, spreadsheets, programming, etc..)
Reading other print media simultaneously.

7. Do you watch television? This would include watching network/cable/on-demand/TiVo programs, as well as watching videos and/or DVDs on a TV (as opposed to a computer)
8. Approximately how many hours a week do you spend doing this activity? (please count all hours spent doing this activity, whether you are doing this activity only, or whether you are doing additional things at the same time)
9. When you are watching television, how often are you also doing the following at the same time:

Never A little of the time Some of the time Most of the time

Watching other television, video, and/or DVDs (on a TV) simultaneously
Watching video content on a computer
Listening to music
Listening to non-musical audio (news radio, podcasts, etc…)
Playing video or computer games
Talking on the phone
Instant messaging (chat)
Mobile phone text-messaging
Reading/writing e-mails

Reading web pages, pdfs, and/or other electronic documents
Using other computer applications (word processing, spreadsheets, programming, etc..)
Reading print media

10. Do you watch video on a computer? This includes YouTube, watching television episodes on your computer, DVDs, online lectures, video streaming, etc.
11. Approximately how many hours a week do you spend doing this activity? (please count all hours spent doing this activity, whether you are doing this activity only, or whether you are doing additional things at the same time)
12. When you are watching video on a computer, how often are you also doing the following at the same time:

Never A little of the time Some of the time Most of the time

Watching television, video, and/or DVDs (on a TV)
Watching other video content on a computer simultaneously
Listening to music
Listening to non-musical audio (news radio, podcasts, etc…)
Playing video or computer games
Talking on the phone
Instant messaging (chat)
Mobile phone text-messaging
Reading/writing e-mails
Reading web pages, pdfs, and/or other electronic documents
Using other computer applications (word processing, spreadsheets, programming, etc..)
Reading print media

13. Do you listen to music? This would include listening to an MP3 player (such as an iPod), listening to music on CDs, on the radio, on the internet or on your computer, etc.
14. Approximately how many hours a week do you spend doing this activity? (please count all hours spent doing this activity, whether you are doing this activity only, or whether you are doing additional things at the same time)
15. When you are listening to music, how often are you also doing the following at the same time:

Never A little of the time Some of the time Most of the time

Watching television, video, and/or DVDs (on a TV)
Watching video content on a computer
Listening to other music simultaneously
Listening to non-musical audio (news radio, podcasts, etc…)
Playing video or computer games
Talking on the phone
Instant messaging (chat)
Mobile phone text-messaging
Reading/writing e-mails
Reading web pages, pdfs, and/or other electronic documents
Using other computer applications (word processing, spreadsheets, programming, etc..)
Reading print media

17. Do you listen to non-musical audio? This includes news/sports/talk radio, podcasts, web-casts, audio books, etc.

18. Approximately how many hours a week do you spend doing this activity? (please count all hours spent doing this activity, whether you are doing this activity only, or whether you are doing additional things at the same time)
19. When you are listening to non-musical audio, how often are you also doing the following at the same time:

Never A little of the time Some of the time Most of the time

Watching television, video, and/or DVDs (on a TV)
Watching video content on a computer
Listening to music
Listening to other non-musical audio (news radio, podcasts, etc…) simultaneously
Playing video or computer games
Talking on the phone
Instant messaging (chat)
Mobile phone text-messaging
Reading/writing e-mails
Reading web pages, pdfs, and/or other electronic documents
Using other computer applications (word processing, spreadsheets, programming, etc..)
Reading print media

20. Do you play video or computer games? This includes online role-playing and multi-player games, console games, portable games, any computer-games, etc.
21. Approximately how many hours a week do you spend doing this activity? (please count all hours spent doing this activity, whether you are doing this activity only, or whether you are doing additional things at the same time)
22. When you are playing video or computer games, how often are you also doing the following at the same time:

Never A little of the time Some of the time Most of the time

Watching television, video, and/or DVDs (on a TV)
Watching video content on a computer
Listening to music
Listening to non-musical audio (news radio, podcasts, etc…)
Playing other video or computer games simultaneously
Talking on the phone
Instant messaging (chat)
Mobile phone text-messaging
Reading/writing e-mails
Reading web pages, pdfs, and/or other electronic documents
Using other computer applications (word processing, spreadsheets, programming, etc..)
Reading print media

23. Do you talk on the phone? This includes both land-line and mobile phones, as well as computer-based voice calls and video conferencing calls using such services as Skype or iChat.
24. Approximately how many hours a week do you spend doing this activity? (please count all hours spent doing this activity, whether you are doing this activity only, or whether you are doing additional things at the same time)
25. When you are talking on the phone, how often are you also doing the following at the same time:

Never A little of the time Some of the time Most of the time

Watching television, video, and/or DVDs (on a TV)
Watching video content on a computer
Listening to music
Listening to non-musical audio (news radio, podcasts, etc…)
Playing video or computer games
Talking to somebody else on a phone or video conference
Instant messaging (chat)
Mobile phone text-messaging
Reading/writing e-mails
Reading web pages, pdfs, and/or other electronic documents
Using other computer applications (word processing, spreadsheets, programming, etc..)
Reading print media

26. Do you use instant messaging? This includes text-based instant messaging programs such as AIM, Adium, Google Talk, iChat or Skype chats (NOT voice or video calls), etc. Please do not include mobile-phone text-messaging, SMS, MMS, or IM
27. Approximately how many hours a week do you spend doing this activity? (please count all hours spent doing this activity, whether you are doing this activity only, or whether you are doing additional things at the same time)
28. When you are using instant messaging, how often are you also doing the following at the same time:

Never A little of the time Some of the time Most of the time

Watching television, video, and/or DVDs (on a TV)
Watching video content on a computer
Listening to music
Listening to non-musical audio (news radio, podcasts, etc…)
Playing video or computer games
Talking on the phone
Instant messaging (or chatting with) multiple people at the same time
Mobile phone text-messaging
Reading/writing e-mails
Reading web pages, pdfs, and/or other electronic documents
Using other computer applications (word processing, spreadsheets, programming, etc..)
Reading print media

29. Do you send and receive text messages or SMSs using a mobile phone? This includes MMSs (Multimedia Messaging Service - such as picture messages).
30. Describe your use of mobile-phone texting. Do you use it for continuous conversations, simple questions and answers, or just to send out an occasional piece of info?
31. Approximately how many text messages do you send and receive on an average day?
32. When you are texting your friends with your mobile phone, how often are you also doing the following at the same time:

Never A little of the time Some of the time Most of the time

Watching television, video, and/or DVDs (on a TV)
Watching video content on a computer
Listening to music

Listening to non-musical audio (news radio, podcasts, etc…)
Playing video or computer games
Talking on the phone
Instant messaging (chat)
Texting with multiple people at the same time
Reading/writing e-mails
Reading web pages, pdfs, and/or other electronic documents
Using other computer applications (word processing, spreadsheets, programming, etc..)
Reading print media

33. Do you read and write e-mail? This includes regular e-mail and webmail
34. Approximately how many hours a week do you spend doing this activity? (please count all hours spent doing this activity, whether you are doing this activity only, or whether you are doing additional things at the same time)
35. When you are reading and/or writing e-mails, how often are you also doing the following at the same time:

Never A little of the time Some of the time Most of the time

Watching television, video, and/or DVDs (on a TV)
Watching video content on a computer
Listening to music
Listening to non-musical audio (news radio, podcasts, etc…)
Playing video or computer games
Talking on the phone
Instant messaging (chat)
Mobile phone text-messaging
Reading and/or writing multiple e-mails at the same time
Reading web pages, pdfs, and/or other electronic documents
Using other computer applications (word processing, spreadsheets, programming, etc..)
Reading print media

36. Do you surf the web, read web pages, pdfs, and/or other electronic documents?
37. Approximately how many hours a week do you spend doing this activity? (please count all hours spent doing this activity, whether you are doing this activity only, or whether you are doing additional things at the same time)
38. When you are reading web pages, pdfs, and/or electronic documents, how often are you also doing the following at the same time:

Never A little of the time Some of the time Most of the time

Watching television, video, and/or DVDs (on a TV)
Watching video content on a computer
Listening to music
Listening to non-musical audio (news radio, podcasts, etc…)
Playing video or computer games
Talking on the phone
Instant messaging (chat)
Mobile phone text-messaging
Reading/writing e-mails
Reading multiple web pages, pdfs, and/or other electronic documents at the same time

Using other computer applications (word processing, spreadsheets, programming, etc..)
Reading print media

39. Do you use computer applications such as word processing, speradsheets, programming, and other applications not already asked about?
40. Approximately how many hours a week do you spend doing this activity? (please count all hours spent doing this activity, whether you are doing this activity only, or whether you are doing additional things at the same time)
41. When you are using these "other" applications, how often are you also doing the following at the same time:

Never A little of the time Some of the time Most of the time

Watching television, video, and/or DVDs (on a TV)
Watching video content on a computer
Listening to music
Listening to non-musical audio (news radio, podcasts, etc…)
Playing video or computer games
Talking on the phone
Instant messaging (chat)
Mobile phone text-messaging
Reading/writing e-mails
Reading web pages, pdfs, and/or other electronic documents
Using more than one of these "other" applications at the same time
Reading print media

APPENDIX C: BRIEF SELF-CONTROL SCALE

Using the scale provided, please indicate how much each of the following statements describes how you typically are.

	Not at all				**Very Much**
1. I am good at resisting temptation.	1	2	3	4	5
2. I have a hard time breaking bad habits.	1	2	3	4	5
3. I am lazy.	1	2	3	4	5
4. I say inappropriate things.	1	2	3	4	5
5. I do certain things that are bad for me,					
6. if they are fun.	1	2	3	4	5
7. I refuse things that are bad for me.	1	2	3	4	5
8. I wish I had more self-discipline.	1	2	3	4	5
9. People would say that I have iron self-discipline.					
	1	2	3	4	5
10. Pleasure and fun sometimes keep me from getting work done.					
	1	2	3	4	5
11. I have trouble concentrating.	1	2	3	4	5
12. I am able to work effectively toward long-term goals.					
	1	2	3	4	5
13. Sometimes I can't stop myself from doing something, even if I know it is wrong.					
	1	2	3	4	5
14. I often act without thinking through all the alternatives.					
	1	2	3	4	5

APPENDIX D: BARRATT IMPULSIVENESS SCALE

DIRECTIONS: People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement and put an X on the appropriate circle on the right side of this page. Do not spend too much time on any statement. Answer quickly and honestly.

	O	O	O	O
	Rarely/Never	Occasionally	Often	Almost Always/Always

1	I plan tasks carefully.	O	O	O	O
2	I do things without thinking.	O	O	O	O
3	I make-up my mind quickly.	O	O	O	O
4	I am happy-go-lucky.	O	O	O	O
5	I don't "pay attention."	O	O	O	O
6	I have "racing" thoughts.	O	O	O	O
7	I plan trips well ahead of time.	O	O	O	O
8	I am self controlled.	O	O	O	O
9	I concentrate easily.	O	O	O	O
10	I save regularly.	O	O	O	O
11	I "squirm" at plays or lectures.	O	O	O	O
12	I am a careful thinker.	O	O	O	O
13	I plan for job security.	O	O	O	O
14	I say things without thinking.	O	O	O	O
15	I like to think about complex problems.	O	O	O	O
16	I change jobs.	O	O	O	O
17	I act "on impulse."	O	O	O	O
18	I get easily bored when solving thought problems.	O	O	O	O
19	I act on the spur of the moment.	O	O	O	O
20	I am a steady thinker.	O	O	O	O
21	I change residences.	O	O	O	O
22	I buy things on impulse.	O	O	O	O
23	I can only think about one thing at a time.	O	O	O	O
24	I change hobbies.	O	O	O	O
25	I spend or charge more than I earn.	O	O	O	O
26	I often have extraneous thoughts when thinking.	O	O	O	O
27	I am more interested in the present than the future.	O	O	O	O
28	I am restless at the theater or lectures.	O	O	O	O
29	I like puzzles.	O	O	O	O
30	I am future oriented.	O	O	O	O

APPENDIX E: ADULT ADHD SELF-REPORT SCALE

Instructions: Please circle the response for each question that is most accurate for the past six months.

1. How often do you make careless mistakes when you have to work on a boring or difficult project? **Very Often Often Sometimes Rarely Never**

2. How often do you have difficulty keeping your attention when you are doing difficult or boring work. **Very Often Often Sometimes Rarely Never**

3. How often do you have difficulty concentrating on what people are saying to you, even when they are speaking to you directly? **Very Often Often Sometimes Rarely Never**

4. How often do you have trouble wrapping up the fine details of a project, once the challenging parts have been done? **Very Often Often Sometimes Rarely Never**

5. How often do you have difficulty getting things in order when you have to do a task that requires organization? **Very Often Often Sometimes Rarely Never**

6. When you have a task that requires a lot of thought, how often do you avoid or delay getting started? **Very Often Often Sometimes Rarely Never**

7. How often do you misplace or have difficulty finding things at home or work? **Very Often Often Sometimes Rarely Never**

8. How often are you distracted by activity or noise around you? **Very Often Often Sometimes Rarely Never**

9. How often do you have trouble remembering appointments or obligations? **Very Often Often Sometimes Rarely Never**

10. How often do you fidget or squirm with your hands or your feet when you have to sit down for a long time? **Very Often Often Sometimes Rarely Never**

11. How often do you leave your seat during meetings or other situations in which you are expected to remain seated? **Very Often Often Sometimes Rarely Never**

12. How often do you feel restless or fidgety? **Very Often Often Sometimes Rarely Never**

13. How often do you have difficulty unwinding or relaxing when you have time to yourself? **Very Often Often Sometimes Rarely Never**

14. How often do you feel overly active and compelled to do things, like you were driven by a motor? **Very Often Often Sometimes Rarely Never**

15. How often do you find yourself talking too much when you are in a social situation? **Very Often Often Sometimes Rarely Never**

16. When you're in a conversation, how often do you find yourself finishing the sentences of the people that you are talking to, before they can finish them themselves? **Very Often Often Sometimes Rarely Never**

17. How often do you have difficulty waiting your turn in situations when turn-taking is required? **Very Often Often Sometimes Rarely Never**

18. How often do you interrupt others when they are busy? **Very Often Often Sometimes Rarely Never**

APPENDIX F: BUSS PERRY AGGRESSION QUESTIONNAIRE

Please rate each of the following items in terms of how characteristic they are of you. Use the following scale for answering these items.

1	2	3	4	5	6	7
extremely uncharacteristic of me						**extremely characteristic of me**

1) Once in a while I can't control the urge to strike another person.
2) Given enough provocation, I may hit another person.
3) If somebody hits me, I hit back.
4) I get into fights a little more than the average person.
5) If I have to resort to violence to protect my rights, I will.
6) There are people who pushed me so far that we came to blows.
7) I can think of no good reason for ever hitting a person.
8) I have threatened people I know.
9) I have become so mad that I have broken things.
10) I tell my friends openly when I disagree with them.
11) I often find myself disagreeing with people.
12) When people annoy me, I may tell them what I think of them.
13) I can't help getting into arguments when people disagree with me.
14) My friends say that I'm somewhat argumentative.
15) I flare up quickly but get over it quickly.
16) When frustrated, I let my irritation show.
17) I sometimes feel like a powder keg ready to explode.
18) I am an even-tempered person.
19) Some of my friends think I'm a hothead.
20) Sometimes I fly off the handle for no good reason.
21) I have trouble controlling my temper.
22) I am sometimes eaten up with jealousy.
23) At times I feel I have gotten a raw deal out of life.
24) Other people always seem to get the breaks.
25) I wonder why sometimes I feel so bitter about things.
26) I know that "friends" talk about me behind my back.
27) I am suspicious of overly friendly strangers.
28) I sometimes feel that people are laughing at me behind my back.
29) When people are especially nice, I wonder what they want.

APPENDIX G: NATIONAL YOUTH SURVEY VIOLENCE ITEMS

How many times in your life have you engaged each of the following behaviors?

If you are not sure, please provide your best estimate.

_____ 1. thrown objects (such as rocks or bottles) at cars or people?

_____ 2. carried a hidden weapon other than a plain pocket knife?

_____ 3. attacked someone with the idea of seriously hurting or killing him/her?

_____ 4. been involved in gang fights?

_____ 5. hit or threatened to hit a teacher at school?

_____ 6. hit one of your parents?

_____ 7. hit other students?

_____ 8. had (or tried to have) sexual relations with someone against their will?

_____ 9. used force (strong-arm methods) to get money or things from other students?

_____ 10. used force (strong-arm methods) to get money or things from non-students?

APPENDIX H: DEMOGRAPHICS & LIFE EXPERIENCES

1. Are you: ❑ Male ❑ Female

2. What is your current age? (in years) _____

3. How would you classify yourself?
❑ African American ❑ Latino/Hispanic ❑ Native American
❑ Asian/Pacific Islander ❑ Multi-Racial ❑ White ❑Other(*Specify:*_____)

4. What was your **GPA** (on a four point scale – i.e., 0.0 – 4.0) in the **previous semester**?

5. What is the highest level of education your mother (or stepmother) finished?

❑ Some high school ❑ Some college ❑ Graduate or professional school
❑ High school ❑ College ❑ Don't know

6. What is the highest level of education your father (or stepfather) finished?

❑ Some high school ❑ Some college ❑ Graduate or professional school
❑ High school ❑ College ❑ Don't know

7. When you last lived with your parents, how many toilets did you have in your household? _____ toilets

8. What is your parent's current combined annual income?
❑ $19,999 or less ❑ $20,000-$39,999 ❑ $40,000-$59,999
❑ $60,000-$99,999 ❑ $100,000-149,999 ❑ $150,000-$199,999
❑ $200,000 or more ❑ Don't know

9. Is English your native language? ❑ Yes ❑ No

10. Have you ever been diagnosed with a learning disorder (such as dyslexia)? Yes / No

11. Have you ever been diagnosed with an attention disorder (such as ADD or ADHD)? Yes / No

12. If so, are you currently taking medication for an attention disorder? Yes / No

13. Has either of your parents ever been diagnosed with an attention disorder (such as ADD or ADHD)? Yes / No

14. How many siblings (brothers and sisters) do you have? _____

15. How many of your siblings have ever been diagnosed with an attention disorder (such as ADD or ADHD)? _____

16. Has any other family member ever been diagnosed with an attention disorder (such as ADD or ADHD)? Yes/No

17. What is your parent's marital status? ❑ Married (to each other) ❑ Divorced
❑ Separated
❑ Widowed/deceased ❑ Never Married

18. Have either of your parents ever been arrested? Yes / No

19. Have you ever lived in a foster home? Yes / No

20. How often did one or both of your parents yell or shout at each other? Never Rarely Sometimes Often

21. How often did one or both of your parents throw things at or hit each other? Never Rarely Sometimes Often

22. Have either of your parents ever been diagnosed with a mental disorder? Yes / No

23. In the past week, on how many days did you eat candy? 0 1 2 3 4 5 6 7

24. In the past week, on how many days did you eat potato chips, tortilla chips, or pretzels? 0 1 2 3 4 5 6 7

APPENDIX I: STROOP TASK

Stroop task:

In this task, participants first receive instructions about how the task will work. They must indicate the color of the text displayed on the screen by pressing the corresponding key on the keyboard. Possible colors are red, yellow, blue, and green. In order to allow participants to memorize the keys corresponding to each color, participants complete 40 practice trials in which the letters "XXXXXXXXXX" appear in one of these four colors (10 trials of each color). Font colors appear in parentheses. For example:

XXXXXXXXXX (red)

XXXXXXXXXX (blue)

XXXXXXXXXX (yellow)

XXXXXXXXXX (green)

Next, participants complete 24 practice trials in which the words are depicted on the screen using different colored font. On 12 trials, the word meaning and font color are compatible:

RED (red)

BLUE (blue)

YELLOW (yellow)

GREEN (green)

On the other 12 practice trials, the word meaning and font color are incompatible:

RED (green)	RED (blue)	RED (yellow)
BLUE (yellow)	BLUE (red)	BLUE (green)
YELLOW (red)	YELLOW (blue)	YELLOW (green)
GREEN (red)	GREEN (yellow)	GREEN (blue)

Now that participants are familiar with the task, they will complete 96 critical trials (as the previous 24 practice trials) in a random order. Of these 48 are compatible trials (each of the four depicted above appearing 12 times). The other 48 include each of the 12 incompatible trials depicted above appearing 4 times. Reaction time and accuracy of response will be recorded for each word during these 96 trials. Trials are divided up so that one block of 48 trials will include 36 compatible trials and 12 incompatible trials and the other block of 48 trials will include 12 compatible trials and 36 incompatible trials.

APPENDIX J: DISTRACTIBILITY TASK

Essay 1:
Warm-blooded animals have elaborate physiological controls to maintain constant body temperature (in humans, 37° C). Why then during sickness should temperature rise, apparently increasing stress on the infected organism? It has long been known that the level of serum iron in animals falls during infection. Garibaldi first suggested a relationship between fever and iron. He found that microbial synthesis of siderophores -- substances that bind iron -- in bacteria of the genus Salmonella declined at environmental temperatures above 37° C and stopped at 40.3° C. Thus, fever would make it more difficult for an infecting bacterium to acquire iron and thus to multiply. Cold-blooded animals were used to test this hypothesis because their body temperature can be controlled in the laboratory. Kluger reported that of iguanas infected with potentially lethal bacterium A. hydrophilia, more survived at temperatures of 42°C than at 37°C, even though healthy animals prefer the lower temperature. When animals at 42°C were injected with an iron solution, however, mortality rates increased significantly. Research to determine whether similar phenomena occur in warm-blooded animals is sorely needed.

Q1: **The passage is primarily concerned with attempts to determine**
1. the role of siderophores in the synthesis of serum iron
2. new treatments for infections that are caused by A. hydrophilia
3. the function of fever in warm-blooded animals
4. the mechanisms that ensure constant body temperature
5. iron utilization in cold-blooded animals

Q2: According to the passage, Garibaldi determined which of the following?
1. That serum iron is produced through microbial synthesis
2. That microbial synthesis of siderophores in warm-blooded animals is more efficient at higher temperatures
3. That only iron bound to other substances can be used by bacteria
4. That there is a relationship between the synthesis of siderophores in bacteria of the genus Salmonella and environmental temperature
5. That bacteria of the genus Salmonella require iron as a nutrient

Q3: Which of the following can be inferred about warm-blooded animals solely on the basis of information in the passage?
1. The body temperatures of warm-blooded animals cannot be easily controlled in the laboratory.
2. Warm-blooded animals require more iron in periods of stress than they do at other times.
3. Warm-blooded animals are more comfortable at an environmental temperature of 37°C than they are at a temperature of 42°C.
4. In warm-blooded animals, bacteria are responsible for the production of siderophores, which, in turn, make iron available to the animal.
5. In warm-blooded animals, infections that lead to fever are usually traceable to bacteria.

Q4: If it were determined that "similar phenomena occur in warm-blooded animals" which of the following, assuming each is possible, is likely to be the most effective treatment for warm-blooded animals with bacterial infections?
1. Administering a medication that lowers the animals' body temperature
2. Injecting the animals with an iron solution
3. Administering a medication that makes serum iron unavailable to the bacteria
4. Providing the animals with reduced-iron diets
5. Keeping the animals in an environment with temperatures higher than 37°C

Essay 2:
The common belief of some linguists that each language is a perfect vehicle for the thoughts of th nation speaking it is in some ways the exact counterpart of the conviction of the Manchester school of economics that supply and demand will regulate everything for the best. Just as economists were blind to the numerous cases in which the law of supply and demand left actual wants unsatisfied, so also many linguists are deaf to those instances in which the very nature of a language calls forth misunderstandings in everyday conversation, and in which, consequently, a word has to be modified or defined in order to present the idea intended by the speaker: "He took his stick – no, not John's, but his own." No language is perfect, and if we admit this truth, we must admit that it is not unreasonable to investigate the relative merits of different languages or of different details in languages.

Q5: The primary purpose of the passage is to
1. analyze an interesting feature of the English language
2. refute a belief held by some linguists
3. show that economic theory is relevant to linguistic study
4. illustrate the confusion that can result from the improper use of language
5. suggest a way in which languages can be made more nearly perfect

Q6. The misunderstanding presented by the author is similar to which of the following:
A. X uses the word "you" to refer to a group, but Y thinks X is refering to one person only.
B. X mistakenly uses the word "anomaly" to refer to a typical example, but Y knows that "anomaly" means "exception."
C. X uses the word "bachelor" to mean "unmarried man," but Y mistakenly thinks that bachelor means "unmarried woman."
1. A only
2. B only
3. C only
4. A and B only
5. B and C only

Q7: In presenting the argument, the author does all of the following EXCEPT
1. give an example
2. draw a conclusion

3. make a generalization
4. make a comparison
5. present a paradox

Q8: Which of the following contributes to the misunderstanding described by the author?
1. It is unclear whom the speaker of the sentence is addressing.
2. It is unclear to whom the word "his" refers the first time it is used.
3. It is unclear to whom the word "his" refers the second time it is used.
4. The meaning of "took" is ambiguous.
5. It is unclear to whom "He" refers.

Essay 3:

It is frequently assumed that the mechanization of work has a revolutionary effect on the lives of the people who operate the new machines and on the society into which the machines have been introduced. For example, it has been suggested that the employment of women in industry took them out of the household, their traditional sphere, and fundamentally altered their position in society. In the nineteenth century, when women began to enter factories, Jules Simon, a French politician, warned that by doing so, women would give up their femininity. Friedrich Engels, however, predicted that women would be liberated from the "social, legal, and economic subordination" of the family by technological developments that made possible the recruitment of "the whole female sex...into public industry." Observers thus differed concerning the social desirability of mechanization's effects, but they agreed that it would transform women's lives.

Historians, particularly those investigating the history of women, now seriously question this assumption of transforming power. They conclude that such dramatic technological innovations as the spinning jenny, the sewing machine, the typewriter, and the vacuum cleaner have not resulted in equally dramatic social changes in women's economic position or in the prevailing evaluation of women's work. The employment of young women in textile mills during the Industrial Revolution was largely an extension of an older pattern of employment of young, single women as domestics. It was not the change in office technology, but rather the separation of secretarial work, previously seen as an apprenticeship for beginning managers, from administrative work that in the 1880's created a new class of "dead-end" jobs, thenceforth considered "women's work." The increase in the numbers of married women employed outside the home in the twentieth century had less to do with the mechanization of housework and an increase in leisure time for these women than it did with their own economic necessity and with high marriage rates that shrank the available pool of single women workers, previously, in many cases, the only women employers would hire.

Women's work has changed considerably in the past 200 years, moving from the household to the office or the factory, and later becoming mostly white-collar instead of blue-collar work. Fundamentally, however, the conditions under which women work have changed little since before the Industrial Revolution: the segregation of occupations by gender, lower pay for women as a group, jobs that require relatively low levels of skill and offer women little opportunity for advancement all persist, while women's household labor

remains demanding. Recent historical investigation has led to a major revision of the notion that technology is always inherently revolutionary in it effects on society. Mechanization may even have slowed any change in the traditional position of women both in the labor market and in the home.

Q9: Which of the following statements best summarizes the main idea of the passage?
1. The effects of the mechanization of women's work have not borne out the frequently held assumption that new technology is inherently revolutionary.
2. Recent studies have shown that mechanization revolutionizes a society's traditional values and the customary roles of its members.
3. Mechanization has caused the nature of women's work to change since the Industrial Revolution.
4. The mechanization of work creates whole new classes of jobs that did not previously exist.
5. The mechanization of women's work, while extremely revolutionary in its effects, has not, on the whole, had the deleterious effects that some critics had feared.

Q10: The author mentions all of the following inventions as examples of dramatic technological innovations EXCEPT the
1. sewing machine
2. vacuum cleaner
3. typewriter
4. telephone
5. spinning jenny

Q11: It can be inferred from the passage that, before the Industrial Revolution, the majority of women's work was done in which of the following settings?
1. Textile mills
2. Private households
3. Offices
4. Factories
5. Small shops

Q12: It can be inferred from the passage that the author would consider which of the following to be an indication of a fundamental alteration in the conditions of women's work?
1. Statistics showing that the majority of women now occupy white-collar positions
2. Interviews with married men indicating that they are now doing some household tasks
3. Surveys of the labor market documenting the recent creation of a new class of jobs in electronics in which women workers outnumber men four to one
4. Census results showing that working women's wages and salaries are, on the average, as high as those of working men.
5. Enrollment figures from universities demonstrating that increasing numbers of young women are choosing to continue their education beyond the undergraduate level

Essay 4:

It has ben known for many decades that the appearance of sunspots is roughly periodic, with an average cycle of eleven years. Moreover, the incidence of solar flares and the flux of solar cosmic rays, ultraviolet radiation, and x-radiation all vary directly with the sunspot cycle. But after more than a century of investigation, the relation of these and other phenomena, known collectively as the solar-activity cycle, to terrestrial weather and climate remains unclear. For example, the sunspot cycle and the allied magnetic-polarity cycle have been linked to periodicities discerned in records of such variables as rainfall, temperature, and winds. Invariably, however, the relation is weak, and commonly of dubious statistical significance.

Effects of solar variability over longer terms have also been sought. The absence of recorded sunspot activity in the notes kept by European observers in the late seventeenth and early eighteenth centuries has led some scholars to postulate a brief cessation of sunspot activity at that time (a period called the Maunder minimum). The Maunder minimum has been linked to a span of unusual cold in Europe extending from the sixteenth to the early nineteenth centuries. The reality of the Maunder minimum has yet to be established, however, especially since the records that Chinese naked-eye observers of solar activity made at that time appear to contradict it. Scientists have also sought evidence of long-term solar periodicities by examining indirect climatological data, such as fossil records of the thickness of ancient tree rings. These studies, however, failed to link unequivocally terrestrial climate and the solar-activity cycle, or even to confirm the cycle's past existence.

If consistent and reliable geological or archaeological evidence tracing the solar-activity cycle in the distant past could be found, it might also resolve an important issue in solar physics: how to model solar activity. Currently, there are two models of solar activity. The first supposes that the Sun's internal motions (caused by rotation and convection) interact with its large-scale magnetic field to produce a dynamo, a device in which mechanical energy is converted into the energy of a magnetic field. In short, the Sun's large-scale magnetic field is taken to be self-sustaining, so that the solar-activity cycle it drives would be maintained with little overall change for perhaps billions of years. The alternative explanation supposes that the Sun's large-scale magnetic field is a remnant of the field the Sun acquired when it formed, and is not sustained against decay. In this model, the solar mechanism dependent on the Sun's magnetic field runs down more quickly. Thus, the characteristics of the solar-activity cycle could be expected to change over a long period of time. Modern solar observations span too short a time to reveal whether present cyclical solar activity is a long-lived feature of the Sun, or merely a transient phenomenon.

Q13: The author focuses primarily on

1. presenting two competing scientific theories concerning solar activity and evaluating geological evidence often cited to support them

2. giving a brief overview of some recent scientific developments in solar physics an assessing their impact on future climatological research

3. discussing the difficulties involved in linking terrestrial phenomena with solar activity and indicating how resolving that issue could have an impact on our understanding of solar physics

4. pointing out the futility of a certain line of scientific inquiry into the terrestrial effects of

solar activity and recommending its abandonment in favor of purely physics-oriented research
5. outlining the specific reasons why a problem in solar physics has not yet been solved and faulting the overly theoretical approach of modern physicists

Q14: Which of the following statements about the two models of solar activity is accurate?
1. In both models cyclical solar activity is regarded as a long-lived feature of the Sun, persisting with little change over billions of years.
2. In both models the solar-activity cycle is hypothesized as being dependent on the large-scale solar magnetic field.
3. In one model the Sun's magnetic field is thought to play a role in causing solar activity, whereas in the other model it is not.
4. In one model solar acttivity is presumed to be unrelated to terrestrial phenomena, whereas in the other model solar activity is thought to have observable effects on the Earth.
5. In one model cycles of solar activity with periodicities longer than a few decades are considered impossible, whereas in the other model such cycles are predicted.

Q15: It can be inferred from the passage that Chinese observations of the Sun during the late seventeenth and early eighteenth centuries
1. are ambiguous because most sunspots cannot be seen with the naked eye
2. probably were made under the same weather conditions as those made in Europe
3. are more reliable than European observations made during this period
4. record some sunspot activity during this period
5. have been employed by scientists seeking to argue that a change in solar activity occurred during this period

Q16: It can be inferred from the passage that studies attempting to use tree-ring thickness to locate possible links between solar periodicity and terrestrial climate are based on which of the following assumptions?
1. The solar-activity cycle existed in its present form during the time period in which the tree rings grew.
2. The biological mechanisms causing tree growth are unaffected by short-term weather patterns.
3. Average tree-ring thickness varies from species to species.
4. Tree-ring thicknesses reflect changes in terrestrial climate.
5. Both terrestrial climate and the solar activity cycle randomly affect tree-ring thickness.

Video 1 Questions:
Have you ever seen the television show played during the reading passage?
Yes
No
Don't know/Not sure

What is the name of this show? (fill in the blank)

Q1: According to Eddie, how many dawns does each day have?
1. One
2. Three
3. Seven
4. Twenty-four

Q2: How many "waves" of invasion does Nostradamus' quatrain predict.
1. One
2. Two
3. Three
4. Four

Q3: Where is Cade's hometown?
1. New York City
2. Paris
3. Detroit
4. Chicago

Q4: What does Eddie call Cade?
1. The chosen one
2. The twice blessed man
3. Nostradamus' heir
4. An assassin

Video 2 Questions:
Have you ever seen the television show played during the reading passage?
Yes
No
Don't know/Not sure

What is the name of this show? (fill in the blank)

Q5: What country released the virus discussed in the video clip?
1. United States
2. Australia
3. Japan
4. Iraq

Q6: Who was mostly killed off by the virus?
1. Americans
2. Australians
3. Men
4. Children

Q7: What is the facility in which the characters are being held?
1. A top secret prison
2. A breeding facility
3. A military research facility
4. A biological containment facility

Q8: Who does the stranger know who will help the characters escape?
1. His gang
2. The Australians
3. His wife and sister
4. A prison guard

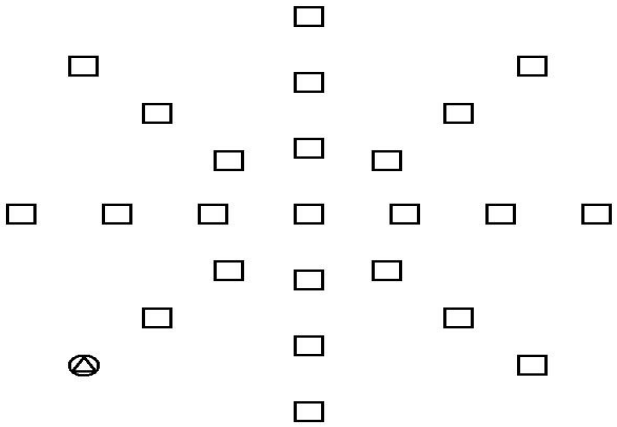
APPENDIX K: USEFUL FIELD-OF-VIEW TASK

Task overview: After receiving instructions, participants complete 24 practice trials (one target in each of the 24 positions). Then participants complete the 96 recorded trials in a random order (4 trials for each possible position of the target).

Steps in each trial

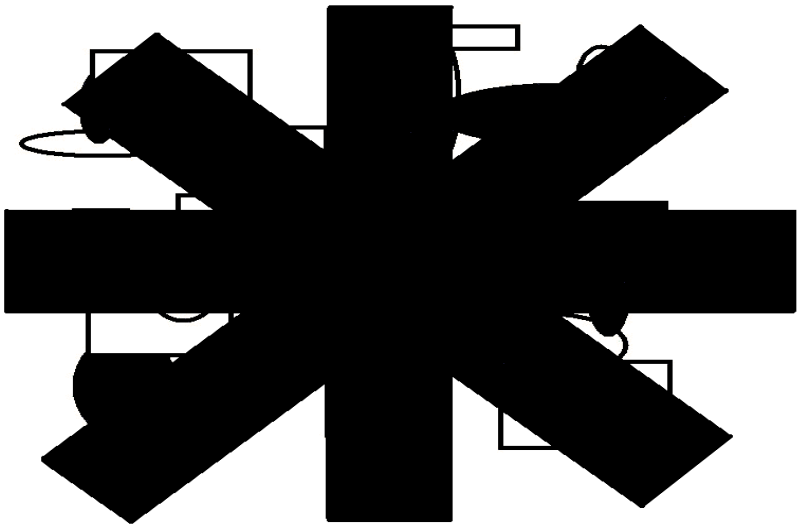
Fixation point (appears for 1000 ms between each trial):

Target screen (appears for 17 ms in each trial):

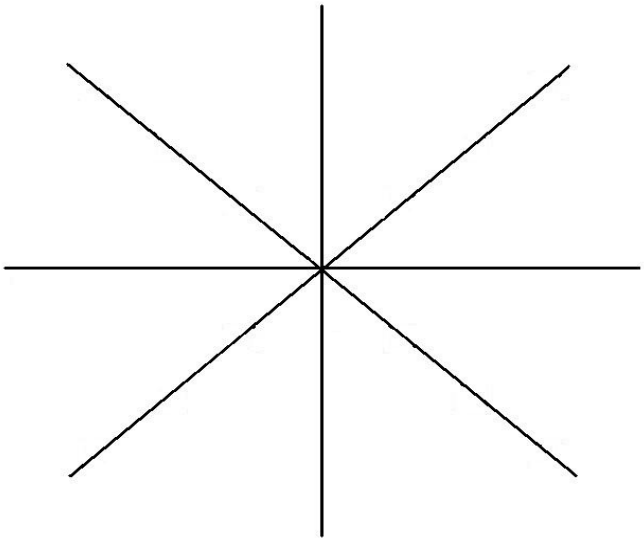


In this example, the target (circle with a triangle inside of it) appears in place of one of the lower left squares. Participants would indicate this position by pressing the “1” key on the keyboard number pad.

Mask screen (appears for 500 ms during each trial):



Response screen (appears after mask and remains until participant responds):



APPENDIX L: VIDEO GAME EVALUATION

Please answer the following questions about the single player video game you played over the course of this study. To ensure confidentiality, please do **not** put you name or social security number on the sheet.

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Please rate the video game you played on the following dimensions. Use the following scale:

1 2 3 4 5 6 7 8 9 10
strongly disagree — strongly agree

_____ 1The game was difficult to play.
_____ 2The game was absorbing.
_____ 3The game was action-packed.
_____ 4The game was arousing.
_____ 5The game was boring.
_____ 6The game was enjoyable.
_____ 7The game was entertaining.
_____ 8The game was exciting.
_____ 9The game was frustrating.
_____ 10The game was fun
_____ 11The game was involving.
_____ 12The game was stimulating.
_____ 13The game was violent.
_____ 14The game was "addicting."
_____ 15The game was fast paced.
_____ 16 My abilities on the video game task were:

1 2 3 4 5 6 7
Well Below Average — Average — Well Above Average

_____ 17 How much did your abilities improve from the first five minutes to the last five minutes:

1 2 3 4 5 6 7
No Improvement — Extreme Improvement

APPENDIX M: RECENT MEDIA SUMMARY

Please answer the following questions about how much you used each type of media in the past three weeks.

_____ 1. How many hours of television have you watched on an average day in the past three weeks?

_____ 2. How many hours of video games have you played on an average day in the past three weeks?

3. How many hours have you spent using computers (not counting schoolwork) on an average day in the past three weeks?

_____ 4. How many hours have you spent using your cellular phone on an average day in the past three weeks?

_____ 5. How many hours have you spent listening to music on an average day in the past three weeks?

_____ 6. What percentage of the time during the above activities were you also using another type of electronic device at the same time over the past three weeks? (0-100)

APPENDIX N

Means and standard deviations of the proactive cognitive control, reactive cognitive control, and distractibility from the first and last session of the experimental study.

		First Session		Last Session	
	N	**Mean**	**SD**	**Mean**	**SD**
Proactive Control					
UT2004	10	219.91	224.15	58.79	108.46
Sims 2	5	-75.29	97.14	98.31	42.34
No Game	7	-4.09	155.17	71.35	136.71
Control (both)	12	-33.76	133.82	83.60	30.54
Reactive Control					
UT2004	10	-237.60	131.21	-192.51	59.09
Sims 2	5	-169.16	74.78	-212.82	103.24
No Game	7	-209.22	47.70	-105.61	100.97
Distractibility					
UT2004	10	0.20	1.03	-0.30	0.82
Sims 2	5	0.40	0.55	1.20	0.45
No Game	7	0.43	1.27	-1.00	1.15

APPENDIX O

Means and standard deviations of the proactive cognitive control, reactive cognitive control, and distractibility from the correlational study (high violent video game players [+1 SD or more], low violent video game players [-1 SD or less] and total.

	N	Mean	SD	95% LL	95% UL
Proactive Control					
Low VGV	36	130.79	167.98	75.92	185.66
High VGV	39	64.64	137.89	21.36	107.92
Total	216	105.02	166.26	82.85	127.19
Reactive Control					
Low VGV	36	-432.24	244.24	-512.03	-352.46
High VGV	39	-295.76	217.90	-364.15	-227.37
Total	216	-340.97	220.37	-370.36	-311.58
Distractibility					
Low VGV	42	0.69	2.03	0.08	1.30
High VGV	40	0.95	1.48	0.49	1.41
Total	225	0.63	1.83	0.39	0.87

APPENDIX P

Means and standard deviations of useful field-of-view accuracy (percentage) at 10°, 20°, 30°, and overall from the first and last session of the experimental study.

		First Session		Last Session	
	N	**Mean**	**SD**	**Mean**	**SD**
UFOV 10°					
UT2004	10	29.69	27.92	68.75	34.23
Sims 2	5	62.50	45.71	65.63	47.08
No Game	7	75.00	23.18	81.70	24.50
Control (both)	12	69.79	33.08	75.00	34.67
UFOV 20°					
UT2004	10	23.75	18.17	48.44	31.95
Sims 2	5	58.75	39.86	58.75	47.16
No Game	7	56.70	22.05	60.27	32.36
Control (both)	12	57.55	29.06	59.64	37.15
UFOV 30°					
UT2004	10	19.06	7.28	30.00	20.42
Sims 2	5	29.38	25.83	45.63	31.37
No Game	7	36.16	14.75	31.70	17.90
Control (both)	12	33.33	19.33	37.50	24.17
UFOV Total					
UT2004	10	24.17	16.87	49.06	26.33
Sims 2	5	50.21	35.04	56.67	41.64
No Game	7	55.95	18.43	57.89	23.55
Control (both)	12	53.56	25.31	57.38	30.55

APPENDIX Q

Means and standard deviations of useful field-of-view accuracy (percentage) at 10°, 20°, 30°, and overall from the correlational study (high action gamers [+1 SD or more], low action gamers [-1 SD or less], and the full sample).

	N	Mean	SD	95% LL	95% UL
UFOV 10°					
High Action Gaming	43	60.32	33.49	50.31	70.33
Low Action Gaming	63	34.33	29.59	27.02	41.64
Total	230	49.42	34.93	44.91	53.93
UFOV 20°					
High Action Gaming	43	45.93	26.09	38.13	53.73
Low Action Gaming	63	27.98	23.45	22.19	33.77
Total	230	39.17	27.85	35.57	42.77
UFOV 30°					
High Action Gaming	43	33.14	22.79	26.33	39.95
Low Action Gaming	63	20.49	14.66	16.87	24.11
Total	230	27.38	19.21	24.90	29.86
UFOV Total					
High Action Gaming	43	46.46	25.76	38.76	54.16
Low Action Gaming	63	27.60	21.52	22.29	32.91
Total	230	38.65	26.00	35.29	42.01