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If It Feels Good, View It: Selective Exposure and Desensitization Moderate the Association Between Video Gameplay and Pleasure-Oriented Aggression

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Abstract

A number of studies have indicated that violent video gameplay is associated with higher levels of aggression, and desensitization to violent content contributes to this association. Utilizing a rapid serial visual presentation (RSVP) task, the current study used event-related potentials (ERPs) to investigate selective attention (N1 activation), cognitive control (N2 activation), and desensitization (P3 activation) as neurocognitive mechanisms potentially underlying the association between gameplay and subtypes of aggression. Results showed video game players and non-players differed significantly in brain activation when engaged with violent imagery. N1 and P3 amplitude moderated the association between gameplay and pleasure-oriented aggression. Follow-up analyses further revealed that individuals who play games for many hours and show large N1 activation (high selective attention) in the face of violence have small P3 activation (heightened desensitization). Thus, our results suggest that selective attention to violent content and subsequent desensitization effects moderate the association between video gameplay and aggression.

Keywords: Aggression; Desensitization; Selective Attention; Media Violence; ERP; Video Games

Introduction

In 2016, at an average age of 35 years old, 155 million Americans play video games (ESA, 2015; ESA, 2016), suggesting that gaming exists as an irrevocably intrinsic part of modern culture. While it would be inaccurate to generalize the content of any medium as totally violent, content analyses from the 1980's and 90's revealed the most popular video gaming mediums of their time – arcade and console, respectively – were made up of mostly violent content (Braun & Giroux, 1989; Dietz, 1998). Further, the majority of today's apparent best-selling video game titles are violent (NPD, 2015, 2016; ESRB, 2016), as are many of video gaming's most influential and historically significant titles (Chaplin, 2007), suggesting that people who play video games could be exposed to violence at a greater rate than a person who abstains from gameplay altogether. In America – a nation that deals with unique types of mass murderers (Lankford, 2015) and whose citizens are 20 times more likely to be killed by a gun than is someone from another developed country (Fisher, 2012) – debate amongst scholars and the public alike about the link between video gameplay and aggression has intensified over the years, coming to a head with the *Brown v. EMA* Supreme Court Case in 2011 (Ferguson & Kilburn, 2010; Bushman & Anderson, 2011; Ferguson, 2014; Bushman & Huesmann, 2014).

Despite skepticism about the precise role of media content consumption in causing aggressive outcomes or increasing aggressive thoughts and behavior, numerous studies have indeed revealed an association between exposure to media violence and higher levels of aggression (Anderson & Bushman, 2001; Anderson et al., 2010). Some theories have suggested that desensitization – the flattening of cognitive, emotional, and physiological responses to a stimulus (Funk, 2005) – underlies this association (Dill, 2013). Carnagey et al. (2007) offer a method of operationalizing desensitization, noting that it should be displayed through a reduction in emotion-related physiological reactivity to real violence. For example, the process of emotional blunting to arousing events has been shown to be associated with a reduced sympathetic skin conductance response to violent movies and portrayals of real life aggression in children who were previously exposed to violent media (Cline et al., 1973; Thomas et al., 1977). Recently, studies have begun to utilize event-related potentials (ERP) and functional magnetic resonance imaging (fMRI) methods to further investigate the process of desensitization as an underlying mechanism of the association between video gameplay and aggression (as reviewed by Bartholow & Hummer, 2014). For example, Bartholow and his colleagues (2006) found decreased P3 amplitudes—an ERP that has been shown to reflect the activation of the aversive motivational system when elicited by negative information (Cacioppo et al., 1994; Ito, 1998)—for video game players compared to non-players when passively viewing violent imagery during an oddball task. These decreases were further shown to be associated with elevated levels of aggression. Thus, reduced P3 activation during exposure to violent stimuli may be indicative of reduced aversive emotional responding – in other words, desensitization.

Theory suggests that because pain is usually a negative outcome, most people typically respond to violence with avoidance-related motivational strategies; thus, aversive responses such as anxiety, fear, or feelings of discomfort are most common (Cantor, 1998; Anderson & Dill, 2000; Bartholow et al., 2006). However, given the absence of any apparent consequence, like pain, and the positive context in which video games often frame violence (i.e. harming or killing others in pursuit of further achievement), it is theorized that individuals desensitized to violence experience an approach-avoidance conflict, adopting more aggressive, approach-related strategies when faced with depictions of violence (Bandura et al., 1967; Epstein, 1978; Linz et al., 1988). However, the cognitive mechanisms through which desensitization might lead to higher levels of aggressive thoughts, feelings, and behavior still remain largely unexplored.

Numerous theories have been put forth. One prevailing theory suggests that desensitization to aversive stimuli leads to disinhibition or a loss of inhibitory control (e.g., Josephson, 1987). A second prevailing theory suggests that desensitized individuals will selectively expose themselves to violence to adjust their pleasure-oriented arousal levels (e.g., Slater, 2007; Zillman, 1988). The current study will examine differential patterns of ERP activation between video game players and non-players, as well as the roles of both cognitive control – specifically inhibitory control – and selective attentional biases within the context of the association between video gameplay and aggression, during an emotionally charged cognitive task.

As outlined above, one potential explanation for motivational and emotional changes in the processing of violent imagery may be disinhibition. More specifically, according to Huesmann & Kirwil (2007), desensitization may lead to decreased inhibitory control as it relates to aggressive thoughts and behaviors. Inhibitory control, as defined by Davis et al. (2003), is the capacity for active inhibition or modulation of a pre-potent response. The theory espouses the notion that aversive reactions normally associated with violence have an inhibitory influence on how an individual thinks about violence. When aversive reactions become blunted and neutralized via desensitization, the desensitized individual undergoes a disinhibition – or loss of inhibitory control and increased impulsivity (Josephson, 1987) – of aggressive thoughts and feelings, leading to a higher likelihood of engagement with aggressive content. Indeed, recent cognitive neuroscientific studies have reported associations between media violence exposure and activational deficits in the ACC (Weber et al., 2006; Gentile et al., 2014) and DLPFC (Mathews et al., 2005; Hummer et al., 2010) – regions associated with aspects of cognitive control, such as inhibitory control (Stuss & Benson, 1986; Nieuwenheuss & Yeung, 2003). These "deficits," however, may not necessarily reflect deficits in inhibitory control. For example, Bavelier et al. (2012) interpreted similar findings as indicating more efficient neural processing amongst action video game players. Furthermore, within a sample of experienced first-person-shooter gamers, Colzato et al. (2012) found enhanced cognitive flexibility for gamers' working memory, but no association either way between inhibitory control and violent video gameplay. Thus, the role of inhibitory control – and, more broadly, cognitive control – as it pertains to the association between video gameplay and aggression remains unclear.

Alternatively, a second perspective, which allows for intact cognitive control amongst desensitized individuals, proposes that individuals will actively seek to alter their environment to regulate their affective state, including by means of selectively exposing themselves to particular media content (Zillman, 1988). Krahe and his colleagues (2011) took a psychophysiological approach towards examining how the absence of negative affectivity in the face of depictions of violence opens individuals up to experiencing different affective states in atypical circumstances, such as feeling pleasure while viewing violence. In an experiment that used skin conductance levels as its primary measure while participants watched violent clips, their results revealed that high violent media exposure correlated negatively with skin conductance levels, but positively with feelings of positive affect during the viewing of violent clips. In line with empirical evidence showing that fearful individuals prefer films with lower victimization scores (Wakshlag et al., 1983) and bored individuals selectively seek out exciting television programming (Bryant & Zillman, 1984), it has been suggested that individuals who are characteristically low in affect might seek out "thrilling" content as a means of adjusting their arousal to satisfactory levels (Zillman, 1988; Huesmann & Kirwil, 2007). Further, Slater (2007) has proposed that the selection of an individual's media content and the resulting subsequent attitudinal or behavioral outcomes affecting its consumption reinforce each other. Indeed, past studies have even suggested that it is probable in many contexts that media use is actually predicted by the outcome of interest (Steele & Brown, 1995; Slater et al., 2003). Thus, a video game player might choose to expose himself/herself to violent content for "thrills," remember violence as an enjoyable experience, and become more inclined to select that same sort of media again in the future (Whitaker, 2013). Thus, in the context of classical conditioning, media content (unconditioned stimulus) paired with aggressive behavior required by the game (conditioned stimulus) might lead to pleasure becoming a conditioned or learned response to aggressive behavior.

While poor inhibitory control and selective exposure to violent content may well be moderators in an association between video gameplay and the broad construct of aggression, a large body of literature suggests that aggression is, in fact, not a unitary construct and can be primarily broken down into two subtypes: impulsive (reactive) and non-impulsive (proactive) aggression (Dodge & Coie, 1989; Panksepp, 1998; Barratt et al., 1999; Kempes et al., 2005). According to Barratt et al. (1999), impulsive aggression can occur in defense of a threat or as an otherwise unplanned and uncontained act of aggression perpetrated by someone with “a short fuse.” Conversely, non-impulsive acts of aggression are characterized as premeditated, planned, proactive, and goal-oriented. Panksepp (1998), based on non-human animal data, theorized aggressive behavior as being comprised of impulsive and non-impulsive actions as well, but conceptualized these actions as occurring via distinctive aggressive circuits/systems in the mammalian brain. According to his model, predatory (non-impulsive) and rage (impulsive) types of aggression are actually promoted by two entirely different operating systems. Acts of aggression that are motivated by impulse (i.e. frustration, threat, irritability, explosiveness) occur via the *rage system*, particularly physiologically characterized by high autonomic arousal levels. Conversely and more in line with desensitized profiles, relatively low autonomic arousal levels physiologically characterize predatory attacks (Conner, 2002). Further, such predatory, non-impulsive forms of aggression are elicited by stimulation of the lateral hypothalamus from sites where self-stimulation reward is typically evoked – in other words, the mesolimbic dopaminergic circuit. Commonly referred to as the “reward pathway”, in Panksepp’s model, this circuit is coterminous with what he calls the *seeking circuit* underlying the *seeking system*. In turn, it can be assumed that predatory aggression is a subjectively pleasurable experience for the predator.

However, while hunting and subsequent attacking of prey is the primary seeking behavior observed in carnivorous mammals, it is theorized that this type of behavior could manifest itself differently in other species, especially those with higher order thinking abilities and more complex goals, like humans (Panksepp & Zellner, 2004). Indeed, studies have shown that while impulsive or reactive acts of aggression often result from a hostile attribution bias, in which an individual interprets malicious intent in social stimuli – regardless of whether others would normally interpret the same social stimuli as malicious – non-impulsive or proactive acts of aggression often occur within the context of decision-making and the evaluation of potential responses. More specifically, non-impulsive/proactive acts of aggression arise from a biased evaluation of aggressive acts in which individuals expect positive outcomes or rewards to result from aggression (Crick & Dodge, 1996), and studies have shown that aggression can be both pleasurable (Ramírez et al., 2005) and rewarding (Krämer et al., 2007) for human aggressors. Moreover, similar results have been found within the context of viewing violent content as well (Huesmann & Kirwil, 2007; Krahe et al., 2011), suggesting that aggression may be an appetitive option for desensitized video game players due to changes in their reward seeking tendencies. Thus, along with aggression more broadly, we will also examine alternative subtypes of impulsive aggression and pleasure-oriented aggression as they relate to video gameplay.

The current study will use a number of ERPs to ascertain 1) if desensitization, poor inhibitory control, selective attention, or some combination of the three might moderate the association between video gameplay and aggression, and 2) if these patterns differ for impulsive aggression and pleasure-oriented aggression.

We will start by confirming the current literature. More specifically, we will use P3 amplitudes, an ERP associated with the activation of the aversive motivational system when elicited by negative information (Cacioppo et al., 1994; Ito, 1998), to confirm that deficits in the aversive motivational system, i.e., desensitization, moderate the association between game play and aggression. Consistent with the works of Bartholow and his colleagues (2006), we predict specifically that video game players who have smaller P3 amplitudes in the face of violent content will show higher levels of aggression.

The second ERP we will examine is the N2, a component that has been associated with aspects of cognitive control (Lamm et al., 2011), such as inhibitory control (Falkenstein, Hoormann, & Hohnsbein, 1999), and is thought to have underlying neural sources in prefrontal areas, such as the DLPFC and ACC (Ladouceur et al., 2007; Bekker et al., 2005). If poor cognitive control underlies the association between game play and aggression, we would expect video game players and non-players to show different profiles of N2 activation. More specifically, differential N2 amplitudes should moderate the association between video gameplay and impulsive aggression (possibly also pleasure-oriented aggression) .

Additionally, we will examine N1 amplitudes – an early sensory ERP component often associated with selective attention (Coull, 1998; Vogel & Luck, 2000). Several ERP studies of visuospatial attention have shown that attention can influence processing within 100 milliseconds of stimulus onset (Vogel, Luck & Shapiro, 1998; Hillyard & Anllo-Vento, 1998), showing that attended-location stimuli elicit larger amplitudes in early sensory components than ignored-location stimuli. Additionally, several studies have shown that N1 amplitudes are sensitive to emotional valence (e.g., Foti & Hajcak, 2008; Foti, Hajcak, & Dien, 2009). For our purposes, more negative N1 amplitude when fixated on negative content would be indicative of a negative selective attentional bias amongst video game players. Thus, to support the selective attention hypothesis, we hypothesis that individuals who are video game players and have larger (more negative) N1 amplitudes when engaged with negative imagery will show the greatest levels of overall aggression and pleasure–oriented aggression. However, this increase would not be associated with impulsive aggression in any way.

In the present experiment, participants – video game players and non-players – performed an emotionally charged, Rapid Serial Visual Presentation (RSVP) task to measure N1, N2, and P3 amplitudes. Although past ERP research has used other cognitive tasks, like the oddball task (Bartholow et al., 2006), we used a task that better emulated a real-world gaming environment because it presented target images in the context of rapidly presented distractor stimuli, similar to actual video games. Specifically, we used an RSVP task that presents players with two targets embedded in a stream of 17 complex stimuli (Raymond, Shapiro, & Arnell, 1992) instead of just a single, briefly exposed target, outside of any other stimuli. To the best of our knowledge, the task we used has never previously been used in the context of a gaming study. However, the task is not novel and has been extensively used in the context of the Attentional Blink literature (e.g., Most et al., 2005; Raymond & O'Brien, 2009; Raymond, Shapiro, & Arnell, 1992). According to the theory, an attentional blink is generated when an emotionally challenging stimulus requiring substantial attentional resources is presented shortly before a stimulus requiring action. The second stimulus is "blinked" likely because there are insufficient attentional resources left to encode the information in working memory (e.g., Most, Chun, Widders, & Zald, 2005; Shapiro, Schmitz, Martens, Hommel, & Schnitzler, 2006). In line with the Most et al. (2005) attentional blink task, our task presented participants with two target images, of which the first one consisted of negative images (73% of which were violent in nature) or neutral images, and the second one, presented shortly after the first one, required participants to provide a behavioral response. Thus, given the nature of this task, i.e., having to selectively attend to key images within the context of other distracting images (selective attention) and having to inhibit processing of distractor images (inhibitory control), we believed this task was ideal for testing which of these two cognitive processes best moderated the association between game play and aggression.

Method

2.1 Participants

Participants were undergraduate students (n = 67; 24 male; 32 video game players) who attended the University of New Orleans. Participants ranged in age from 18 to 41 (mean age = 22.29; SD of age = 5.21). Video game players and non-players did not differ significantly in age, t(64) = -.55, *p* = .58, sex, $\chi 2$ (1, N = 67) = .62, p = .43, ethnicity/race, $\chi 2$ (4, N = 67) = 3.71, p = .45, or household yearly income, $\chi 2$ (5, N = 67) = 1.402, p = .92. All participants had normal or corrected-to-normal vision, had a hair style that was conducive to EEG data collection procedures, and were free of current psychiatric diagnoses. In total, 114 participants took part in the study. One participant, who reportedly played video games for 40 hours per week, was excluded from the analysis as an outlier. Forty-six other participants were excluded from the study for a number of reason: 1) insufficient number of trials to make an ERP (due to artifacts or poor performance), 2) had hairstyles that were not conducive to EEG research, or 3) equipment failure. Thus, the final sample size used for statistical analyses was 67 (24 male). Included and excluded participants did not differ significantly in age, t(110) = .63, *p* = .53, sex, $\chi 2$ (1, N = 113) = .71, p = .40, ethnicity/race, $\chi 2$ (6, N = 113) = 7.79, p = .26, video gameplay status, $\chi 2$ (1, N = 113) = 2.58, p = .11, or household yearly income, $\chi 2$ (5, N = 113) = 1.792, p = .88. Participants were recruited through undergraduate classes and earned course credit for their participation. This study received IRB approval from the University of New Orleans.

2.2 Procedure

After obtaining written consent, questionnaires were completed and participants were seated 67 cm from a computer monitor. Instructions on how to do the task were given, and participants completed a practice block – identical to the main task – of 10 trials. When proficiency was shown on the practice block, participants went on to perform the actual task. On average, the task took 30 minutes to complete.

2.3 Measures

Demographics Questionnaire. Data on ethnicity/race, age, sex, parental education, household yearly income, and video gameplay habits (i.e. Do you play video games? If so, for how many hours a week on average?) were collected using a demographics questionnaire.

Buss-Perry Aggression Scale (Anderson & Dill, 2000; Buss & Perry, 1992). The Buss-Perry Aggression Scale is a 29-item self-report measure that has been deemed to be both reliable and valid. All 29 items were averaged to yield an overall aggression score.

Adult Temperament Questionnaire (ATQ; Evans & Rothbart, 2007). The ATQ is a 77-item self-report measure of adult temperament and reactivity deemed to be both reliable and valid. The measure computes 11 sub-scales and 3 scales. For the purpose of our study, items from the ATQ were used in conjunction with the Buss Perry Aggression Scale to generate proxy variables for our aggressive subtypes of interest – impulsive aggression and pleasure-oriented aggression. Impulsive aggression was created by first standardizing Disinhibition – an inverted version of the ATQ's Effortful Control scale, which includes subscales designed to measure inhibitory, attentional, and activational control. Buss Perry Aggression Scale was also standardized, and the average score of these standardized scales were used to create our Impulsive Aggression outcome variable. Similarly, Pleasure-Oriented Aggression was taken from an average of the standardized versions of the Buss Perry Aggression scale and the ATQ's High Intensity Pleasure subscale.

2.4 Task

This study used a Rapid Serial Visual Presentation (RSVP) task – specifically, an attentional blink paradigm. Raymond and colleagues (1992) were the first to coin the phrase attentional blink (AB)—a psychological construct in which attention is momentarily inaccessible due to the processing of previous information. When two targets are to be identified among non-target distractors, most individuals show an AB in reporting the second target. Correct identification of the first target (T1) impedes the detection of a second target (T2) that appears within 500 ms of T1 (Chun & Potter, 1995; Raymond et al, 1992). The failure to report a T2 is believed to happen because a large amount of attentional resources have been allocated to T1 (Shapiro et al., 2006). The attentional blink is believed to be induced when salient stimuli cause a focus of attention. This task was adapted from a previous version (Most et al., 2005) and presented using E-Prime software (Schneider, Eschman, & Zuccolotto, 2002). T1 events consisted of a balanced number of negative (73% violent) and neutral pictures from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008) presented pseudo randomly (trials were presented in the exact same order for every participant). Each T1 picture was surrounded with a yellow frame to differentiate these images from the neutral distractor images (see Figure 1). Trials consisted of a RSVP stream of 17 black and white images, presented for 75-120 ms, and jittered trial-by-trial to avoid ERP artifact. Depending on the trial, T1 was presented as the 4th, 6th, or 8th stimulus. T2 was presented either two or eight pictures after T1 (lag 2 and lag 8). T2 events were pictures of houses either tilted 90 degrees to the left or to the right. Neutral distractor photos did not include any house photos, to prevent confusion. At the end of each RSVP stream, participants were asked if the T2 (house picture) was tilted to the left or the right. Participants had an infinite amount of time to respond. Participants had to press the left (button 1) or right (button 4) button on a button box to indicate direction of house tilt. House pictures were drawn from publicly available sources. In order to make missed or "blinked" T2 trials a viable option, 1/6 of trials did not have a T2 event. Thus, participants were also given the option to indicate that no house was presented by pressing button 3. Error trials were composed only of data from trials in which participants responded with button 3, i.e., they thought no house image was presented, despite the presence of a house image, suggesting a "blinked" trial. To prevent participants from looking at their hands to indicate the correct button, which would lead to EEG eye artifact, button 3 was marked by a large fuzzy sticker, which could easily be identified by touch alone. The task consisted of 4 blocks of 120 trials each.

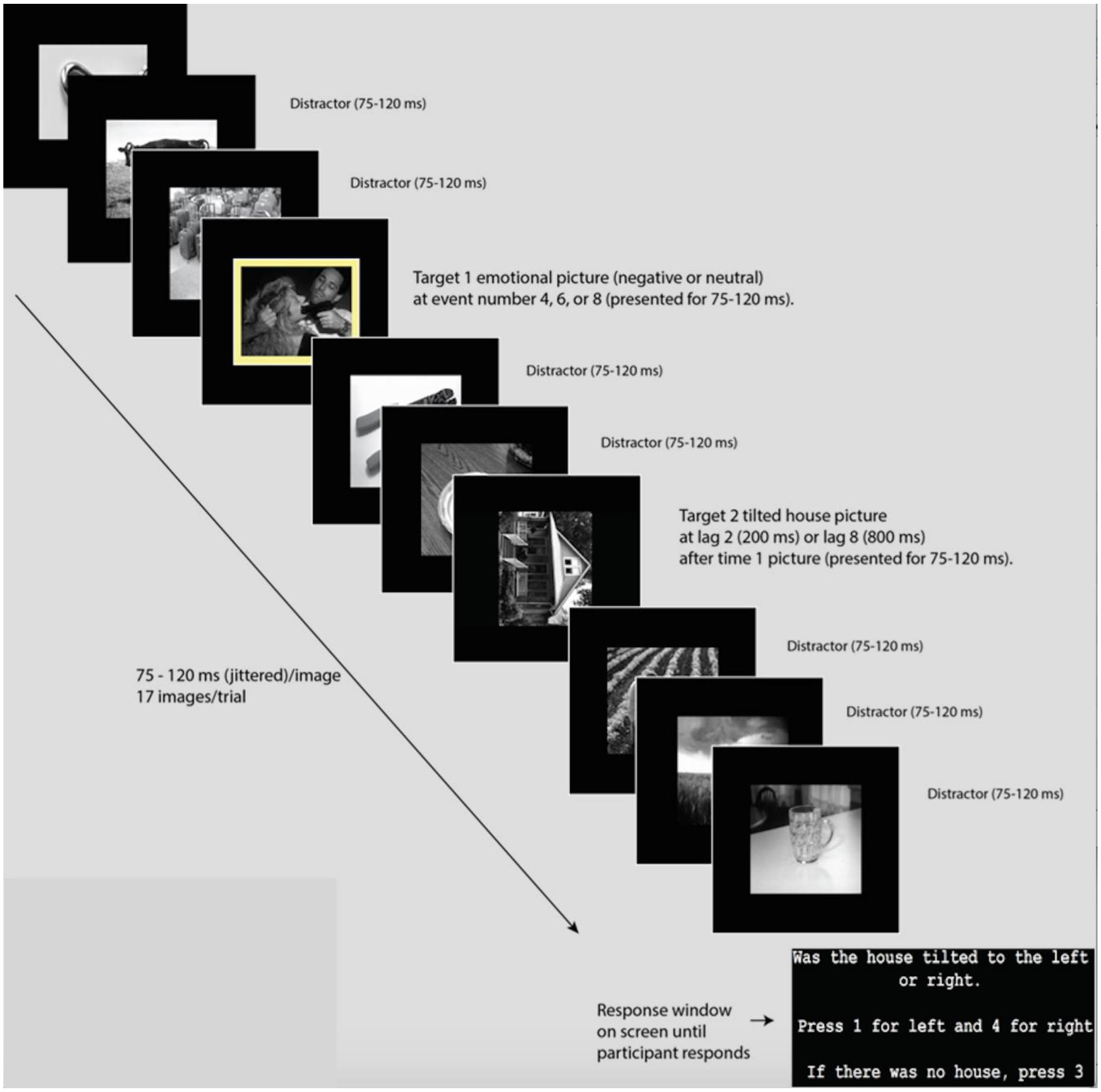

Figure 1. RSVP Task

2.5 EEG data collection and analyses

EEG was recorded using a 128-channel Geodesic Sensor Net and sampled at 250 Hz, using EGI software (Net Station; Electrical Geodesic, Inc., Eugene, OR). Data acquisition was started after all impedances for all EEG channels were reduced to below 50 kΩ. All channels were referenced to Cz (channel 129) during recording and were later re-referenced against an average reference corrected for the polar average reference effect (PARE correction; Junghoefer, Elbert, Tucker, & Braun, 1999). Data was filtered using a FIR bandpass filter with a lowpass frequency of 50 Hz and a highpass frequency of .3 Hz. To best capture eye blink artifacts, the threshold was set to 140 µV threshold (peak-to-peak) and all trials in which this threshold was violated were excluded from analyses. Furthermore, signal activation change (peak-to-peak) exceeding 100 μV across the entire segment were marked as bad and interpolated. Baseline correction for all ERP components was 150 ms before time locking (either T1 or T2) stimulus onset. ERP component time ranges were based on the grand averaged waveform. The same electrode montages and time ranges (from specific time locking stimulus) were used for T1 and T2 stimuli. All ERP component values analyzed were maximal activation across time, most negative for N1 (100 - 200 ms) and N2 (340– 470 ms) and most positive for P3 (450 - 750 ms), from a baseline determined hypothetical zero. All ERP activation analyzed was comprised of the average activation across clusters of electrodes (see Figure 2 for ERP clusters) from electrode montages pre-specified by the literature: N1 occipital (Farroni et al., 2002; Vogel & Luck, 2000), N2 mediofrontal (Luu & Pederson, 2004; Lamm et al., 2011), and P3 parietal cluster (Ila & Polich, 1999; Katayama & Polich, 1999). Participants whose ERP components were made up of less than 8 trials were excluded from statistical analyses: error T1 neutral trials (Mean = 26.82 SD = 11.62), error T1 negative trials (Mean = 21.84 SD = 10.39), error T2 neutral trials (Mean = 27.34 SD = 11.85), and error T2 negative trials (Mean = 22.04 SD = 10.49).

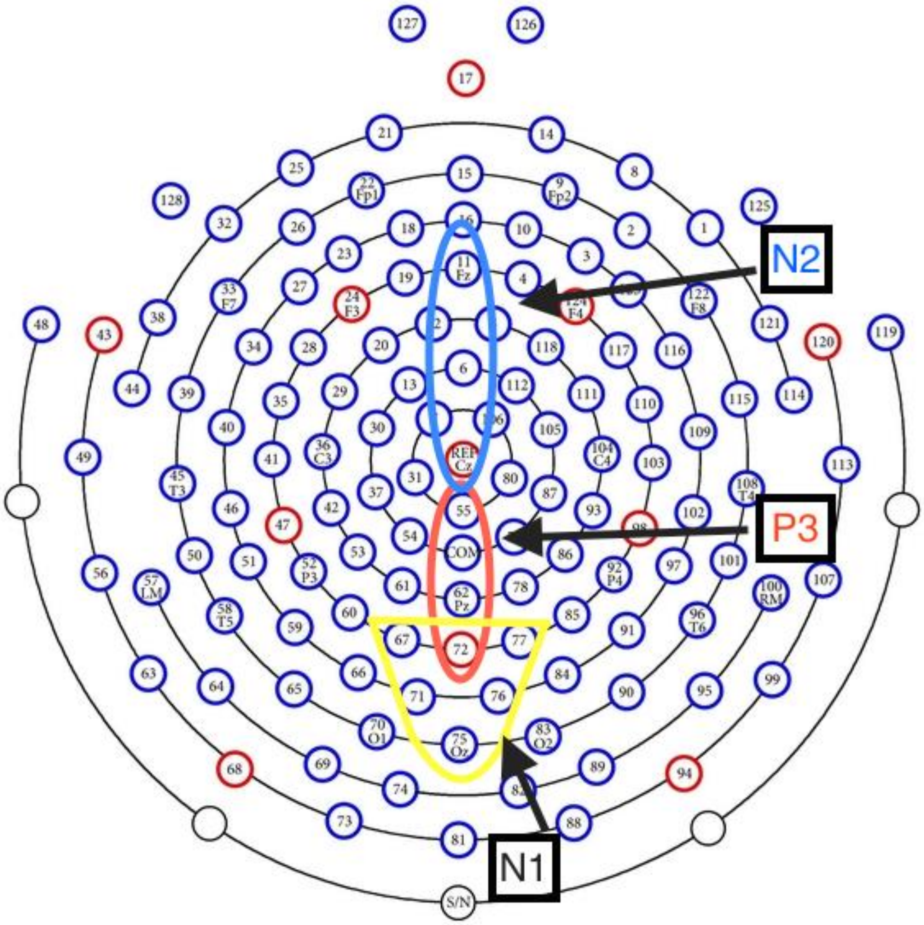

Figure 2. ERP Electrode Montage

2.6 Statistical Analyses

For all analyses, we collapsed across trials that consisted of houses tilted right or left. To verify effectiveness of the task, we first examined performance accuracy differences for lag 2 and lag 8 trials. Previous research has shown that the attentional blink phenomenon occurs roughly 200 to 500 ms after the T1 is presented (For a review, see Martens & Wyble, 2010). Therefore, we predicted that lag 8 trials would show better performance accuracy than lag 2 trials. Indeed, this was the case: neutral = $t(66) = 4.17$, $p < .001$; negative = $t(66) = 6.63$, $p < .001$. These results suggest that we administered the attentional blink task effectively. All subsequent analyses will be conducted on Lag 2 trials since Lag 8 trials were only included to test the effectiveness of the task.

Given our theoretical model and very specific hypotheses we are only going to analyze three trial types/ERP components: 1) T1 P3 to measure desensitization, 2) T1 N1 to measure selective attention, and 3) T2 N2 to measure inhibitory control. N1 and P3 activation will be measured time locked to the T1 condition because these mechanisms are best measured in the context of salient images. N2 activation, on the other hand, will be time locked to the T2 condition since this mechanism is best measured in the context of inhibiting emotional reactions in order to accurately encode the house information. Since deficits in any of these mechanisms would lead to an erroneous response, we are only examining error trials. Lastly, we will be examining these components in both the neutral and negative conditions.

Independent samples t-tests were used to test for sex differences amongst all variables of interest. Results yielded no significant differences; however, given that our sample was two-thirds female, to be certain that sex did not interact with ERP amplitudes and gameplay status, we utilized hierarchical linear regression analyses and found that a three-way interaction of these variables (ERP-by-gameplay-by-sex) did not explain a significant additional amount of the variance over and above the two way interaction (ERP-by- gameplay). Therefore, we proceeded without entering sex as a predictor or interaction term in any of our analyses.

Analyses below consist of independent sample t-tests and hierarchical linear regression. For all t-tests, the homogeneity of variance assumption was tested using the Levene's test. When this assumption is violated, we report results for which equal variances are not assumed. Additionally, for variables included in the t-tests, we tested for normality of distributions, i.e., if the significantly deviated from the normal distribution, using the Shapiro-Wilks test. No variables violated the normality assumption. For the regression analyses, we tested for multicolinearity, homogeneity of variance, normality, linearity, and independence. For multicollinearity, we verified that the variance inflation factors were within acceptable levels. If they were not, we indicate below. Scatterplots were used to examine the relationship between variables, i.e., check the linearity assumption. Durbin

Watson tests were used to test for independence of observations. Lastly, similar to the t-tests, the Shapiro-Wilks test was used to test for normality of distributions. Any violations of these assumptions are indicated below as well.

Results

3.1 Group Differences

3.1.1 Behavioral Analyses

To ascertain if there were group differences in performance accuracy, i.e., video game players vs. non-players, we conducted two t-tests on performance accuracy – one for each of the emotion conditions (neutral and negative). Results yielded no significant differences in performance accuracy between video game players and non-players in neither neutral, $t(65) = .179$, $p = .86$, or negative, $t(65) = .807$, $p = .42$, trials.

Additional t-tests were conducted to ascertain the relationship between video gameplay and our three measures of aggression—overall aggression, impulsive aggression, and pleasure-oriented aggression. Results revealed no significant association between video gameplay and aggression, $t(65) = 1.36$, $p = .18$, or impulsive aggression, $t(65) = 1.50$, $p = .14$. Results did, however, indicate a significant association between video gameplay and pleasure-oriented aggression, $t(65) = 2.55$, $p = .01$, with video game players showing higher levels of pleasure-oriented aggression.

3.1.2 ERP Analyses

Independent sample t-tests were conducted to test for differences in mean ERP amplitudes (T1 N1, T1 P3, T2 N2) and aggressive tendencies between video game players and non-players in negative and neutral conditions. There were no significant differences at all in brain data between video game players and non-players during neutral trials. The following reported results are all for the negative condition. Results indicated significant differences between video game players and non-players for T1 N1, t(64) = -2.11, p = .04 and T1 P3, t(65) = -2.17, p = .03. Results revealed that video game players displaying smaller P3 amplitudes and larger (more negative) N1 amplitudes than non-players. Additionally, there were no significant differences for T2 N2 amplitudes. Consistent with previous literature (Huesmann & Kirwil, 2007; Carnagey et al., 2007), these results suggest that video game players specifically process negative stimuli differently than non-players.

3.2 Brain Data Moderational Analyses

We conducted a number of moderational analyses. For these analyses, we entered all independent variables to test for main effects. We also entered interaction terms between all independent variables. For example, if the analysis required three independent variables, we would generate three separate 2-way interaction terms between the independent variables and enter these into the model. Additionally for this example model, we would generate a 3-way interaction term and entered it last into the model. Lastly, our three aggression measures comprised the dependent variables. We start by examining the impact of gaming status and ERP amplitude on overall aggression and then follow with separate sections on impulsive aggression and pleasure-oriented aggression. To avoid multi-collinearity, continuous predictor variables were mean centered and interaction variables were calculated as product terms of the mean-centered predictors in all moderational analyses (Aiken & West, 1991). Any significant or trend-level interaction terms were then decomposed by recalculating ERP activation into new variables representing high activation and low activation and running additional regression analyses using the re-calculated scores, as suggested by Aiken and West (1991). All moderational analyses outlined below are for the negative condition since no effects were significant or trend-level for the neutral condition.

3.2.1 Overall Aggression

As outlined above, linear regression was used to test the theory that desensitization (low P3 amplitude) moderates the association between video gameplay and aggression (Engelhardt, Bartholow, Kerr, & Bushman, 2011). Results of this analysis confirmed that video gameplay was not significantly associated with aggression (no main effect), $\beta = 1.36$, t (63) = 1.10, $p = .274$. As well, T1 P3 amplitudes were not associated with aggression, $\beta = .206$, t (63) = 1.29, $p = .20$. However, P3 amplitudes interacted with video gameplay significantly on aggression, $\beta = -.47$, t (63) = -2.50, $p = .02$.

The interaction term was decomposed as outlined above. Results indicate that the association between video gameplay and aggression was only significant for those who displayed low levels of P3 amplitude in the negative condition, $\beta = .45$, t (63) = 2.63, $p = .01$ (see Figure 3). These results indicate that players who display small P3 amplitudes also show heightened levels of aggression. Additionally, the same association was also revealed to be non-significant amongst video game players and non-players who displayed high levels of P3 activation in the same conditions, $\beta = -.18$, t (63) = -.98, $p = .33$.

Identical linear regression models were also used to test N1 and N2 amplitudes for their potential roles as moderators in the association between video gameplay and aggression. As outlined earlier, N1 activation was used as a marker of selective attention and N2 activation was used as a marker of inhibitory control. Results revealed no main effects for N1, $\beta = -.038$, t (62) = -.20, $p = .84$, or N2, $\beta = -.171$, t (63) = -1.09, $p = .28$, on aggression. As well, N1, $\beta = .219$, t (62) = 1.18, $p = .24$, and N2, $\beta = .034$, t (63) = 0.22, $p = .83$, did not significantly interact with video gameplay on aggression. Furthermore, to test if inhibitory control and desensitization together contribute to heightened aggression, we generated a gameplay-by-N2-by-P3 interaction term and tested if it was associated with aggressive behavior. Results indicated that this 3-way interaction was not significantly or trend-level associated with overall aggression, $\beta = .168$, t (59) = -.068, $p = .63$. Similarly, to test if selective attention and desensitization together contribute to heighted aggression, we generated a gameplay-by-N1-by-P3 interaction term and tested if it was associated with aggressive behavior. Results revealed that this interaction term was not associated (significant or trend-level) with overall aggression, β = .111, *t* (58) = .696, *p* = .49. Thus, neither selective attention nor inhibitory control interacted with desensitization to explain significant amounts of variance in overall aggressive behavior. Moreover, the results of these analyses indicate that even though higher levels of aggression are not associated with video gameplay in and of itself (no main effect), desensitization to violent imagery – as has been reflected in media violence literature (Anderson et al., 2010; Greitemeyer & Mügge, 2014) – plays a moderating role in the association between video gaming and overall aggression.

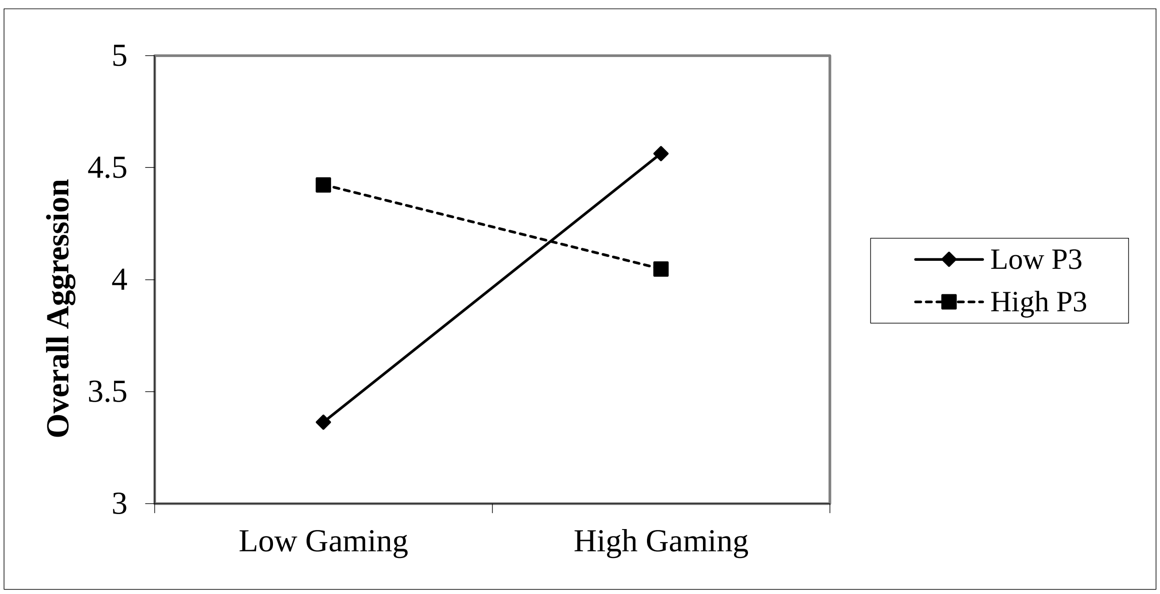

Figure 3. Moderation plots: Interaction between Video Gameplay and P3 amplitude on Overall Aggression

3.2.2 Impulsive Aggression

Further moderational analyses were conducted to examine the roles of differential ERP amplitudes as potential moderators in the association between video gameplay and impulsive aggression – a subtype of aggression (Dodge & Coie, 1989; Panksepp, 1998). Consistent with our t-tests, results showed no significant main effect of video games on impulsive aggression, β = .192, *t*

(63) = 1.56, *p* = .87. Similarly, we found no main effect of N2 activation on impulsive aggression, β = -.174, *t* (63) = -1.12, *p* = .27. Additionally, no significant interaction effects were revealed between video gameplay and any brain data – N1, β = .279, *t* (63) = 1.50, *p* = .14, N2, β = .026, *t* (63) = .166, *p* = .87, or P3, β = .165, *t* (63) = .847, *p* = .40, amplitudes – on impulsive aggression. As outlined earlier, we were also interested in if game status and either the N1 or the N2 interacted with P3 activation to explain variance in impulsive aggression. Therefore, 3-way interactions of gameplay-by-P3-by-N1, β = .037, *t* (58) = .18, *p* = .86, and gameplay-by-P3-by-N2, β = .096, *t* (59) = .53, *p* = .60, were conducted and found to be not significant.

3.2.3 Pleasure Oriented Aggression

Linear regression was further utilized to examine the roles of differential ERP amplitudes in the association between video gameplay and pleasure-oriented aggression – another subtype of aggression (Panksepp & Zillner, 2004; Ramirez et al., 2005). Results revealed no significant main effect of P3 amplitude on pleasure-oriented aggression, β = .236, *t* (63) = 1.52, *p* = .13. Video gameplay, however, was significantly associated with pleasure-oriented aggression, β = .286, *t* (63) = 2.39, *p* = .02, and in line with our broad aggression results, P3 amplitudes interacted significantly with video gameplay and was associated with pleasure-oriented aggression, β = -.360, *t* (63) = -2.34, *p* = .02 (see Figure 4), and simple slopes tests revealed that the association between video gameplay and pleasure-oriented aggression was significant amongst those who displayed low levels of P3 amplitude in the negative condition, β = .572, *t* (63) = 3.45, *p* = .001, but not for those who displayed high levels of P3 activation, β = -.001, *t* (63) = -.01, *p* = .99. More specifically, these results indicate that it is video game players with low levels of P3 activation – a marker of desensitization – who show the highest levels of pleasure-oriented aggression.

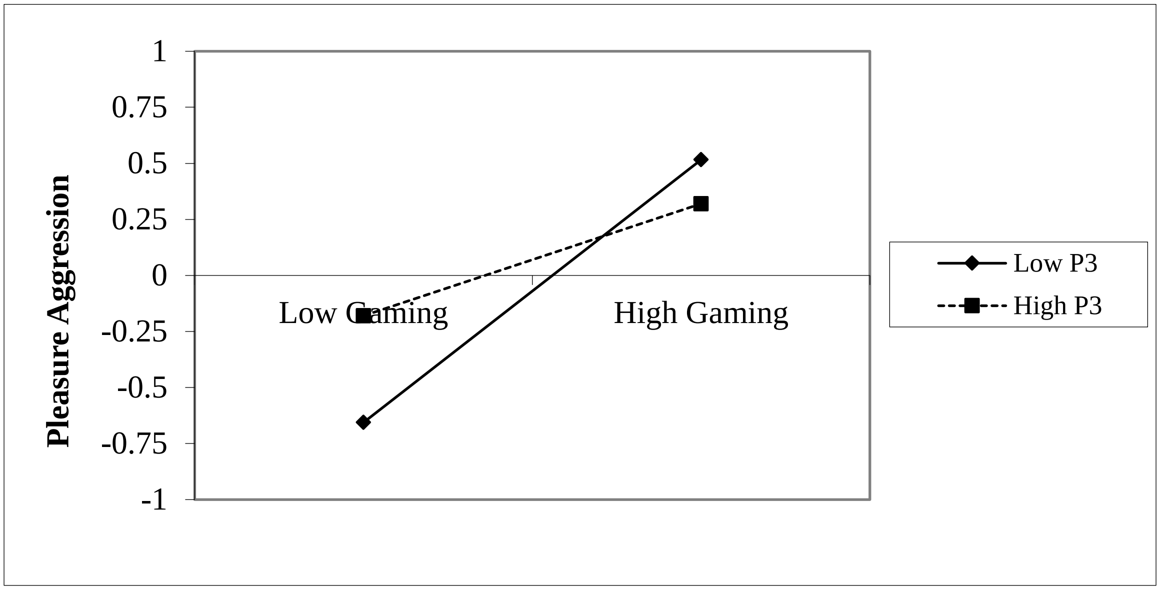

Figure 4. Moderation plots: Interaction between Video Gameplay and P3 amplitude on Pleasure-Oriented Aggression

Next, we examined if gamers with high levels of selective attention (N1 amplitudes) showed the greatest levels of pleasure-oriented aggression. Like in our P3 model, results revealed no significant main effect of brain data (N1 amplitude) on pleasure-oriented aggression, β = .225, *t* (62) = 1.39, *p* = .17, but video gameplay was again shown to be significantly associated with pleasure-oriented aggression, β = .277, *t* (62) = 2.29, *p* = .03. Results of this analysis indicated a significant gameplay-by-N1 interaction on pleasure-oriented aggression, β = .401, *t* (62) = 2.27, *p* = .03 (see Figure 5). This interaction term was decomposed using simple slopes (as outlined above). Since the N1 is a negative going ERP component, "greater" activation was actually "more negative" N1. Thus, new variables were labeled as "more negative" N1 and "less negative" N1. Post-hoc probing indicated that the association between video gameplay and pleasure-oriented aggression was significant amongst those who displayed more negative levels of N1 amplitudes in response to violent imagery, β = .555, *t* (62) = 3.28, *p* = .002, but not for those who displayed less negative levels of N1 activation, β = -.001, *t* (62) = -.01, *p* = .99 These results suggest that when engaged with negative imagery, video game players who also display larger N1 amplitudes – a marker of a selective attentional bias – show the highest levels of pleasure-oriented aggression.

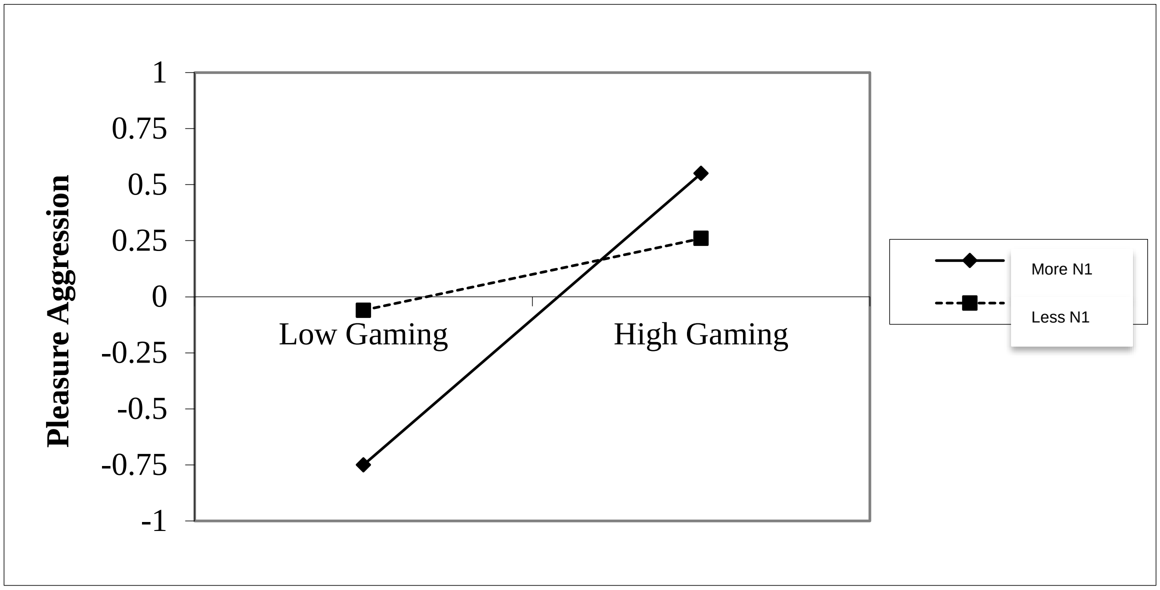

Figure 5. Moderation plots: Interaction between Video Gameplay and N1 amplitude on Pleasure-Oriented Aggression

Our next analysis examined if gamers with deficits in inhibitory control showed elevated levels of pleasure-oriented aggression. No significant main effects or interactions, β = -.148, *t* (63) = -1.01, *p* = .32, were found. Additionally, to see if gameplay interacted with both desensitization and selective attention, we generated a 3-way interaction term and entered it as an independent variable. Results revealed that gameplay-by-P3-by-N1 was not associated with pleasure-oriented aggression, β = .227, *t* (58) = 1.21, *p* = .23. Similarly, the interaction term between gameplay-desensitization-and-inhibitory control (gameplay-by-P3-by-N2) was not significantly associated with pleasure-oriented aggression, β = -.053, *t* (59) = -.32, *p* = .75.

3.3.1 Moderational Analyses of a Reinforcing Spirals Theory

Given the moderational roles of N1 and P3 amplitudes in the association between video gameplay and pleasure-oriented aggression, follow-up analyses were conducted with only our video game player sample to further investigate Slater's (2007) theoretical reinforcing spirals. Slater (2007) proposed that the selection (selective attention; N1 activation) of an individual's media content and the resulting subsequent attitudinal or behavioral outcomes (desensitization; P3 activation) affecting its consumption reinforce each other. We focused this analysis only on the video game players because our non-gamers reported zero hours of gaming and therefore had insufficient variance. Therefore, we conducted hierarchical linear regression analyses to test if N1 amplitudes (selective attention) moderate the association between hours per week spent playing video games and P3 amplitudes (desensitization), and vice versa, i.e., if P3 amplitudes moderate the association between hours per week spent playing video games and N1 amplitudes. Results of these analyses, indeed, revealed a significant interaction of gaming hours-by-N1 amplitudes on P3 amplitudes, $\beta = .57$, $t\ (27) = 2.64$, $p = .01$ (see Figure 6). However, the gaming hours-by-P3 interaction term was not associated with N1 amplitudes, $\beta = .063$, $t\ (27) = .344$, $p = .734$. Thus, simple slopes were used only to decompose the gaming hours-by-N1 amplitudes interaction on P3 amplitudes. Results revealed that individuals who played games for a larger amount of time and had elevated (more negative) N1 activation (selective attention) showed the greatest reductions in P3 activation (desensitization), $\beta = -.77$, $t\ (27) = -2.41$, $p = .02$. Further, individuals who played games for a larger amount of time and had reduced (less negative) N1 activation showed the greatest levels of P3 activation, $\beta = 1.26$, $t\ (27) = 2.64$, $p = .01$.While both slopes were revealed to be significant, the key finding here is that high frequency gamers who have large N1 activation (more selective attention) show smaller P3 amplitudes, suggestive of increased desensitization.

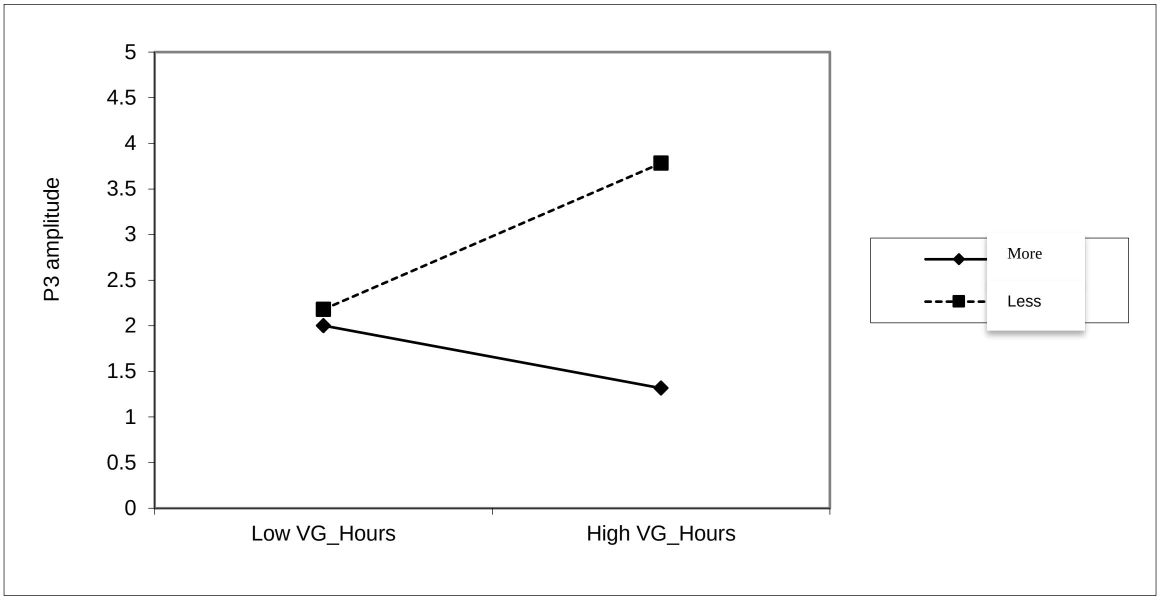

Figure 6. Moderation plots: Interaction between Video Gameplay and N1 amplitude on P3 amplitude

General Discussion

Much of the previous literature has suggested that the association between video game play and aggressive tendencies is brought about by deviations in three different cognitive mechanisms: emotional desensitization (Cline et al., 1973; Bartholow et al., 2006; Carnagey et al., 2007), selective attention (Zillman, 1988; Slater, 2007), and inhibitory control (Josephson, 1987; Hummer et al. 2010). The current study drills down into the association between gaming behavior and aggression to see which mechanisms moderate this association. We used an emotional RSVP paradigm to examine ERP activational differences between video game players and non-players. Unlike previous media violence studies, which have focused only on P3 amplitude as a physiological measure for a blunted aversive motivational system (i.e., desensitization; Bartholow et al., 2006), we also tested N1 and N2 ERP amplitudes to investigate the roles of selective attention and aspects of cognitive control, specifically inhibitory control (disinhibition) – respectively – in the association between video gameplay and aggression. Additionally, because aggression is not a unitary construct (Barratt et al., 1999), we have examined the moderational effects of these ERPs on the association between video game play and various types of aggression. More specifically, because much of the aggression literature highlights an impulsive type of aggression and a pleasure-oriented kind of aggression (Bartholow, 2006; Huesmann & Kirwil, 2007; Krahe et al., 2011), we have focused specifically on these subtypes of aggression.

Consistent with past findings and theory (e.g., Engelhardt et al., 2011), video game players showed blunted P3 amplitudes. Amongst these players, decreased P3 amplitudes were indeed associated with higher levels of aggression, suggesting that desensitization to violent imagery underlies the association between video gameplay and aggression. Interestingly, in our sample, video gameplay itself was not significantly associated with higher levels of overall aggression or impulsive aggression, but it was associated with our pleasure-oriented aggression measure. Further, P3 moderational effects were found for our overall aggression measure and our pleasure-oriented aggression measure but not our impulsive aggression measure. These results suggest that gaming behavior combined with desensitization might lead to a type of pleasure-oriented aggression rather than an impulsive type of aggression. These findings will be discussed in greater detail later.

Results also revealed that video game players with heightened (more negative) N1 amplitudes were most likely to exhibit aggressive behavior when faced with violent stimuli. Furthermore, because this bias was only found for pleasure-oriented aggression, these results suggest that video game players may view aggression as a source of pleasure. In line with previous research, we interpreted these N1 amplitude findings to be reflective of an early selective attentional bias amongst players towards violent imagery (Luck & Shapiro, 1998). These results further suggest that selective attention may be a key contributing cognitive mechanism in the context of an avoidance-approach motivational shift, as suggested in a priori literature (Bartholow & Hummer, 2014), in which desensitized individuals engage with violence aggressively compared to individuals who are averse to violence. Many aggression studies have shown that for some people aggression can be pleasurable (Panksepp & Zillner, 2004; Ramirez et al., 2005). However, to the best of our knowledge, our study is the first to use patterns of neural activation underlying selective attention to show this effect specifically for video game players compared to non-players.

Previous research has also suggested differences in cognitive control between video game players and non-players (Bavelier et al., 2012, Hummer et al., 2014). However, these studies have yielded seemingly conflicting results. Some studies have suggested that deficits in inhibitory control (disinhibition), an aspect of cognitive control, contribute to aggressive behavior (Mathews et al., 2005; Bartholow & Hummer, 2014) while others have interpreted these same differences as actually being indicative of improved cognitive control for video game players (Bavelier et al., 2012, Colzato et al., 2012). To attempt to unpack these conflicting results, we analyzed the N2 – a biological marker measuring aspects of cognitive control, including inhibitory control, for activational differences between players and non-players as well as for moderational effects in the association between gaming behavior and aggression. However, our results revealed no differences in N2 activation between game players and non-players in the context of violence. As well, N2 activation did not moderate associations between video gameplay and any of our aggression proxies, including impulsive aggression. Our results suggest that video game players do not experience any apparent deficits in cognitive control. More specifically, our results do not indicate disinhibition effects amongst video game players while engaged with violent imagery.

Finally, because our results suggested that both selective attention (N1) and desensitization (P3) moderate the association between game play and pleasure-oriented aggression, we conducted follow-up analyses to see how these two moderators might interact to bring about pleasure-oriented aggressive behavior. Our findings suggest that for our game playing sample selective attention (N1 amplitudes) moderated the association between hours spent playing video games and desensitization (P3 amplitudes). However, desensitization did not moderate the association between hours spent playing video games and selective attention. Thus, high frequency game players with an affinity for violent content show the highest levels of desensitization. Although we did not find support for a reinforcing spirals theory, in which desensitization increases the likelihood a video game player will select violent content (Slater, 2007), our results suggest that higher levels of violent content selection might increase desensitization effects. While these results do not indicate causality because they were measured at the same time, they are novel and thus interesting, and future research should explore if selectively attending to violent imagery might cause emotional desensitization. If selective attention were to contribute to emotional desensitization, future research should explore if attention-training approaches might decrease levels of emotional desensitization.

Limitations

There are limitations to the current study. First, although video games may be a medium broadly made up of much violent content, the current study used a simplistic measure that did not aim to specify the precise content consumed by video game playing participants. To further highlight the role specifically played by violent content in the association between video gameplay and aggression, future studies should improve upon our measure by inquiring more thoroughly about the kinds of games played by participants who engage in video gameplay.

Second, we utilized questionnaire data to create proxy outcome variables. Questionnaire data can often be disingenuous due to participants' social desirability biases. Future studies should at least implement a social desirability questionnaire as a control variable. Ideally, future studies should also aim to use in-lab behavioral measures of aggression as outcome variables.

Third, while the RSVP task was deemed to be a more realistic task to explore gaming behavior, the task is quite complex and therefore requires considerable trials to fulfill all the required conditions. To prevent the task from becoming overly tiring, we had to limit the number of trials fulfilling each condition. Thus, we lost a number of participants simply because they did not yield enough artifact free trials for one condition or another.

Conclusion

Our results suggest that desensitized video game players not only experience decreased aversion to violent pictures, but they also display a selective attentional bias for such content, which is not due to an inability to inhibit inappropriate approach strategies. Instead, desensitized video game players may view violent content as a source of pleasure, allocating more early attentional resources towards selecting, seeking out, and viewing it. Together, these findings highlight the importance of translating such research findings to the real world so that consumers are aware of the potential deleterious side effects of consuming violent content. This translation needs to go beyond simple explanations, such as "it increases aggressive behavior" but to decompose the cognitive mechanisms that may bring about social and political problems. Desensitization to media violence has been shown to extend to how we empathize with victims of violence in news reports (Scharrer, 2008), and there is some evidence (e.g., Leonard, 2004; Stahl, 2006; Debrix, 2008) suggesting that selecting digital war games, like Call of Duty, may promote pro-war sentiment (Sisler, 2008; Gagnon, 2010). Therefore, in a time in which our media interactions carry important sociopolitical implications, it is essential that we work towards a more complete understanding of the impact that cognitive mechanisms (e.g. selective attention and desensitization) have on our thoughts and behavior.

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Appendix A

ID Number:

Age: ____________________________Date of Birth: __ __ / __ __ / __ __ __ __ (MM/DD/YYYY)

Year in College (please select):

- ❑Freshman
- ❑Sophomore
- ❑Junior
- ❑Senior
- ❑Other If "other" please explain:

Sex:

Handedness: Right Left

Best time to do hard cognitive activities (please circle below):

Before noon 12-4 pm After 4 pm

Ethnic Category (please select):

- ❑Hispanic or Latino
- ❑Not Hispanic or Latino

Racial Category (please select):

- ❑American Indian/Alaska Native
- ❑Asian
- ❑Native Hawaiian or Other Pacific Islander
- ❑Black or African American
- ❑Caucasian

House Hold Yearly Income:

- o Less then $15,000
- o $15,000 to $30,000
- o $30,000 to $50,000
- o $50,000 to $80,000
- o $80,000 to $120,000

- Over $120,000

Continues on reverse side

Mother Highest Education Completed:

- K-8 (elementary school)
- High school
- Community College
- 2-3 year university degree (undergraduate)
- 4 year university degree (undergraduate)
- Master's level university degree
- Ph.D. level university degree
- Medical school
- Other:

Father Highest Education Completed:

- K-8 (elementary school)
- High school
- Community College
- 2-3 year university degree (undergraduate)
- 4 year university degree (undergraduate)
- Master's level university degree
- Ph.D. level university degree
- Medical school
- Other:

Type of hair (please check all that apply):

- Fine straight
- Thick straight
- Fine curly
- Thick curly
- Short
- Long
- Long-term braids
- Extensions
- Hair is died
- Hair is permed
- Other:

Hair products used since the last hair washing:

- Hair gel
- Hair spray
- Hair conditioner
- Hair mousse
- Hair dye
- Hair oil

Hair last washed ________________ day(s) ago.

Do you play video games? Yes No

If so, how many hours a week (on average)?

Can we contact you again for other studies: Yes No

Participant ID Number: ________________

Buss-Perry Scale

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 me back.
29) When people are especially nice, I wonder what they want.

ADULT TEMPERAMENT QUESTIONNAIRE (VERSION 1.3)

Directions

On the following pages you will find a series of statements that individuals can use to describe themselves. There are no correct or incorrect responses. All people are unique and different, and it is these differences which we are trying to learn about. Please read each statement carefully and give your best estimate of how well it describes you. Circle the appropriate number below to indicate how well a given statement describes you.

circle #:	if the statement is:
1	extremely untrue of you
2	quite untrue of you
3	slightly untrue of you
4	neither true nor false of you
5	slightly true of you
6	quite true of you
7	extremely true of you

If one of the statements does not apply to you (for example, if it involves driving a car and you don't drive), then circle "X" (not applicable). Check to make sure that you have answered every item.

1	2	3	4	5	6	7	X
extremely untrue	quite untrue	slightly untrue	neither true nor false	slightly true	quite true	extremely true	not applicable

1. I become easily frightened.

   1 2 3 4 5 6 7 X

2. I am often late for appointments.

   1 2 3 4 5 6 7 X

3. Sometimes minor events cause me to feel intense happiness.

   1 2 3 4 5 6 7 X

4. I find loud noises to be very irritating.

   1 2 3 4 5 6 7 X

5. It's often hard for me to alternate between two different tasks.

   1 2 3 4 5 6 7 X

6. I rarely become annoyed when I have to wait in a slow moving line.

   1 2 3 4 5 6 7 X

7. I would not enjoy the sensation of listening to loud music with a laser light show.

   1 2 3 4 5 6 7 X

8. I often make plans that I do not follow through with.

   1 2 3 4 5 6 7 X

9. I rarely feel sad after saying goodbye to friends or relatives.

   1 2 3 4 5 6 7 X

10. Barely noticeable visual details rarely catch my attention.

    1 2 3 4 5 6 7 X

11. Even when I feel energized, I can usually sit still without much trouble if it's necessary.

    1 2 3 4 5 6 7 X

12. Looking down at the ground from an extremely high place would make me feel uneasy.

    1 2 3 4 5 6 7 X

13. When I am listening to music, I am usually aware of subtle emotional tones.

1 2 3 4 5 6 7 X

1	2	3	4	5	6	7	X
extremely untrue	quite untrue	slightly untrue	neither true nor false	slightly true	quite true	extremely true	not applicable

14. I would not enjoy a job that involves socializing with the public.

1 2 3 4 5 6 7 X

15. I can keep performing a task even when I would rather not do it.

1 2 3 4 5 6 7 X

16. I sometimes seem to be unable to feel pleasure from events and activities that I should enjoy.

1 2 3 4 5 6 7 X

17. I find it very annoying when a store does not stock an item that I wish to buy.

1 2 3 4 5 6 7 X

18. I tend to notice emotional aspects of paintings and pictures.

1 2 3 4 5 6 7 X

19. I usually like to talk a lot.

1 2 3 4 5 6 7 X

20. I seldom become sad when I watch a sad movie.

1 2 3 4 5 6 7 X

21. I'm often aware of the sounds of birds in my vicinity.

1 2 3 4 5 6 7 X

22. When I am enclosed in small places such as an elevator, I feel uneasy.

1 2 3 4 5 6 7 X

23. When listening to music, I usually like turn up the volume more than other people.

1 2 3 4 5 6 7 X

24. I sometimes seem to understand things intuitively.

1 2 3 4 5 6 7 X

25. Sometimes minor events cause me to feel intense sadness.

1 2 3 4 5 6 7 X

26. It is easy for me to hold back my laughter in a situation when laughter wouldn't be appropriate.

1 2 3 4 5 6 7 X

1	2	3	4	5	6	7	X
extremely untrue	quite untrue	slightly untrue	neither true nor false	slightly true	quite true	extremely true	not applicable

27. I can make myself work on a difficult task even when I don't feel like trying.

1 2 3 4 5 6 7 X

28. I rarely ever have days where I don't at least experience brief moments of intense happiness.

1 2 3 4 5 6 7 X

29. When I am trying to focus my attention, I am easily distracted.

1 2 3 4 5 6 7 X

30. I would probably enjoy playing a challenging and fast paced video-game that makes lots of noise and has lots of flashing, bright lights.

1 2 3 4 5 6 7 X

31. Whenever I have to sit and wait for something (e.g., a waiting room), I become agitated.

1 2 3 4 5 6 7 X

32. I'm often bothered by light that is too bright.

1 2 3 4 5 6 7 X

33. I rarely notice the color of people's eyes.

1 2 3 4 5 6 7 X

34. I seldom become sad when I hear of an unhappy event.

1 2 3 4 5 6 7 X

35. When interrupted or distracted, I usually can easily shift my attention back to whatever I was doing before.

1 2 3 4 5 6 7 X

36. I find certain scratchy sounds very irritating.

1 2 3 4 5 6 7 X

37. I like conversations that include several people.

1	2	3	4	5	6	7	X

38. I am usually a patient person.

1	2	3	4	5	6	7	X

1	2	3	4	5	6	7	X
extremely untrue	quite untrue	slightly untrue	neither true nor false	slightly true	quite true	extremely true	not applicable

39. When I am resting with my eyes closed, I sometimes see visual images.

1 2 3 4 5 6 7 X

40. It is very hard for me to focus my attention when I am distressed.

1 2 3 4 5 6 7 X

41. Sometimes my mind is full of a diverse array of loosely connected thoughts and images.

1 2 3 4 5 6 7 X

42. Very bright colors sometimes bother me.

1 2 3 4 5 6 7 X

43. I can easily resist talking out of turn, even when I'm excited and want to express an idea.

1 2 3 4 5 6 7 X

44. I would probably not enjoy a fast, wild carnival ride.

1 2 3 4 5 6 7 X

45. I sometimes feel sad for longer than an hour.

1 2 3 4 5 6 7 X

46. I rarely enjoy socializing with large groups of people.

1 2 3 4 5 6 7 X

47. If I think of something that needs to be done, I usually get right to work on it.

1 2 3 4 5 6 7 X

48. It doesn't take very much to make feel frustrated or irritated.

1 2 3 4 5 6 7 X

49. It doesn't take much to evoke a happy response in me.

1 2 3 4 5 6 7 X

50. When I am happy and excited about an upcoming event, I have a hard time focusing my attention on tasks that require concentration.

1 2 3 4 5 6 7 X

1	2	3	4	5	6	7	X
extremely untrue	quite untrue	slightly untrue	neither true nor false	slightly true	quite true	extremely true	not applicable

51. Sometimes, I feel a sense of panic or terror for no apparent reason.

1 2 3 4 5 6 7 X

52. I often notice mild odors and fragrances.

1 2 3 4 5 6 7 X

53. I often have trouble resisting my cravings for food drink, etc.

1 2 3 4 5 6 7 X

54. Colorful flashing lights bother me.

1 2 3 4 5 6 7 X

55. I usually finish doing things before they are actually due (for example, paying bills, finishing homework, etc.).

1 2 3 4 5 6 7 X

56. I often feel sad.

1 2 3 4 5 6 7 X

57. I am often aware how the color and lighting of a room affects my mood.

1 2 3 4 5 6 7 X

58. I usually remain calm without getting frustrated when things are not going smoothly for me.

1 2 3 4 5 6 7 X

59. Loud music is unpleasant to me.

1 2 3 4 5 6 7 X

60. When I'm excited about something, it's usually hard for me to resist jumping right into it before I've considered the possible consequences.

1 2 3 4 5 6 7 X

61. Loud noises sometimes scare me.

1 2 3 4 5 6 7 X

1 extremely untrue	2 quite untrue	3 slightly untrue	4 neither true nor false	5 slightly true	6 quite true	7 extremely true	X not applicable

62. I sometimes dream of vivid, detailed settings that are unlike anything that I have experienced when awake.

1 2 3 4 5 6 7 X

63. When I see an attractive item in a store, it's usually very hard for me to resist buying it.

1 2 3 4 5 6 7 X

64. I would enjoy watching a laser show with lots of bright, colorful flashing lights.

1 2 3 4 5 6 7 X

65. When I hear of an unhappy event, I immediately feel sad.

1 2 3 4 5 6 7 X

66. When I watch a movie, I usually don't notice how the setting is used to convey the mood of the characters.

1 2 3 4 5 6 7 X

67. I usually like to spend my free time with people.

1 2 3 4 5 6 7 X

68. It does not frighten me if I think that I am alone and suddenly discover someone close by.

1 2 3 4 5 6 7 X

69. I am often consciously aware of how the weather seems to affect my mood.

1 2 3 4 5 6 7 X

70. It takes a lot to make me feel truly happy.

1 2 3 4 5 6 7 X

71. I am rarely aware of the texture of things that I hold.

1 2 3 4 5 6 7 X

1	2	3	4	5	6	7	X
extremely untrue	quite untrue	slightly untrue	neither true nor	slightly true	quite true	extremely true	not applicable

72. When I am afraid of how a situation might turn out, I usually avoid dealing with it.

1 2 3 4 5 6 7 X

73. I especially enjoy conversations where I am able to say things without thinking first.

1 2 3 4 5 6 7 X

74. Without applying effort, creative ideas sometimes present themselves to me.

1 2 3 4 5 6 7 X

75. When I try something new, I am rarely concerned about the possibility of failing.

1 2 3 4 5 6 7 X

76. It is easy for me to inhibit fun behavior that would be inappropriate.

1 2 3 4 5 6 7 X

77. I would not enjoy the feeling that comes from yelling as loud as I can.

1	2	3	4	5	6	7	X

Adult Temperament Questionnaire

The Adult Temperament Questionnaire (ATQ) was adapted from the Physiological Reactions Questionnaire developed by Derryberry and Rothbart (1988). Based upon the results from recent studies (Rothbart, Ahadi, & Evans, 2000; Evans & Rothbart, in preparation;) we have formulated a self-report model of temperament that includes general constructs of effortful control, negative affect, extraversion/surgency, and orienting sensitivity. The general constructs are referred to as factor scales (i.e., they have resulted in superfactors) and the sub-constructs are referred to as scales. The ATQ short form includes 77 items and includes the same general constructs and sub-constructs as the long form.

References

Derryberry, D. & Rothbart, M.K. (1988). Arousal, affect, and attention as components of temperament. Journal of Personality and Social Psychology, 55, 958-966.

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Adult Temperament Questionnaire SHORT FORM

RELIABILITIES AND CORRELATIONS WITH LONG FORM SCALES

For statistics reported here, the **sample size = 258 undergraduates**.

Factor scales listed in bold type. Scales (i.e., sub-constructs) for factor scales listed in normal print below their factor scale.

	Reliability (Alpha)
Negative Affect	**.81**
Fear	.64
Sadness	.62
Discomfort	.69
Frustration	.72
Effortful Control	**.78**
Inhibitory Control	.60
Activation Control	.69
Attentional Control	.73
Extraversion	.75
Sociability	.71
High Pleasure	.68
Positive Affect	.62
Orienting Sensitivity	**.85**
Neutral Perceptual Sensitivity	.64
Affective Perceptual Sensitivity	.79
Associative Sensitivity	.67

	Correlations of Short Form Scales with Long Form Scales
Negative Affect	**.93**
Fear	.91
Sadness	.87
Discomfort	.85
Frustration	.93
Effortful Control	**.96**
Inhibitory Control	.90
Activation Control	.96
Attentional Control	.94
Extraversion	**.91**
Sociability	.93
High Pleasure	.86
Positive Affect	.90
Orienting Sensitivity	**.95**
Neutral Perceptual Sensitivity	.86
Affective Perceptual Sensitivity	.91

Associative Sensitivity	.90

Hierarchical Listing of Scales

Factor scales listed in capital bold print.

Main scales as sub-components of factor scales listed in red beneath the factor scale that they are associated with.

NEGATIVE AFFECT

Fear: Negative affect related to anticipation of distress.

Sadness: Negative affect and lowered mood and energy related to exposure to suffering, disappointment, and object loss.

Discomfort: Negative affect related to sensory qualities of stimulation, including intensity, rate or complexity of visual, auditory, smell/taste, and tactile stimulation.

Frustration: Negative affect related to interruption of ongoing tasks or goal blocking.

EXTRAVERSION/SURGENCY

Sociability: Enjoyment derived from social interaction and being in the presence of others.

Positive Affect: Latency, threshold, intensity, duration, and frequency of experiencing pleasure.

High Intensity Pleasure: Pleasure related to situations involving high stimulus intensity, rate, complexity, novelty, and incongruity.

EFFORTFUL CONTROL

Attentional Control: Capacity to focus attention as well as to shift attention when desired.

Inhibitory Control: Capacity to suppress inappropriate approach behavior.

Activation Control: Capacity to perform an action when there is a strong tendency to avoid it.

ORIENTING SENSITIVITY

Neutral Perceptual Sensitivity: Detection of slight, low intensity stimuli from both within the body and the external environment.

Affective Perceptual Sensitivity: Spontaneous emotionally valenced, conscious cognition associated with low intensity stimuli.

Associative Sensitivity: Spontaneous cognitive content that is not related to standard associations with the environment.

SCORING INSTRUCTION for Adult Temperament Questionnaire SHORT FORM

Reversed (R) Items: After the initial coding of the questionnaire, reversed items need to be reverse coded (i.e., a response of 1=7, 2=6, 3=5, 4=4, 5=3, 6=2, and 7=1). Items that are reversed are marked with an "R" next to their item number in the listing of items by scale.

Missing Data: Our work with this adult questionnaire has been with undergraduate students. When sampling from this type of population, there is typically a minimal number of 1) non-responses, 2) more than one response for the same item, or 3) and selection of the "not applicable" response option. All three of these cases constitute missing values. We insert the mean item response from the whole sample to replace these missing values. For dealing with a larger number of missing values, one option is use a mean score by adding the number of Likert-scale responses for a given subject followed by dividing by the number of valid (nonmissing) responses.

Scale names are listed in **red print**. To score the main scales, add all of the Likert-responses within a given scale together and divide by the number of valid item responses (or all items constructed for a scale if the sample mean is used to replace missing values). The listing of items by scales below displays the factor scales with their corresponding regular scale sub-constructs.

Factor-scales names are listed in **bold print**. To score factor scales for the short form, add the Likert scores for all of the items of scales that are listed below a given factor scale and then divide by the total number of items belonging to that factor scale. ***Note:*** The instructions for scoring factor scales in the short form are different than the long form (see long form scoring instructions).

Note: Most statistics programs will carry out these steps for you. Users of SPSS can copy the following commands into a syntax file to reverse items and calculate scale scores. The syntax assumes that items are titled "atq1", "atq2", "atq3", etc. It is also assumed that no score was entered when caregivers omitted an item or checked "Does not apply".

```
COMPUTE atq68r = (8-atq68).
COMPUTE atq75r = (8-atq75).
COMPUTE atq6r = (8-atq6).

COMPUTE atq38r = (8-atq38).
COMPUTE atq58r = (8-atq58).
COMPUTE atq9r = (8-atq9).

COMPUTE atq20r = (8-atq20).
COMPUTE atq34r = (8-atq34).
COMPUTE atq2r = (8-atq2).

COMPUTE atq8r = (8-atq8).

COMPUTE atq72r = (8-atq72).
COMPUTE atq5r = (8-atq5).
```

```
COMPUTE atq29r = (8-atq29).
COMPUTE atq40r = (8-atq40).
COMPUTE atq50r = (8-atq50).
COMPUTE atq53r = (8-atq53).
COMPUTE atq60r = (8-atq60).
```

COMPUTE atq63r = (8-atq63).
COMPUTE atq14r = (8-atq14).
COMPUTE atq46r = (8-atq46).
COMPUTE atq7r = (8-atq7).

COMPUTE atq44r = (8-atq44).
COMPUTE atq77r = (8-atq77).
COMPUTE atq16r = (8-atq16).
COMPUTE atq70r = (8-atq70).
COMPUTE atq10r = (8-atq10).
COMPUTE atq33r = (8-atq33).
COMPUTE atq71r = (8-atq71).
COMPUTE atq66r = (8-atq66).

COMPUTE fea = mean (atq1, atq12, atq22, atq51, atq61, atq68r, atq75r).
COMPUTE fru = mean (atq6r, atq17, atq31, atq38r, atq48, atq58r).
COMPUTE sad = mean (atq9r, atq20r, atq25, atq34r, atq45, atq56,
atq65). COMPUTE dis = mean (atq4, atq32, atq36, atq42, atq54, atq59).
COMPUTE acv = mean (atq2r, atq8r, atq15, atq27, atq47, atq55, atq72r).
COMPUTE att = mean (atq5r, atq29r, atq35, atq40r, atq50r).

COMPUTE inh = mean (atq11, atq26, atq43, atq53r, atq60r, atq63r,
atq76). COMPUTE soc = mean (atq14r, atq19, atq37, atq46r, atq67).

COMPUTE hig = mean (atq7r, atq23, atq30, atq44r, atq64, atq73,
atq77r). COMPUTE pos = mean (atq3, atq16r, atq28, atq49, atq70r).

COMPUTE nps = mean (atq10r, atq21, atq33r, atq52, atq71r).

COMPUTE aps = mean (atq13, atq18, atq57, atq66r, atq69).

```
COMPUTE ase = mean (atq24, atq39, atq41, atq62, atq74).

EXECUTE.
```

SHORT FORM ITEMS BY SCALES

FACTOR SCALES IN CAPITAL, BOLD PRINT
Regular scales in red print

NEGATIVE AFFECT

Fear

1. I become easily frightened.

12. Looking down at the ground from an extremely high place would make me feel uneasy.

22. When I am enclosed in small places such as an elevator, I feel uneasy.

51. Sometimes, I feel a sense of panic or terror for no apparent reason.

61. Loud noises sometimes scare me.

68R. It does not frighten me if I think that I am alone and suddenly discover someone close by.

75R. When I try something new, I am rarely concerned about the possibility of failing.

Frustration

6R. I rarely become annoyed when I have to wait in a slow moving line.

17. I find it very annoying when a store does not stock an item that I wish to buy.

31. Whenever I have to sit and wait for something (e.g., a waiting room), I become agitated. 38R. I am usually a patient person.

48. It doesn't take very much to make feel frustrated or irritated.

58R I usually remain calm without getting frustrated when things are not going smoothly for me.

Sadness

9R. I rarely feel sad after saying goodbye to friends or relatives.

20R. I seldom become sad when I watch a sad movie.

25. Sometimes minor events cause me to feel intense sadness.

34R. I seldom become sad when I hear of an unhappy event.

45. I sometimes feel sad for longer than an hour.

56. I often feel sad.

65. When I hear of an unhappy event, I immediately feel sad.

Discomfort

4. I find loud noises to be very irritating.

32. I'm often bothered by light that is too bright.
36. I find certain scratchy sounds very irritating.

42. Very bright colors sometimes bother me.

54. Colorful flashing lights bother me.

59. Loud music is unpleasant to me.

EFFORTFUL CONTROL

Activation Control

2R. I am often late for appointments.

8R. I often make plans that I do not follow through with.

15. I can keep performing a task even when I would rather not do it.

27. I can make myself work on a difficult task even when I don’t feel like trying.

47. If I think of something that needs to be done, I usually get right to work on it.

55. I usually finish doing things before they are actually due (for example, paying bills, finishing homework, etc.).

72R. When I am afraid of how a situation might turn out, I usually avoid dealing with it.

Attentional Control

5R. It’s often hard for me to alternate between two different tasks.

29R. When I am trying to focus my attention, I am easily distracted.

35. When interrupted or distracted, I usually can easily shift my attention back to whatever I was doing before.

40R. It is very hard for me to focus my attention when I am distressed.

50R. When I am happy and excited about an upcoming event, I have a hard time focusing my attention on tasks that require concentration.

Inhibitory Control

11. Even when I feel energized, I can usually sit still without much trouble if it’s necessary.

26. It is easy for me to hold back my laughter in a situation when laughter wouldn't be appropriate.

43. I can easily resist talking out of turn, even when I’m excited and want to express an idea.

53R. I usually have trouble resisting my cravings for food drink, etc.

60R. When I'm excited about something, it's usually hard for me to resist jumping right into it before I've considered the possible consequences.

63R. When I see an attractive item in a store, it’s usually very hard for me to resist buying it.

76. It is easy for me to inhibit fun behavior that would be inappropriate.

<u>EXTRAVERSION/SURGENCY</u>

Sociability

14R. I would not enjoy a job that involves socializing with the public.

19. I usually like to talk a lot.

37. I like conversations that include several people.

46R. I rarely enjoy socializing with large groups of people.

67. I usually like to spend my free time with people.

High Intensity Pleasure

7R. I would not enjoy the sensation of listening to loud music with a laser light show.

23. When listening to music, I usually like turn up the volume more than other people.

30. I would probably enjoy playing a challenging and fast paced video-game that makes lots of noise and has lots of flashing, bright lights.

44R. I would probably not enjoy a fast, wild carnival ride.

64. I would enjoy watching a laser show with lots of bright, colorful flashing lights.

73. I especially enjoy conversations where I am able to say tings without thinking first.

77R. I would not enjoy the feeling that comes from yelling as loud as I can.

Positive Affect

3. Sometimes minor events cause me to feel intense happiness.

16R I sometimes seem to be unable to feel pleasure from events and activities that I should enjoy.

28. I rarely ever have days where I don’t at least experience brief moments of intense happiness.

49. It doesn’t take much to evoke a happy response in me.

70R It takes a lot to make me feel truly happy.

ORIENTING SENSITIVITY

Neutral Perceptual Sensitivity

10R. Barely noticeable visual details rarely catch my attention.

21. I'm often aware of the sounds of birds in my vicinity.
33R. I rarely notice the color of people's eyes.

52. I often notice mild odors and fragrances.

71R. I am rarely aware of the texture of things that I hold.

Affective Perceptual Sensitivity

13. When I am listening to music, I am usually aware of subtle emotional tones.

18. I tend to notice emotional aspects of paintings and pictures.

57. I am often aware how the color and lighting of a room affects my mood.

66R. When I watch a movie, I usually don't notice how the setting is used to convey the mood of the characters.

69. I am often consciously aware of how the weather seems to affect my mood.

Associative Sensitivity

24. I sometimes seem to understand things intuitively.

39. When I am resting with my eyes closed, I sometimes see visual images.

41. Sometimes my mind is full of a diverse array of loosely connected thoughts and images.

62. I sometimes dream of vivid, detailed settings that are unlike anything that I have experienced when awake.

74. Without applying effort creative ideas sometimes present themselves to m

Vita

The author obtained his bachelor's degree in psychology from the University of New Orleans in 2013. He joined the University of New Orleans' psychology graduate program to pursue a PhD in Biopsychology and became a member of Professor Connie Lamm's research group – the Developmental Cognitive Affective Psychophysiology Lab – in 2014.