Violent video games: Sensitisation or desensitisation? A mixed methods study

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ABSTRACT

This study analysed the effects of playing a violent video game on emotional desensitisation. A sample consisting mainly of university students (N=30) were assigned to play either a violent game (VG) or non-violent game (NVG) and were then exposed to a series of images depicting scenes of real-life violence. During both game-play and exposure to images, participants' heart rate (HR) and galvanic skin response (GSR) were recorded. Also, the Self-Assessment Manikin scale was used as a measure of self-report valence (SRV) and self-report arousal (SRA) at both of these times. Self-report and physiological measures were combined in this study as previous research has henceforth been inconclusive in regards to the effects of VGs on reactions to depictions of real-life violence. Data from all four of these variables (HR, GSR, SRV, SRA) were analysed to ascertain whether playing a VG led participants to show attenuated reactions to the images i.e. desensitisation. Of these four variables, SRV was the only variable to indicate a significant difference between groups in terms of ratings given when exposed to the images. Contrary to previous findings, this finding indicated sensitisation as opposed to desensitisation, suggesting that playing violent games increases displeasure to real-life violence rather than decreasing it as desensitisation would suggest. Although findings for GSR and SRA were non-significant, they also point towards sensitisation. In regards to HR, findings were also non-significant, although descriptive findings suggest that playing VGs leads to desensitisation. These findings are discussed in relation to the extended general aggression model (Carnagey et al, 2007), although further study is suggested to clarify findings. In regards to the effects of VGs, such games can, for example, lead to changes in the individual's state aggression, their pro-social behaviour as well as their physiological arousal (Anderson & Bushman, 2001).

KEY WORDS:	SENSITISATION/ DESENSITISATION	VIOLENT GAMES	HEART RATE	GALVANIC SKIN RESPONSE	SELF-ASSESSMENT MANIKIN SCALE

INTRODUCTION

In the last decade, the retail unit sales figures of video games have risen from 208.6 to 229.8 million units sold, when examining statistics for the number of units sold in 2011 compared to 2001 in the US (ESA, 2012). Combined with a significant rise in the amount of money spent on video games by consumers in the US in 2011 compared to 2000 (8.8 billion dollars and 5.5 billion dollars respectively), it is unsurprising that there has been a heavy academic focus on the effects of playing video games on the game-player, with over 2000 articles being published on the subject. Largely, the focus has been on the effects of violent video games, most likely due to a sub-genre of violent games (shooter games) ranking as the second best-selling genre of video game after action games (ESA, 2012), suggesting a large population of video game players are exposed to the violent imagery in the video games.

Recently, research has investigated whether the effects of violent video games occur consistently over time for every time the individual plays the game, or whether repeated exposure to these kinds of games leads the individual to show attenuated reactions to the violent imagery i.e. whether repeated exposure to a violent game could lead an individual to become desensitised to its effects. Earlier research conceptualised this as a 'bystander effect', whereby it was posited that people who are regularly exposed to violent entertainment tend to become more desensitised to both media and 'real-life' violence, more callous, and less sympathetic to victims of violence (Gentile & Anderson, 2003).

However, desensitisation has recently been more generally defined by Anderson et al (2010) as a reduction in negative emotional responses to scenes of violence, with the best measures of desensitisation indeed being suggested to be negative-emotion related e.g. measuring heart rate and skin conductance, levels which may increase upon the experience of some negative emotions. A similar, though more technical definition, is provided by Arriaga et al (2011), whereby desensitisation is conceptualised as an indirect and subtle effect of exposure to media violence, which includes video games. Arriaga and colleagues outline the idea of media violence leading to intense physiological arousal, as well as to affective states such as anger, anxiety, fear and disgust. Furthermore, they suggest that continued exposure to violent video games could lead to the initial adverse reactions to violence, such as anxiety, to become attenuated or blunted.

The theoretical grounding for desensitisation to violence is rooted in the extended version of the General Aggression Model (GAM, Anderson & Bushman, 2002), which was extended by Carnagey et al (2007) with the purpose of theoretically explaining desensitisation effects. This extended General Aggression Model (E-GAM) provides a good social-cognitive framework for understanding the desensitisation process and builds upon the original GAM, which posits aggressive behaviour is an outcome of

the learning, activation and application of aggression-related knowledge structures that are stored in a person's memory.

Looking at the model in regards to desensitisation, as opposed to focusing entirely on aggression, the first part of the explanation for desensitisation by Carnagey and colleagues (2007) is centred on the context in which the violent stimulus is presented. E-GAM postulates that the repeated presentation of violent stimuli in a positive context leads to a reduction in the initial distressing reactions experienced in response to violent stimuli. For example, presenting violent stimuli alongside exciting background music, sounds effects, visual effects, and giving rewards for violent actions in games are all suggested to lead to attenuated reactions to violent stimuli with repeated exposure.

Furthermore, in this extended model, desensitisation is seen as a process whereby initial arousal responses to violent stimuli are reduced, which in turn causes changes in what Carnagey et al (2007) refer to as the individual's 'present internal state'. In other words, the model suggests that attenuated physiological reactions to real life violence, after having been repeatedly exposed to violent video games, is an indicator of desensitisation. As well as physiological changes, E-GAM also discusses how desensitisation can also lead to changes in cognitive and affective reactions to stimuli presented to desensitised individuals, in comparison to reactions that would have otherwise occurred in the absence of desensitisation. Examples of changes in cognitive and affective reactions are given by Carnagey et al (2007), whereby desensitised people may be less likely to notice aggressive events, perceive fewer or less severe injuries, feel less sympathy to victims of violence, believe the world is less of a safe place, and have less negative attitudes towards violence.

Moreover, these cognitive and affective reactions are also referred to as 'sequela' (Carnagey et al, 2007) and are described as a subsequent occurrence to desensitisation. Sequela are also important in determining the subsequent episodic decisions and actions of the desensitised individual. Therefore, as desensitisation can ultimately influence the subsequent actions of the individual, it is important to look at research that has investigated the process of desensitisation in order to see how an individual's reactions to stimuli presented after initial exposure to violent stimuli are affected.

One such example of literature regards the exploration of whether the amount of exposure to entertainment TV violence relates to reactions when reading news stories that recount violent events (Scharrer, 2008). It was found that, when individuals had low trait empathy, local news consumption contributed to blunted responses to news stories that were related to real-life violence. This research therefore demonstrates a desensitisation effect, whereby being heavily exposed to violent TV entertainment led the individuals to display blunted responses when later responding to similar real-life violence.

Other research has also used empathy to use as a measure when looking at desensitisation effects. For example, Funk et al (2003) examined the relationships between short and long-term exposure to violent games and desensitisation, measured using components of moral evaluation. It was found that long term exposure to violent games contributed to lower empathy scores, although the game conditions (violent vs. control) did not affect responses. The results of this study suggest that long-term exposure to violent games could be associated with desensitisation, as reflected in lower empathy scores. However, the authors concluded that the direction of causality yet remains unclear; as is the case for previous desensitisation research involving empathy. That is, it is unclear whether those individuals who show desensitisation to violent stimuli are intrinsically low in empathy or whether it was in fact the stimuli that affected their empathy scores.

Moreover, both of the studies by Scharrer (2008) and Funk et al (2003) used self-report empathy measures when investigating desensitisation, whereas as mentioned earlier, others have argued that the best measure of desensitisation are negative emotion-related physiological measures (Anderson et al, 2010). One example is heart rate, which may increase upon exposure to negative affective stimuli such as a violent picture.

One of the earliest demonstrations of desensitisation to violence using physiological measures was conducted by Lazarus and colleagues (1962), whereby participants' galvanic skin response was measured while they watched a documentary of a tribal ceremony that showed incisions being made to the human body. It was found that participants had lower GSR levels towards the end of the film in comparison to the beginning, due to having been desensitised to the imagery being shown to them.

Nonetheless, research has moved on from examining habituation to a continuous display of stimuli, as demonstrated by Lazarus et al (1962). Rather, it is asked whether exposure to stimuli at any one time can cause short-term desensitisation effects that have implications for participant's reactions to stimuli presented later. A study from Fanti et al (2009) is a prime example of this, whereby desensitisation to violence over a short period of time was investigated. Fanti and colleagues found that repeated exposure to media violence reduces the physiological impact of media violence in the short term, thus desensitising viewers to media violence.

This finding has also been found in relation to violent video games, as opposed to general media violence, whereby Carnagey et al (2007) experimentally investigated the effects of violent video games on physiological desensitisation. The findings of this study showed that participants who had played the violent game, as opposed to a non-violent game, had lower heart rate and GSR while viewing filmed real violence. These findings indicate physiological desensitisation to violence, whereby participants showed less physiological arousal to depicted violence in the real world after exposure to video game violence in the virtual world.

Additionally, a meta-analysis from Anderson et al (2010) reiterates these findings, whereby the authors tested the effects of violent games on a variety of factors, namely physiological arousal and desensitisation. Anderson and colleagues found significant effects for both of these outcome variables, and concluded that violent game exposure is significantly related to increased desensitisation.

However, the research presented hitherto has used either self-report or physiological methods in isolation, including Anderson et al (2010) who incidentally particularly commended the use of physiological methods for use in desensitisation research. However, most research into desensitisation effects shuns the use of self-report methods as a measure of emotional desensitisation. Nevertheless, some have highlighted the utility of self-report measures for the understanding of emotional desensitisation (e.g. Mullin & Linz, 1995; Linz et al, 1995). Moreover, there are some studies implicating both self-report and physiological methodology for investigating desensitisation.

One of the few examples of research using this methodology is a study by Straude-Miller et al (2008), whereby physiological arousal was measured continuously while male participants either played a high or low violence version of a first person shooter game. Subsequently, self-report emotional reactions and physiological reactions to aversive stimuli were measured. Although no differences in emotional responses to the stimuli were found, the physiological reactions were found to be different between conditions. That is, high violence participants showed significantly weaker reactions to aversive stimuli, indicating desensitisation.

Contrastingly with these results, Arriaga and colleagues (2011) did find that violent video game playing led to emotional desensitisation in their participants when looking at their self-report findings. However, contrary to their predictions, no significant differences between SCRs for the violent and non-violent conditions were found. Therefore, although self-report results indicated emotional desensitisation, the physiological differences between groups did not reach significance.

The present study aims to clarify the disparity between these findings, by once again combining self-report and physiological methodology to investigate whether playing violent video games desensitises participants to the effects of viewing depictions of real-life violence. Additionally, the present study also aims to build upon the methodology of previous studies in a number of ways.

Firstly, some of the previous research that has used self-report and physiological measures in combination has been androcentric in nature. For example, Straude-Miller et al (2008) recruited 42 men to play a violent video game, despite recent statistics highlighting that almost as many women play video games as men, 43% to 57% respectively (ESA, 2012). Therefore, the present study aims to recruit both males and females to record their physiology and self-report reactions to viewing depictions of real-life violence.

Furthermore, the present study further builds on previous research in regards to the manner in which self-report measures were taken. Rather than only taking self-report measures during the exposure to depictions of real-life violence, as was done by Arriaga and colleagues (2011), the present study takes self-report measures in conjunction with physiological measures. That is, self-report will be measured in addition to physiology at both game-play and real-life violence stages, as well as the preliminary baseline stage.

Moreover, physiology will be measured both in terms of heart rate (HR) and galvanic skin response (GSR), rather than just GSR as was done in Arriaga's study (2011). In addition, self-report reactions to viewing the affective stimuli used to portray real-life violence will be measured according to ratings made on the two orthogonal dimensions of arousal and valence, using the Self-Assessment Manikin scale (SAM, Bradley & Lang, 1994). These measures will be taken both while participants play the game and when they make their responses to the affective stimuli.

Based on earlier findings, it is predicted that physiological arousal for participants viewing the affective stimuli will be lower for participants in the VG condition compared to those in the NVG condition. A similar finding is predicted for self-reported arousal: In comparison to those in the NVG condition, it is expected that participants in the VG condition will report a lower level of arousal after viewing the affective stimuli. It is also expected that participants in the VG condition will report less negative affective valence, or less displeasure, towards the affective stimuli than participants in the NVG condition. To summarise, it is expected that there will be significant differences between groups in regards to participants' physiological arousal as well as their self-report arousal and valence, when exposed to the depicted real-life violence affective stimuli.

METHOD

Overview and hypotheses

This was a mixed-between groups design with one categorical independent between-subjects variable with two levels – group one (VG) and group two (non-violent game). This design also has one categorical independent within-subjects variable with three levels - time one (baseline), time two (game-play), time three (exposure to negative emotive images). In addition, the continuous dependent variable consists of ratings measured at each time period i.e. heart rate, galvanic skin response, self-report arousal, self-report valence.

The main goal of this study is to test whether the emotional desensitisation hypothesis is confirmed as a result of playing VGs and whether this is true of both self-report and physiological measures of desensitisation.

On the whole, it is expected that all participants' physiological arousal (HR, GSR) will be significantly lower at time one (baseline) in comparison to both time two (game-

play) and time three (exposure to negative emotive images) respectively. Furthermore, it is expected that all participants' self-report arousal scores will be significantly higher at time one (baseline), thereby indicating low arousal on the SAM scale, in comparison to both time two (game-play) and time three (exposure to negative emotive images) respectively. In regards to self-report valence scores, a low score (1) indicates the participant feels very happy or pleasant, while a high score (9) indicates that the individual feels very sad or unpleasant. It is predicted that participants' scores will be significantly lower at time one (baseline), thereby indicating a greater feeling of happiness, in comparison to both time two (game-play) and time three (exposure to negative emotive images) respectively.

Based on earlier findings, it is predicted that participants' physiological arousal (HR, GSR) at time three (exposure to negative emotive images) will be lower for those in the VG condition in comparison to those in the NVG condition. In regards to self-report arousal, it is predicted that participants' scores at time three (exposure to negative emotive images) will be significantly higher for participants in the VG condition in comparison to the NVG condition. Additionally, in regards to self-report valence, it is predicted that participants' scores at time three (exposure to negative emotive images) will be significantly lower for participants in the VG condition in comparison to the NVG condition.

Participants

Participants mainly consisted of university students volunteering as part of the participation pool points scheme held by the university and included a few people who took part in response to study advertisements posted around Leeds Metropolitan University (10 males, 20 females; age= 19-29 years; M=21 years, SD= 2.27). In this sample, equal numbers of males and females took part in each condition, with 5 males in each of the game conditions and 10 females in each of the game conditions. As a result, the number of participants in each group was equally distributed with half of the participants playing either a violent or non-violent game.

Furthermore, all participants were over the age of 18 and regularly played violent games. The rationale behind recruiting this sample was that it ensured that participants only consisted of individuals who had already been exposed to imagery similar to that of which they would be exposed to as a result of taking part in the study. In response to the anticipated confounding effects of recruiting the aforementioned sample of participants (i.e. that participants in the NVG condition may also show desensitisation effects as well as those in the VG condition due to also having previously been exposed to violent imagery), all participants were asked to refrain from playing combat games for at least a week before taking part in this study. This was to ensure that all participants entered the study on an equal footing in regards to their baseline levels of emotion, as five days has been found to be sufficient enough time for participants to return to baseline levels (Mullin & Linz, 1995). More recent research has also reiterated this effect with a shorter time span,

suggesting behaviour is expected to return to normal 10 minutes following exposure to imagery (Barlett et al, 2009). Therefore, previous exposure to violent games was not expected to be a confounding variable for the purposes of this study.

Measures and Stimuli

Computer games

For this study, three games were used – two of which were played on an XBOX 360 gaming console and one of which was played on a personal computer.

Firstly, all participants played a 'neutral game' - Tetris N-Blox (Nintento, 2003-2009) – for the purposes of reducing the initial physiological impact of playing any game before participants were assigned to a game condition. Tetris N-Blox is considered to be a non-violent puzzle game, requiring the player to rotate different shapes to form horizontal lines with them on the screen. This game has received an ESRB rating of E(Everyone), indicating it has content that may be suitable for ages 6 and older.

Participants in the VG condition played Call of Duty: Modern Warfare 2 (Activison, 2009) in single-player mode against computer opponents. This game has received an ESRB rating of M(Mature), indicating that it contains content suitable for persons aged 17 or older. Participants were assigned to the mission named 'O Cristo Redentor' on regular settings. As this is one of the earlier missions in the game and on the easiest game setting, it was not expected that game difficulty would be a confounding variable in this study. This game is a first-person shooter that requires players to try and successfully complete the mission by killing all 26 enemies in the game, without dying themselves. If the participant was killed in the game, they were asked to restart the mission and continue playing.

Participants in the NVG condition played the action-oriented game Forza Motorsports 4 (Turn 10 Studios, 2011), which has a ESRB rating of E(Everyone). Participants played the "Le Mans Circuit de la Sarthe" circuit on a pre-assigned car to save time, the Ferrari Enzo. The goal of this game was to complete two laps of the circuit faster than 11 computer opponents. Participants adopted the viewpoint of the driver in the game to increase their identification with the character.

Images

The negative emotive images for this study were chosen from an internet search with the purpose of identifying images that showed a depiction of real-life violence. The pictures were also chosen in accordance to their similarity to descriptions of pictures used in previous research e.g. attacking humans, pointed guns, mutilated bodies (see Arriaga et al, 2011).

In total, 25 pictures were chosen and each image was presented for six seconds in the centre of a computer screen with a white background, with a fixation '+' sign set at the centre of a white background immediately prior to picture onset. E-Prime 2.0

Software (Psychology Software Tools, Pittsburgh, PA) controlled stimulus presentation and timing, as well as the rating procedure. Following picture onset, participants first made their self-report arousal rating, after which they were automatically taken to the next page to make the valence rating. After this, by default, the next fixation sign was displayed and this cycle was repeated for each image.

Additionally, a series of pleasant images were also hand-picked in accordance with their similarity to previous research, for the purposes of reducing arousal and increasing happiness following exposure to the VGs and violent images.

Physiological emotional responses

Galvanic skin response

GSR, also known as skin conductance response (SCR) is a peripheral measure of autonomic activity and is considered to be a valid indicator of general sympathetic nervous system activity, as outlined by Dawson et al (2000). In this study, GSR was measured continuously for each of the three parts of the experiment (time one, time two, time three). This was done by attaching two GSR transducers (SS3L), with their electrode cavities filled with gel (GEL100), to the index and middle fingers of the participant's non-dominant hand, with the sensor on the bottom of the fingertips. Transducers enabled the measurement of tonic level (skin conductance level or SCL) and phasic responses (skin conductance response or SCR) via the use of BIOPAC Student Lab PRO (BIOPAC Systems). As outlined by Dawson et al (2000), tonic SCL is a good indicator of general arousal, as it is considered the slow component of skin conductance. Therefore, the mean values of SC during baseline and game-play intervals were analysed. However, phasic SCR, the fast component of SC, is a better provider of information for participant's reactions to specific stimuli and was therefore analysed to measure arousal elicited during the six seconds of picture viewing across all 25 pictures. SCRs were log-transformed to normalise the data (log [GSR+1]), and the correction procedure proposed by Lykken and Venables (1971) was also applied in order to reduce possible individual differences – each SCR was divided by the maximum SCR in the dataset.

Heart rate

HR is another indicator of emotional arousal, and was also measured continuously for each of the three parts of the experiment (time one, time two, time three). This was done by firstly placing one electrode on the medial surface of participants' right leg, just above their ankle bone. Another electrode was placed on the medial surface of participants' left leg, just above their ankle bone. The third electrode was placed on participants' right anterior forearm at the wrist, on the same side of the arm as the palm of the hand. Once all three electrodes were on the participants, the electrode lead (SS2L) was attached to participants, each of the pinch connectors being attached to their respective electrode. Similarly to GSR, mean HRs for baseline and

game-play intervals were analysed, and HR during the six seconds of picture viewing at time three was also analysed across all 25 pictures. HR was log-transformed to normalise the data (log [HR]), and the correction procedure proposed by Lykken and Venables (1971) was also applied in order to reduce possible individual differences – each HR was divided by the maximum HR in the dataset.

Self-report emotional responses

The self-assessment manikin scale (SAM, Bradley & Lang, 1994) was used as a basis on which for participants to record their ratings for affective arousal and valence. This scale has previously been used in written and verbal formats (e.g. Bradley & Lang, 1994; Arriaga et al, 2011), although for the sake of efficiency it was transformed into a computerised version using E-Prime 2.0 Software. Instructions were given to participants on-screen, ensuring standardisation, and responses were recorded by E-Prime when participants selected their response on a 9-point pictorial scale to indicate their subjective levels of arousal and valence.

The SAM scale was initially selected as a measure of self-report arousal and valence mainly due to the theoretical orientation underlying its development relating directly to the variables in question in this study, as well as due to the ease of implementation, and it being language and culture-neutral. Furthermore, the scale has been found to have good psychometric qualities, including high convergent validity (e.g. Morris, 1995).

In order to best conceptualise the emotional desensitisation process, SAM roots itself in contemporary approaches to emotion. Namely, two specific models provide the theoretical basis for this scale – Russel's (1998) Circumplex Model and Lang's (1978; Bradley & Lang, 1994) Bio-informational Model. In both, emotions are considered to be structured by two orthogonal dimensions – valence and arousal. Valence is a dimension ranging, in broad terms, from pleasant to unpleasant; while arousal ranges from calm to excited.

Both dimensions are considered to be linear-dependent and correspond to the direction of the participants emotional response and its intensity (Lang et al, 1990). Therefore, these dimensions are considered appropriate to use as a measure of participants' emotional experience to pictures depicting real-life violence, in the format of the SAM scale (Bradley & Lang, 1994).

Self-report Arousal

The arousal scale encompasses a 9-point pictorial scale, ranging from 'very excited/ high arousal' (1) to 'very calm/low arousal' (9). The pictorial scale itself ranges from an excited, wide-eyed, frenzied image versus a completely unaroused, relaxed, calm image.

Self-report Valence

The valence scale also encompasses a 9-point pictorial scale, which ranges from ‘very happy/pleasant’ (1) to ‘very sad/unpleasant’. The pictorial scale itself ranges from a completely happy, pleased, contented image to a completely unhappy, bored, despaired, melancholic image.

Procedure

Volunteers were sought among students and the wider population around Leeds Metropolitan University to participate in a study examining effects of playing a video game on physiology and emotion. Participants were not initially given a full explanation in regards to the purpose of the study in order to avoid demand characteristics. Instead, participants were informed that they were recruited to participate in a study aimed at examining the effect of playing video games on physiology and emotion.

Participants were first given an information sheet to read, which detailed the stimuli they would be exposed to should they choose to participate and also stated the eligibility criteria for taking part.

Participants signed an informed consent form, which assured them that their participation would be kept anonymous, that all personal data would be kept confidential, and that they were free to withdraw their data up to a week following taking part.

Once the participant had consented to take part, electrodes for HR and GSR were then attached to them. GSR transducer (SS3L/SS3LA) cavities were both filled with gel, and were attached to the subject’s index and middle fingers on their non-dominant hand for five minutes prior to the start of recording.

Electrodes were then placed on the medial surfaces of the left and right legs, just above the ankle bones; and on the right anterior forearm just above the wrist (palm up). These electrodes were also placed on skin five minutes prior to calibration, with the pinch connectors attached to their specific electrode.

Participants were then exposed to a 2min 44s calm melody, “Stories for Solo Piano” (Lee, 2010), to induce a similar state of relaxation in all participants. Whilst this was being played, HR and GSR were also being recorded in order to obtain baseline readings.

Participants were then asked to give baseline self-report arousal and valence ratings using a computerised version of SAM, created for the purposes of this experiment using E-Prime 2.0 Software (Psychology Software Tools, PA). Standardised instructions for the rating procedure were on-screen, which also emphasised participants should give ratings as to how they were feeling at that moment in time.

After this, participants then played Tetris N-Blox for two minutes to reduce the initial psychological impact of playing any game before being assigned to a game condition. Participants were systematically assigned to play one of the two video games – VG (Call of Duty: Modern Warfare 2) or NVG (Forza Motorsports 4) - for ten minutes. Their assignment was dependent on their gender, to ensure that an equal number of males and females were in each condition to avoid gender bias. Before starting the game, participants were informed that they would be asked to pause the game three times during game-play, at which time they should pause the game and keep their fingers still while continuing to imagine playing the game. This was to ensure that finger movement wouldn't have a confounding effect on the results. At each of these 15 second intervals, markers were inserted on a continuous recording on BIOPAC to indicate when the game was paused and when it was resumed. The recordings in each of these intervals were later used to calculate means. Participants were also given instructions on how to play the game in the form of a diagram illustrating the functions of game-pad controls from each of the game's manuals.

After finishing the game, participants were asked to give self-report arousal and valence ratings using the computerised SAM scale, with emphasis on how they were feeling when playing the game.

Participants were then told they were next to be exposed to a series of images depicting real-life violence, and that they should again make the SAM ratings but in regards to how they felt when viewing each picture. Again, these instructions were on-screen, although participants were also verbally reminded that should they find the images overly distressing, they should inform the researcher who would then remove them from sight.

Each image was presented for 6s in the centre of a computer screen, with a fixation plus sign (+) set at the centre of a white background immediately prior to picture onset. E-Prime controlled stimulus presentation and timing, as well as the rating procedure. Following picture onset, Ps first made the arousal rating, after which they were automatically taken to the next page to make the valence rating. Automatically after this, the fixation sign prior to the next image was displayed and the cycle continued for each of the 25 images.

Finally, participants were shown a calm video composed of the same background music used initially to induce a similar state of relaxation in participants and a series of pleasant images to reduce arousal and increase happiness. This was to ensure that all participants left the experiment in a similar, if not in a less distressed manner, from which they entered it.

Participants were then debriefed and thanked for having volunteered to take part in the study. Those who had taken part through the participation pool scheme received 3 points for their participation in the study, a reflection of the length of time the study took to complete, an average of 40 minutes.

RESULTS

Preliminary Analyses

Prior to running any analyses, all data were screened for accuracy of data entry. Following this, preliminary analyses on data were conducted to check that both the video games elicited similar levels of arousal, to avoid the type of game being played becoming a confounding variable. It was therefore expected that both games would produce similar levels of arousal, although only the VG was expected to produce desensitisation. To analyse whether the video games led to the expected reactions prior to participants being exposed to the negative emotive images, the difference between means obtained during game-play and baseline means was calculated. The differences between means at time two and time one are shown for each variable in Table 1 below.

Table 1
Differences between means for variables at time two and at time one for each group (standard deviation in brackets)

	Group	Difference between means at time two and at time one*
Heart rate (HR)	VG	.0033 (.02730)
	NVG	.0056 (.01969)
Galvanic Skin Response (GSR)	VG	.0091 (.03433)
	NVG	.0611 (.26631)
Self-report Arousal (SRA)	VG	-3.2000 (2.80815)
	NVG	-2.6667 (2.60951)
Self-report Valence (SRV)	VG	-.8667 (1.06010)
	NVG	.2667 (2.08624)

*SCRs and HRs were log-transformed to normalise the data and the correction procedure proposed by Lykken and Venables (1971) was also applied in order to reduce possible individual differences.

An independent groups *t*-test for each of the means for each dependent variable (heart rate, galvanic skin response, self-report arousal, and self-report valence) revealed that there were no significant differences between game conditions in regards to these mean differences – HR: $t(28)=-.261$, $p>.05$; GSR: $t(28)=-.751$, $p>.05$; SRA: $t(28)=-.539$, $p>.05$; SRV: $t(28)=-1.876$, $p>.05$.

Main analyses

The present study aimed to investigate whether playing VGs leads participants to become desensitised to violent imagery by analysing four dependent variables (heart rate, galvanic skin response, self-report arousal, self-report valence) across the three time periods (baseline, during game-play, during exposure to negative affective imagery). The results for each mixed between-within subjects analysis of variance for each of the variables is presented in turn below.

Heart Rate

The means and standard deviations for heart rate (log transformed values) are presented in Table 3. For participants in both conditions, HR was highest during game-play and lowest during exposure to the images.

Table 3
Means and standard deviations for heart rate for participants in the violent and non-violent game conditions across the three time periods (untransformed values in brackets)*

	Violent game		Non-violent game	
	M	*SD*	*M*	*SD*
Baseline	.9006 (83.5325)	.03227 (13.16237)	.8969 (81.9035)	.03021 (11.86633)
Game-play	.9039 (85.4376)	.03885 (17.74368)	.9025 (84.6204)	.03708 (15.26957)
Exposure to images	.8917 (79.9155)	.03117 (11.84405)	.8941 (80.6687)	.02777 (10.75547)

*HR was log-transformed to normalise the data and the correction procedure proposed by Lykken and Venables (1971) was also applied in order to reduce possible individual differences.

Before conducting the analysis, tests of normality were consulted; Levene's test of homogeneity of variance gave a non-significant value (p>.05), as did Box's test of equality of covariance matrices, and therefore these assumptions were not violated for this variable.

A mixed between-within subjects analysis of variance was conducted to assess the impact of two different game conditions (VG, NVG) on participants' heart rates across three time periods (baseline, during game-play, during exposure to affective stimuli). There was no significant interaction between game type and time, $F(1, 28) = 1.073$, $p=.356$. As expected, there was a substantial main effect for time, $F(1, 28) = 6.824$, $p=<.05$, with a large effect size (partial eta squared =.37). The difference between mean scores for heart rate at time three compared to time two was greater

for participants in the VG condition (M_{diff} = .0122) than for those in the NVG condition (M_{diff} = .0084). However, the main effect comparing the effect of the two types of game did not reach statistical significance, $F(1, 28) = .007$, $p = .935$. VG participants' mean HRs at time three ($M = .89$, $SD = .03$) were not statistically different from NVG participants' mean HRs at time three ($M = .89$, $SD = .03$).

DISCUSSION

The aim of the present study was primarily to see whether combining self-report and physiological methodology would confirm or refute the suggestion that violent video games lead to emotional and physiological desensitisation. Specifically, whether playing VGs leads to attenuated self-report (SRA, SRV) and physiological (HR, GSR) reactions to stimuli depicting real-life violence. Of these four variables, only one – self-report valence – provided findings that indicated significant differences between groups in regards to the self-report valence ratings given by participants at the three different time-points during the study (baseline, game-play, exposure to images).

It was found that in comparison to game-play, participants felt significantly more unpleasant when viewing the pictures depicting real-life violence. Moreover, this difference between time-points was significantly different between conditions; findings suggest that VG participants felt significantly more unpleasant than NVG participants when viewing the pictures, in comparison to their respective game-play SRV ratings. This finding suggests that playing violent games does not lead to attenuated reactions to depictions of real-life violence. Rather, it suggests that playing violent games leads participants to become sensitised to violent imagery, a finding contrary to past findings. This finding does not support the original hypothesis, which predicted that participants in the VG condition would give lower SRV ratings than those in the NVG condition when viewing depictions of real-life violence.

In regards to SRA, self-report ratings suggest participants in both groups felt significantly calmer during exposure to images in comparison to game-play. Additionally, this difference between time-points was again different between conditions, with VG participants feeling less calm than NVG participants when viewing the pictures, in comparison to their respective game-play SRA ratings. However, this difference between groups was found to be non-significant, therefore it cannot be concluded that playing VGs leads to sensitisation as opposed to desensitisation. Moreover, this finding is not in support of the original hypothesis predicting that participants in the VG condition would give lower SRA ratings in response to exposure to depictions of real-life violence when compared to those in the NVG condition.

Furthermore, although self-report findings suggest that playing VGs leads individuals to become increasingly sensitised to violent imagery, as demonstrated by increased

arousal and feelings of displeasure, participants' responses for physiological measures yielded different results. The most notable finding here regards heart rate – findings suggest that in comparison to game-play, all participants had significantly lower heart rates when viewing the pictures of depicted real-life violence. Moreover, this difference between time-points was different between conditions, though non-significantly, and suggests those who had played the violent game had lower HR when viewing the images in comparison to those who hadn't, therefore suggesting desensitisation to violent imagery. Unlike the results reported hitherto, this finding supports the original hypothesis, which predicted that those in the VG condition would have lower HRs when viewing the images in comparison to those in the NVG condition.

In regards to GSR, no significant differences were found between time-points or between conditions, which opposes the original hypothesis that those in the VG condition would have lower GSR, compared to those in the NVG condition, when viewing the images depicting real-life violence. However, findings suggest that VG participants were more greatly aroused than NVG participants when viewing the pictures, in comparison to their respective game-play GSR. Therefore, conversely to findings for HR, these findings suggest playing VGs leads the game-player to become increasingly sensitised to violent imagery. However, as there were no significant differences between the time-points for this variable, the findings from the other three variables will be the focus of this discussion.

On the whole, the findings from the present study are in opposition to those from previous investigations, and therefore do not support findings of studies suggesting that playing violent games leads the game-player to become desensitised to violent imagery.

In regards to heart rate, previous research has suggested that those who play violent games will have significantly lower HR when exposed to violent stimuli in comparison to those who haven't played VGs (Carnagey et al, 2007). However, the present study opposes this finding as no significant differences were found between groups in regards to their heart rate responses to violent stimuli.

Additionally, findings from the present study also refute past findings that suggest those who play violent games, when compared to those who don't, will show desensitisation as a result of having significantly lower GSR when exposed to violent stimuli (Carnagey et al, 2007). This non-significant finding for GSR is, however, in support of results from Arriaga and colleagues (2011), whereby no significant differences in SCRs were found between VG and NVG groups.

Furthermore, although the present study does reiterate findings by Arriaga et al (2011) in regards to GSR, the findings in relation to self-report measures (SRA, SRV) do not show support for past findings from Arriaga and colleagues. That is, self-report ratings did not show VG-players as having lower arousal and less

displeasure during exposure to violent stimuli in comparison to those who played a NVG. Rather, self-report ratings from the present study indicated that participants who had played the VG became sensitised to the violent imagery, as demonstrated by VG-players giving ratings of feeling less calm and feeling more displeasure in response to violent images than those who had played the NVG. Therefore, looking at the findings from the study as a whole, they generally refute previous findings and instead suggest that playing VGs sensitises people to violent imagery as opposed to having a desensitising effect.

One reason for this clear disparity between present and past findings may be attributable to the presence of a publication bias in literature surrounding the topic of violent video game effects. Previously, it has been found that a publication bias exists for literature looking at the effects of violent video games on aggression (Ferguson, 2007). This is a problem whereby journal editors may prefer to report "positive" findings for publication as they may be construed as more "interesting" and also refers to the problem whereby authors themselves may suppress findings that do not support their hypotheses. Although Ferguson (2007) reports a publication bias for the effects of VGs on aggression and not desensitisation, this can be extended to include research on desensitisation as much research has been conducted to test the hypothesis that desensitisation is a mediating factor between VG-playing and aggression (e.g. Krahe et al, 2011; Engelhardt et al, 2011). Therefore, it is possible that a publication bias for studies suggesting VGs lead to desensitisation exists, which would explain the great disparity between the present findings in comparison to past findings.

Furthermore, the results of the present study can be related back to theory mentioned in the introduction. The extended general aggression model (Carnagey et al, 2007) postulates that the repeated exposure of violent stimuli in a positive context leads to a reduction in the initial distressing reactions experienced in response to violent stimuli. However, the present results suggest that repeated exposure of violent stimuli in a positive context sensitises individuals to violent stimuli, rather than desensitising them. Moreover, in accordance with E-GAM, sensitisation may be seen as a process whereby initial arousal responses to violent stimuli are increased, which in turn causes changes in the individual's 'present internal state'. In other words, increased reactions to real-life violence, after having been repeatedly exposed to VGs, is an indicator of sensitisation.

Furthermore, E-GAM also discusses the implication of desensitisation in regards to its effect on cognitive and affective reactions to stimuli presented to desensitised individuals, in comparison to reactions that would have otherwise occurred in the absence of desensitisation. For desensitised individuals, the model suggests that they may be less likely to notice aggressive events, perceive fewer or less severe injuries, feel less sympathy to victims of violence, believe the world is less of a safe place, and have less negative attitudes towards violence. A reversal of the direction of these examples would give an indication of the implications of sensitisation on the

sensitised individual's cognitive and affective reactions to stimuli presented to them. For example, sensitised individuals may be more likely to notice aggressive events than they would otherwise have done in the absence of sensitisation.

The majority of findings in the study however, were found to be non-significant and therefore should be interpreted with caution, as this finding may be attributable to a few limitations of the study, one being the use of one game per condition. That is, all participants in each condition played the same game, 'Call of Duty: Modern Warfare 2' or 'Forza Motorsports 4'. Although this method is in line with the majority of previous research, it limits generalisation of findings to those who regularly play Call of Duty and not to other violent games. Carnagey and colleagues (2007), however, alternated which participants played one out of eight violent games, controlling for this game bias. This was not feasible for the present study, with such a small sample size, however future research should consider whether their findings are applicable across different violent games rather than assuming generalisation to all violent games.

A further point to note here is the length of game-play; participants only played their assigned game for ten minutes. Although this length of time was originally chosen as previous research had found that short period of game-play were sufficient to have an effect on affective states of participants (e.g. Arriaga et al, 2008) it is advisable for future studies to assign participants to a longer period of game-play to be able to clarify the effects of VGs more clearly. Moreover, taking into account the varied findings found when altering the length of game-play, a suggestion for future study is proposed whereby the effects of different lengths of game-play on reactions to violent stimuli are investigated.

To summarise, the present study presents inconclusive findings as to whether violent games lead to desensitisation, although findings in regards to valence go to suggest that playing violent games may lead to sensitisation to violent imagery rather than desensitisation. Further study is recommended to clarify this finding in regards to physiological measures and self-report arousal, which generally point to sensitisation in the present study although these findings were non-significant.

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