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FlashReport

This is your brain on violent video games: Neural desensitization to violence predicts increased aggression following violent video game exposure

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ABSTRACT

Previous research has shown that media violence exposure can cause desensitization to violence, which in theory can increase aggression. However, no study to date has demonstrated this association. In the present experiment, participants played a violent or nonviolent video game, viewed violent and nonviolent photos while their brain activity was measured, and then gave an ostensible opponent unpleasant noise blasts. Participants low in previous exposure to video game violence who played a violent (relative to a nonviolent) game showed a reduction in the P3 component of the event-related brain potential (ERP) to violent images (indicating physiological desensitization), and this brain response mediated the effect of video game content on subsequent aggressive behavior. These data provide the first experimental evidence linking violence desensitization with increased aggression, and show that a neural marker of this process can at least partially account for the causal link between violent game exposure and aggression.

"The daily spectacle of atrocious acts has stifled all feeling of pity in the hearts of men. When every hour we see or hear of an act of dreadful cruelty we lose all feeling of humanity."—Taylor Caldwell, *A Pillar of Iron*

People today are bombarded by scenes of violence in the mass media. All forms of media have become more graphic, realistic, and violent over time (see Bushman & Anderson, 2001), but this is especially true for video games. In the past, violent video games featured cartoonish characters and stylized blood and gore. Today, the characters, blood, and gore are extremely realistic. One possible consequence of chronic exposure to violence in the media is that people may become desensitized to it.

Desensitization theory proposes that repeated exposure to violence results in habituation of the initially negative cognitive, emotional, and physiological responses people experience when they see blood and gore (see Funk, Bechtoldt-Baldacci, Pasold, & Baumgartner, 2004; Rule & Ferguson, 1986). This theory is supported by research showing that violent media exposure is associated with decreased cardiovascular (e.g., Carnagey, Anderson, & Bushman, 2007; Linz, Donnerstein, & Adams, 1989), electrodermal (e.g., Cline, Croft, & Courier, 1973), neural (Bartholow, Bushman, & Sestir, 2006), and empathic responses (e.g., Fanti, Vanman, Henrich, & Avraamides, 2009) during depictions of real violence.

Desensitization to violent media, in turn, has been theoretically linked to increases in aggressive behavior (see Smith & Donnerstein, 1998). Habitual exposure to violent media may reduce aggressive inhibitions (see Huesmann & Kirwil, 2007) and empathy for the pain and suffering of others (see Mullin & Linz, 1995), and weaken typical aversions to violence (see Cantor, 1998; Funk et al., 2004), all of which should increase the likelihood of aggressive responses.

However, despite the intuitive appeal of desensitization as a plausible mechanism for increases in aggression, to date no study has demonstrated this link. That is, no previous research has specifically tested whether desensitization following media violence exposure mediates the well-known link between media violence exposure and aggression. This experiment fills this important gap in the literature.

Desensitization to media violence is believed to take a long time, presumably occurring over numerous repeated exposures (see Huesmann, Moise-Titus, Podolski, & Eron, 2003; Smith & Donnerstein, 1998). However, experimental research indicates that desensitization can occur following relatively brief exposures. For example, one study found that participants who played a violent video game for just 20 min showed reduced cardiovascular and electrodermal responses to subsequent depictions of real violence, compared with participants who had played a nonviolent game (Carnagey et al., 2007; also see Fanti et al., 2009; Linz et al., 1989; Mullin & Linz, 1995; Strenziok et al., in press).

In the present experiment, participants varying in levels of previous violent video game exposure played either a violent or nonviolent video

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game in the lab. Acute desensitization following game play was determined using the amplitude of the P300 (P3) component of the event-related brain potential (ERP) elicited by photos depicting real violence, and aggression was measured via levels of unpleasant noise blasts participants gave an ostensible opponent.

P3 amplitude provides a useful measure of desensitization to violence in the present context. Recent theory (Nieuwenhuis, Aston-Jones, & Cohen, 2005) links P3 amplitude with evaluative decision-making processes engaged by the locus-coeruleus norepinephrine (LC-NE) system when motivationally relevant stimuli are encountered. According to this model, the more a stimulus engages a relevant motivational system the stronger the LC-NE response will be and, thus, the larger the P3. Consistent with this idea, research shows that the P3 is sensitive to the arousal properties of stimuli that activate the aversive motivational system (Delplanque, Silvert, Hot, Rigoulot, & Sequeira, 2006; Hajcak, Weinberg, MacNamara, & Foti, in press). Thus, a smaller P3 response to violent images indicates weaker activation of aversive motivation (and relevant decision-making processes related to withdrawal behavior).

Based on these ideas, we predicted that participants randomly assigned to play a violent video game would show smaller P3 amplitudes to violent images compared to participants assigned to play a nonviolent game. Following from this prediction, and given that aversive/withdrawal motivation is incompatible with aggression (see Harmon-Jones, 2003), we also predicted that participants who play a violent (relative to a nonviolent) game would subsequently behave more aggressively. Finally, we predicted that the P3 elicited by violent pictures would negatively predict aggressive behavior (see Bartholow et al., 2006), and would mediate the relationship between violent game exposure and aggressive behavior.

Method

Participants

Participants were selected from a pool of over 2000 undergraduates who completed a video game usage questionnaire as part of a battery of measures administered in a web-based survey. Specifically, participants listed their five favorite video games, indicated the number of hours they played each game in an average week, and then rated the violence of their content and graphics (1 = *not at all* to 7 = *extremely*). Previous exposure to violent video games was measured by summing the contents and graphics ratings for each game, multiplying the sum by the number of hours that game was played each week, and then averaging across the five games (see Anderson & Dill, 2000; Cronbach $\alpha = .84$). We randomly selected 35 individuals scoring above the 75th percentile and 35 individuals scoring below the 25th percentile for the present experiment (representing high and low previous exposure groups, respectively). Participants were 18–22 years old (46% female), were predominantly right-handed, and had normal or corrected-to-normal vision.

Procedure

Participants were told that the study concerned the effects of video games on visual perception and reaction time. After participants gave their consent, the researcher applied scalp electrodes for electroencephalogram (EEG) recording.[2] Next, participants were randomly assigned to play either a nonviolent or violent video game for 25 min. The violent games were *Call of Duty: Finest Hour*, *Hitman: Contracts*, *Killzone*, and *Grand Theft Auto: Vice City*. The nonviolent games were *Jak and Daxter: The Precursor Legacy*, *MVP Baseball 2004*, *Tony Hawk's Pro Skater 4*, and *Sonic Plus Mega Collection*. All games were pre-tested to ensure relative equivalence on how enjoyable, arousing, and frustrating they were. All games were played on a Playstation2 console system connected to a 19″ (48.3 cm) television.

Next, participants viewed a series of neutral (e.g., a man on a bicycle) and violent (e.g., a man holding a gun in another man's mouth) pictures from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2001).[3] Images were presented in 2 blocks of 48 trials, with a 2 min rest period between blocks. Each trial contained 4 “context” images (always neutral) and 1 “target” image, shown in position 3, 4 or 5, which was either neutral or violent. Images were displayed for 1 s each and separated by 1 s intervals. Participants were told to think about their reactions to the images.

Following picture viewing, participants completed a competitive reaction time task (Taylor, 1967), a reliable and valid laboratory measure of aggression that has been used for decades (e.g., Giancola & Zeichner, 1995). Participants were told that they and an “opponent” (actually, there was no opponent; all events were controlled by a computer) would have to press a button as fast as possible on each of 25 trials, and that whoever was slower would receive a blast of white noise (sounds like radio static) through headphones. Prior to each trial, participants set the level of noise their “opponent” would receive, ranging from 60 dB (level 1) to 105 dB (level 10, approximately the same volume as a fire alarm). A nonaggressive no-noise option (level 0) also was provided. Participants also controlled how long their “opponent” suffered by setting the noise duration, from 0 to 2.5 s. Prior to the competition, participants experienced sample noise blasts to ensure they knew the noise was indeed unpleasant. The “opponent” set random noise levels throughout the task. Basically, within the ethical limits of the laboratory, participants controlled a weapon that could be used to blast their opponent with noxious noise. Finally, participants were probed for suspicion, debriefed and dismissed.

Results

Data from 3 participants were discarded due to a high proportion of EEG artifacts. Three other participants were discarded because they did not believe they had a real opponent in the competitive reaction time task. Thus, analyses were based on data from 64 participants (32 who played a violent game). Although men were more aggressive than women, violent video game content had a similar effect on men and women. Thus, the data from men and women were combined.

Aggression

To create a more reliable measure of aggression, noise intensity and duration levels from the competitive reaction time task were standardized and summed. We focused on noise levels set on the first trial in order to assess unprovoked aggression. Trial 1 represents unprovoked aggression because participants set those levels prior to receiving any noise blasts from their opponent. After trial 1, levels converged on what participants believed their opponent had done (i.e., tit-for-tat responding), consistent with findings confirming the importance of reciprocation norms in determining aggressive behavior (Axelrod, 1984).

[2] EEG was recorded from 28 electrodes fixed in an electrode cap (Electro-cap International, Eaton, OH) at standard scalp locations, referenced online to the right mastoid (an average mastoid reference was derived offline). EEG was sampled at 250 Hz (online filtered at 0.05–30 Hz) using a Neuroscan Synamps2 system. Stimulus-locked ERP epochs of 1000 ms were derived offline (100 ms pre-stimulus baseline). Impedance was kept below 10 kΩ. Ocular artifacts (blinks) were removed from the EEG using a regression-based procedure (Semlitsch, Anderer, Schuster, & Presslich, 1986). Trials containing voltage deflections of ±75 microvolts (μV) after ocular artifact removal were rejected prior to averaging according to participant, electrode, and stimulus conditions.

[3] Additional images unrelated to the goals of this study also were included, but will not be discussed because they are irrelevant to testing current hypotheses. The identification numbers (from the IAPS manual; Lang et al., 2001) for all of the images used here were 5875, 7493, 2749, 5410, 2840, 2850, 2870, 2880, 8465, 9210, 5500, 7000, 7002, 7009, 7010, 7025, 7030, 7035, 7040, 7080, 7090, 7140, 7217, 7224, 7050, 3500, 3530, 6313, 6350, 6540, 3170, 6415, 9570, 9800, and 9910.