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Violent computer games and their effects on state hostility and physiological arousal

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Violent computer games and their effects on state hostility and physiological arousal

Abstract: An experimental study was conducted to investigate the impact of violent computer games on State Hostility, State Anxiety, and Arousal. Participants were undergraduate students, aged from 18 to 25 years old. Before the experimental sessions, participants filled in self-report measures concerning their video game habits and were also pre-tested for aggressiveness and trait anxiety. Physiological responses (heart rate and skin conductance) were measured during the experiment. After playing, information about State Hostility and State Anxiety was collected. The results showed that participants who played the violent game reported significantly higher State Hostility and thus supporting the assumption that an aggressive personality moderates the effect of playing a violent game on State Hostility.

Key words: Violent computer games; state hostility; physiological arousal

INTRODUCTION

Nowadays, electronic games are one of the most popular forms of entertainment for children, teenagers and even adults. However, just as with television, which has an elevated degree of violent content [Signorielli 2003; Vala and others 2000], a content analysis of the most popular games has also shown violence to be their main ingredient [Dietz 1998; Smith and others 2003]. Also, we must consider the fact that graphic and sound quality is rapidly improving and thus contributing to more realistic and detailed depictions of violence [Dietz 1998].

Concerns related to the use of electronic games have been very similar to those raised about the effects of exposure to violence in other media, such as television.

Desensitization is considered to be one of the effects of violent films on high viewers. Research evidence revealed that a reduction in physiological and emotional responses may occur after repeated exposure to violent scenes [Cline and others 1973; Thomas and others 1977], as well as a sympathetic decrease towards the victims of that violence [Linz and others 1984; Linz and others 1988], an increase of tolerance towards aggression [Drabman and Thomas 1974; Molitor and Hirsch 1994], and an acceptance of violence as a way of solving interpersonal conflicts [Zillmann and Weaver 1997].

The possibility that repeated exposure to television violence contributes to a distorted view of the world has also been tested. Some studies showed that violent films produce exaggerated perceptions regarding the number of people involved in violence [Gerbner and others 1980], others, the development of beliefs that the real world is violent, mean and dangerous [Gerbner and others 1980; Monteiro 1999; Signorielli 1990], and others revealed an attitude of fear of victimization [Bryant and others 1981; Monteiro 1999] or a distrust in interpersonal relationships [Gerbner and others 1980; Monteiro 1999; Shrum 1999].

On the other hand, another hypothesis addresses the possibility that exposure to violent content, besides teaching aggressive behaviour, may precipitate, instigate and also facilitate interpersonal aggression. In fact, most studies concerning exposure to television, film violence or violent electronic games, have focussed on the subsequent instigation and facilitation of aggressive behaviour.

Empirical studies on the behavioural effects of high exposure to television violence have systematically supported the association with interpersonal aggression [Bushman and Anderson 2001; Paik and Comstock 1994; Wood and others 1991]. Likewise, the two meta-analyses published so far regarding electronic games have also revealed that playing violent electronic games has an effect on aggressive behaviour [Anderson and Bushman 2001; Sherry 2001].

Although studies about the exposure to violent content on television and in electronic games draw similar conclusions, the results of the meta-analysis conducted by Sherry [Sherry 2001] suggest that the relationship between playing violent games and interpersonal aggression is lower than research findings of the effects of violence on movie and television viewers. In any case, given that an active participation is required from players, some authors still claim that playing violent electronic games may have worse consequences than exposure to violent images in other media [Calvert and Tan 1994; Irwin and Gross 1995; Schie and Wiegman 1997].

In order to more fully explain and understand the relationship between the exposure to mass media violent content and aggressive behaviour, several theoretical models have been developed laying out a set of mediator and moderator variables. The different approaches can be synthesised in the following theories: social learning theory developed by Albert Bandura [Bandura 1973]; the cognitive-neoassociationistic theory developed by Berkowitz [Berkowitz 1984]; the excitation-transfer theory [Zillmann 1991], and the social-cognitive model developed by Huesmann [Huesmann 1986]. As a detailed explanation of these theoretical models would surpass the aims of this paper, we will focus on the recent General Aggression Model (GAM), proposed by Anderson and colleagues [Anderson and Dill 2000], which brings together the above mentioned theories and other models, such as Dodge and Crick's social information processing model [Dodge and Crick 1990] and Geen's affective aggression model [Geen 1990]. Based on a theoretical review, those researchers proposed certain hypotheses regarding learning, development, instigation and expression of human aggression, and have tested the GAM on a vast range of fields related to aggression, such as the long and short-term effects of playing violent electronic games [Anderson and Dill 2000]. Since in this study we are only concerned with short-term impact of playing violent computer games, we will only describe the short-term processes within the GAM framework.

Briefly, the GAM describes the processes that may heighten the probability of interpersonal aggression. As input variables the authors refer to individual (e.g., gender, personality) and situational factors (e.g., provocation, playing violent games). Both can influence the individual's present internal state in cognitive, affective and physiological ways. Besides that, an interaction among these internal variables may occur, and can lead to automatic appraisals and controlled reappraisals, determining the expression of aggressive behaviour. When applying this model to the issue of playing violent games, the authors claims that playing this type of games may influence aggressive behaviour, via the cognitive (by priming aggressive thoughts), the affective (by increasing state hostility and anger), the arousal route (by increasing the individual's excitement), or by some combination of these variables [Anderson and Dill 2000].

Contrary to the GAM and to the aforementioned theories, the catharsis theory, developed by Feshbach and Singer [Feshbach and Singer 1971], states the possibility that aggression may actually be reduced through mere exposure to aggressive acts. Based on this theory, some authors claimed that playing electronic games with violent content, instead of instigating aggressive behaviour, may have a positive effect on the players insofar, as it allows and encourages the discharge of latent aggressiveness in a socially acceptable way [Cunningham 1995; Gardner 1991; Graybill and others 1985; Hull 1985]. However, this hypothesis has not been supported by studies of exposure to film violence [Geen and Quantly 1977; Zillmann 1998], nor by research concerning electronic games [Anderson and Bushman 2001].

In general, the experimental studies carried out by Anderson and colleagues [Anderson and Dill 2000; Bartholow and Anderson 2002] with undergraduate students support the hypothesis that the use of violent games may elicit aggression, if the individual is provoked after playing. However, research is scarce regarding the analysis of the effects on cognitive, affective and physiological variables, which these authors consider to be potential mediators in the relationship between playing electronic games and aggression.

With respect to physiological arousal, several authors suggest that these games may increase the player's excitement as they require active participation [Anderson and Dill 2000; Ballard and Wiest 1996; Cooper and Mackie 1986; Griffiths and Dancaster 1995; Irwin and Gross 1995]. However, this type of effect does not seem to be limited to games with violent content. Rather, it may apply to other action-oriented games [Ballard and Wiest 1996; Griffiths and Dancaster 1995].

Silvern and Williamson [Silvern and Williamson 1987] randomly exposed children, between the ages of four and seven, to an electronic game with violent content or to a violent cartoon, and then monitored their physical and verbal aggression, in a free play naturalistic setting. They found that exposure both to the violent cartoon and to the violent electronic game contributed to an increase of their aggressive responses. According to Irwin and Gross [Irwin and Gross 1995], an alternative explanation would be that players' emotional arousal, and not the violent content alone, cause a short-term increases in aggressive behaviour. In order to test this physiological arousal effect on impulsive behaviour, Irwin and Gross [Irwin and Gross 1995] carried out a study with seven- and eight-year-old children. They found that playing a violent game had an impact on aggressive behaviour (i. e., physical and verbal aggression toward inanimate objects during free-play; verbal aggression to the confederate during free-play; and physical aggression toward confederate during a competitive/frustrating situation) but did not influence children's preference for more aggressive dolls. They argue that the expression of aggression was not related to an increase of emotional arousal, since there was no significant difference between playing games with or without violent content on physiological arousal.

On the other hand, Ballard and Wiest [Ballard and Wiest 1996] concluded that the level of violence depicted in electronic games may heighten the likelihood of activating thoughts and feelings of hostility, evaluated through self-report measures. The authors also analysed the effects of electronic games on cardiovascular response. The results revealed that high levels of game violence can lead to an increase in heart rate and systolic blood pressure, as well as to higher feelings of hostility. Another interesting result was the positive association found between state hostility and heart rate. Thus, there is a chance that violent games may contribute to an increase of emotional arousal and this, in turn, may raise levels of hostility or that violent electronic games may contribute to increased levels of hostility, which then contribute to an increased heart rate. One of the limitations of this experiment was the difference in the level of violence and action between games. Therefore, the authors suggest the use of an action but non-violent game for the control comparison condition in future research.

Besides analysing the impact of playing or observing violent games on the computer screen, Calvert and Tan [Calvert and Tan 1994] compared the effects of observing a violent game on a video monitor versus playing with it using virtual reality devices. They analysed participants' arousal, state hostility and aggressive thoughts, and also considered individual differences such as gender and hostile personality. The authors found that an increase in HR occurred among those who played the game with virtual reality devices. Participants in the virtual reality immersion condition also reported aggressive thoughts more often. Although contrary to predictions, there were no significant differences between groups in respect to state hostility. The authors concluded that a greater realism in electronic games could have a higher impact on their emotional state.

In fact, although it is still not used by many players, virtual reality (VR) technology grants electronic games an increased realism as it may provide a higher feeling of involvement and immersion in the game and may enhance the experience of presence, which may, in turn, favour the identification with the game character(s) [Tamborini and others 2001].

In an attempt to analyse whether VR technology intensifies the effects of violent games, Tamborini and others [Tamborini and others 2001] found that playing violent games had an effect on the number of hostile thoughts. However, contrary to predictions, after playing a violent game with VR participants did not present a significantly higher number of hostile thoughts, in comparison to the participants who played or observed the same violent game on the computer screen.

In a meta-analysis study, Anderson and Bushman [Anderson and Bushman 2001] concluded that playing electronic games with violence contributes to increase physiological responses measured by heart rate and systolic and diastolic blood pressure. Although, according to Sherry [Sherry 2001] interpretation of his own meta-analysis study, the majority of studies usually evaluate the initial impact of games, and this initial enthusiasm may decrease after prolonged game exposure.

Taking into account the physiological arousal effect games can trigger, some authors

[Anderson and Dill 2000] choose not to measure physiological responses, under the assumption that if they select games that produce similar physiological levels on players, these variables are experimentally controlled and will not affect the results. Instead, the authors have chosen games that are still both action-oriented and only different in content (violent vs. non-violent) [Anderson and Dill 2000; Kirsh 1998]. Nevertheless, for a better understanding of its effects on players, Sherry [Sherry 2001] recommends the use of direct measures of arousal.

As regards to the effects of playing violent computer games on state hostility, besides the above mentioned studies [Ballard and Wiest 1996; Calvert and Tan 1994], the experimental research conducted by Anderson and colleagues has yielded mixed results. In the study carried out in 1986, Anderson and Ford found that playing a violent electronic game had negative short-term effects on affective states and that the participants' emotional state was dependent on the level of the game violence they were subject to. Playing the more violent game led to an increase on the state of anxiety and hostility, evaluated through self-report measures, while the moderately violent game only contributed to an increase on players' state hostility. The main limitation with this experiment was that no comparison was made with a non-violent game, allowing the possibility that playing any kind of game may lead to an increase on state hostility. In a more recent experimental study Anderson and Dill [Anderson and Dill 2000] tested the GAM model, by using games that showed no difference in terms of the physiological arousal they triggered but were different in content (violent game vs. non-violent). The authors found no effect of playing violent games on state-hostility, thus concluding that this variable might not mediate the relationship between playing violent games and interpersonal aggression. However, the Anderson and Bushman [Anderson and Bushman 2001] meta-analysis supported the short-term effect of playing violent games on state hostility.

This review of experimental studies illustrates the complexity of this research field and the need for further theoretical and empirical developments.

THE PRESENT EXPERIMENTAL STUDY

The main goal of the present study is to analyse the short-term effects of playing computer games on the affective state (hostility and anxiety) and on physiological arousal (heart rate and skin conductance).

A between-subjects design is used with four treatment conditions: one sample played a non-violent action-oriented game (Group "Lotus"); another sample a game with neither violence nor action (Group "Flowers"); and the two remaining samples played the action and violent games, one on the computer screen and the other through a Head-Mounted Display (HMD) (Group "Doom I" on the computer and Group "Doom I" using a HMD).

One important aspect to consider is to use action-oriented games, so that they would only differ in terms of violent content [Ballard and Wiest 1996]. However, this option also reduces the likelihood of finding effects of physiological arousal between games. Therefore, it would be also important to compare these games with one that is not action-oriented so as to be able to discern whether physiological activation occurs due to violent content or due to the fact that a game is exciting.

A virtual reality device is also used, since the immersion in a virtual environment may provide players with a sense of presence, a more intense experience of immersion and realism than less interactive technologies [Stanney and others 1998], which could raise the impact of playing violent games. With a few exceptions [Calvert and Tan 1994; Tamborini and others 2001] the study of this new technology applied to entertainment has not been a target for scientific research, perhaps because it is recent and quite expensive.

Based on the empirical findings about the short-term effects of playing violent games on emotional states [Anderson and Bushman 2001], we expect state-hostility to be higher in participants playing a violent computer game, when compared with participants playing a non-violent game. For state anxiety, only Anderson and Ford [Anderson and Ford 1986] study addressed the effects on this variable of playing violent electronic games, therefore, no predictions are made.

In order to reduce the physiological impact of the first task, all participants played a non-violent game with no action before their random assignment to one of the four treatment conditions. Therefore, an increase in HRL from baseline to the first game played is expected. A similar hypothesis can be drawn for SCL, since expectations and the performance of any task cause an initial increase in electrodermal activity, with a tendency to gradually decrease as participants get used to the task [Dawson and others 2000].

It is also expected that different physiological indices will be yielded in the four treatment conditions. Therefore, it is expected: 1) that action conditions will show higher physiological activation compared with non-action conditions; 2) that the violent game condition will trigger higher physiological rates compared to the non violent game; and 3) that playing the violent game through a HMD will contribute to a higher physiological arousal, since literature indicates, that regardless of game content, immersive environments elicit an increase in reactivity, in particular on peripheral measures of autonomic activity [Wiederhold and others 1998].

Given the possibility that exposure to the violent game might intensify the emotional state of the player due to the excitatory effect of the content (because violence "arouses" players), physiological measures will also be used to determine whether this arousal mediates the influence on the relation between playing a violent game and displaying state hostility.

Moreover, as presented in the General Aggression Model [Anderson and Dill 2000], and in line with research that suggests that aggressive individuals could be more affected by the exposure to violent content [Bushman 1995; Bushman and Geen 1990], the possible moderating effect of aggressiveness on the relationship between playing a violent game and state hostility will be also tested.

Finally, potential sex differences in the effects of violent computer games will be also analysed, as findings of the empirical studies undertaken so far have been inconsistent. Cooper and Mackie [Cooper and Mackie 1986] found that violent video games had only an effect on girls' arousal and on their aggressive free play. In this sense, authors like Winkel and others [Winkel and others 1987] claim that electronic games may produce a more pronounced effect on physiological arousal in girls, and the impact of playing games with violent content could be even higher, both in terms of arousal and of aggression. However, according to Bartholow and Anderson [Bartholow and Anderson 2002], Cooper and Mackie's study was the only one that revealed this effect. Research carried out by Anderson and Dill [Anderson and Dill 2000] and by Silvern and Williamson [Silvern and Williamson 1987] found no gender differences, and the recent study undertaken by Bartholow and Anderson [Bartholow and Anderson 2002] suggests that violent video games may have more impact on men's aggressive behaviour.

METHOD

Participants

Eighty-seven undergraduate students (53 male, 34 female), from different courses and universities of Lisbon, aged from 18 to 25 years old ($M = 21$), participated in the experiment. All participants volunteered to participate in the experiment and did not receive any reward for their participation.

Participants were randomly assigned to one of the following four treatment conditions and cells were relatively well balanced for gender: "Lotus" ($n = 20$), "Flowers" ($n = 20$), "Doom I" on the computer screen ($n = 24$) and Doom I with a HMD ($n = 23$). Most of the participants were game players (98.9%), but none had ever played using virtual reality devices.

Measures

Time spent playing games. In order to collect information about participant's time spent playing games, they were asked to estimate, on a scale ranging from 1 (*never*) to 5 (*more than 11 hours per week*), the average amount of time they spent playing electronic games at arcades, computers or consoles, regardless of content.

Aggressiveness. To measure aggressiveness, the Portuguese version of the Aggression Questionnaire [Simões 1993] was used. This 29 items-scale was created by Buss and Perry [Buss and Perry 1992] and contains four subscales of aggression: physical aggression, verbal aggression, anger and hostility. Averaging the subscales formed a single aggressive personality score. The reliability coefficient (Cronbach's alpha), in our study, was .80.

Anxiety. For State and Trait Anxiety we used the State-Trait Anxiety Inventory- Form Y [Spielberger and others 1983]. For state anxiety, which includes 20 items, participants evaluated how they felt on a four-point scale, ranging from 1 (*not at all*) to 4(*very much so*). On the self-evaluation of trait anxiety (20 items), participants were instructed to rate how they generally feel on a four-point scale, ranging from 1 (*almost never*) to 4 (*almost always*). According to Keedwell and Snaith [Keedwell and Snaith 1996], this is the scale for assessing anxiety that has been most used for research purposes. The reliability coefficient (Cronbach's alpha) of state and trait anxiety in our study was, respectively, .87 and .88.

State hostility. We assessed state hostility using the Anderson and Morrow [Anderson and Morrow 1995] 35-items State Hostility Scale (SHS). The SHS was translated to Portuguese. The ratings are based on a five-point scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). In this Experiment the SHS displayed a high reliability ($\alpha = .87$).

Arousal. Heart Rate Levels (HRL) and Skin Conductance Levels (SCL) were used as peripheral measures of autonomic activity. Besides being a measure of arousal, HR may be related to hostility [Ballard and Wiest 1996]. Compared to HR, SCL is considered a "pure" index of sympathetic activity and it bears a more linear association with arousal [Bauer 1998]. The Biopac System MP100 was used in order to ensure the continuous monitoring of physiological measures. For analysis, data were transmitted from the Biopac system to a Pentium PC. Three electrodes were used to measure HR, two were placed on wrists, and one on the ankle. For skin conductance Ag/AgCl electrodes were filled with electrode gel and attached to the second phalanx of the third and fourth fingers on the participant's nondominant hand. For each participant, HRL (expressed as beats-per-minute; bpm) and SCL (measured in micro-ohms) were averaged separately across Baseline, "Tetris" initial game and Treatment conditions.

Game Analysis. A Gaming Scale, specifically developed for this experiment, included statements related to game action, frustration, perceived violence, perceived reality, excitement, enjoyment while playing, absorption in the game, nausea and dizziness. Participants were asked to rate each of the statements on a 5-point scale.

Materials

Games. The following conditions served as criteria to choose the games: (1) relatively simple to play; (2) belonging to a different category in order to study their distinct emotional and physiological impact; (3) playable by a single player; and (4) the violent game had to be playable both on a computer screen and through a HMD.

To reduce possible physiological impact of the initial exposure to a computer game a neither non-violent nor action game was used ("Tetris Classic", Version 1.0) before all the four experimental conditions. "Tetris" is a puzzle game that requires the manipulation of geometrically shaped pieces with the purpose of getting the best packing to form horizontal lines. After playing "Tetris" participants played one of the following three games: "Flowers", "Lotus", or "Doom I".

"Flowers" (Version 1.0) is a strategic domino-like board game with flower-shaped pieces. The main purpose is to place pieces of four flowers next to each other, matching the flowers' colours. It has no violence nor is it action-oriented.

"Lotus" is a non-violent, action-oriented rally race game, in which players compete against other computer character drivers. The aim of this game is to negotiate the racetrack in the fastest time.

"Doom I" is a popular violent game involving death and gore, in which players defeat characters in order to survive. To reach the exit door of each level the player has to kill the enemies, get points and find the door keys. Whenever the opponents attack a player, their character looses health. The Entertainment Software Rating Board [ESRB 1999-2004] rated this game for "Mature (17+)" players, and described it as having "Animated Blood & Gore, and Animated Violence". In the violent game conditions participants were exposed to the same violent game but with two levels of immersion: high immersion (played through a HMD) or low immersion (played on a two-dimensional computer screen). In the virtual reality condition, participants played "Doom I" on a Forte Technologies VFX1 virtual reality system and in the other three group conditions participants played on a 17-inch computer screen.

Procedures

One month before the experimental session, participants filled in self-report questionnaires so as to collect data concerning their electronic game habits, aggressiveness and trait anxiety (pre-test session). These questionnaires were completed during a regular class.

Participants were then recruited to the laboratory and were led to believe that the purpose of this study was to test the effects of computer game performance on physiological arousal. The experimenter asked each participant to read and sign a consent form. Then, participants were wired up to a heartbeat and skin conductance apparatus and these physiological measures were taken throughout the entire experiment.

To familiarise the participants with the games, they were given instructions explaining how to play “Tetris” and the other computer game to which they were assigned (“Doom I”, “Lotus” or “Flowers”).

The experimental session involved four phases: 1) A pre-test session (the baseline period), in which participants listened to soft music while we started recording their physiological measures (three minutes); 2) A task preparation, in which participants played the computer game “Tetris” (two minutes), after which scores were collected; 3) A test session (treatment condition), in which participants were randomly assigned to one of the four experimental conditions. In a post-test session the Gaming, State Hostility and State Anxiety scales were administrated. They were asked if they had ever played the game before. After they had completed the questionnaire, they were thanked for their participation and encouraged to talk to us for a debriefing at the conclusion of the study.

Design

This experiment is based on a 4 (Game Condition: “Flowers”, “Lotus”, “Doom I” played on a computer screen, “Doom I” played through a HMD) X 2 (Sex: male, female) factorial between-subjects design.

RESULTS

Time spent with computer games. A multivariate analysis of variance (MANOVA) was performed with Game Condition and Gender as independent variables and the average time spent playing electronic games at arcades, on computers or with consoles as the three dependent variables. A significant main effect for Gender was found, F (3, 77) = 2.99, p<.05. Results of the analyses of variance (ANOVAs) indicated that boys spend more time playing with computer games (*M* = 2.57) than girls (*M*= 2.03), F (1, 79) = 7.45, p<.01, but no significant differences of playing at arcades or with consoles.

Manipulated and controlled variables check. Participants were asked to assess the violence of the game they played as well as perceived reality, game action speed, excitement, enjoyment while playing, frustration, absorption in the game, nausea and dizziness. Given that none of these variables were correlated, various analyses of variance were computed with Game Condition and Gender as independent variables. When a significant F ratio was found, the post-hoc Tukey HSD test was used for comparisons between conditions.

As expected, for violent content the results indicated a significant main effect of Game Condition, F (3, 79) = 42.49, p < .001. The violent game ("Doom I"), played on the computer screen (*M*= 3.14) or through a HMD (*M*= 3.10), was perceived as significantly more violent than "Lotus" (*M*= 1.29) or "Flowers" (*M*= 1.25). There were also differences among Groups on ratings of game action speed, F (3, 79) = 17.78, p < .001, but no Gender effect was found. Tukey HSD *post-hoc* analyses for action speed revealed significant differences between games, "Flowers" (*M*= 2.44) less than "Lotus" (*M*= 3.51) and "Doom I" (*M*= 4.04 played through a HMD and *M*= 4.06 played on the computer). There were no differences on ratings of game realism, enjoyment, excitement, frustration, absorption in the game, nauseas and dizziness.

In regard to their previous experience with the game they were assigned, 65% of participants in the "Lotus" group were familiarized with this game, 42.6% of participants in the violent game conditions had already played "Doom I", but none in the "Flowers" group had ever played the "Flowers" game, χ^2 (2, N = 87) = 18.87, p < .001.

Once "Tetris" was the only game that all participants were exposed to, a 4 (Game Condition) x 2 (Gender) between-subjects ANOVA was computed on "Tetris" scores. There were Gender differences, F (1, 79) = 6.89, p < .05, but no effect for Game Condition or for interaction on Game Condition X Gender was found. Compared with men, women had lower scores on the "Tetris" game (M = 986 for women vs. M = 1315 for men).

State Anxiety, State Hostility, and Physiological Arousal.

Table I reports the analysis for State Anxiety and State Hostility as a function of Gender and Game Conditions.

Insert Table 1 about here

For State Anxiety a 4 (Game Condition) × 2 (Gender) ANCOVA was performed, with Trait Anxiety as a covariate. Results indicated a significant main effect of Gender, F (1, 78) = 4.19, $p < .05$, with females reporting higher (M = 34.76) State Anxiety than males (M = 32). Trait Anxiety was also significant as a covariate, F (1, 78) = 14.63, $p < .001$. Differences between Game conditions were non significant as well as the interaction between Game condition and Gender.

For the analysis of State Hostility, the 4 (Game Condition) × 2 (Gender) between-subjects ANOVA indicated a significant main effect of Game Condition, F (3, 79) = 3.10, $p < .05$, but the Gender main effect and the interaction between these two variables were non significant. Participants who played the violent game on the computer screen reported a higher State Hostility (M = 62.81) when compared with participants who played the non-violent games (M = 54.48 and M = 54.79, respectively for "Lotus" and "Flowers" games). There were no differences between playing "Doom I" through a HMD (M = 58.80) and the other three games.

To analyze if Aggressiveness moderated the link between playing a violent computer game and subsequent State Hostility, we tested whether the interaction Game Content X Trait Aggressiveness significantly predicted State Hostility. Multiple regression analyses were conducted. The moderator is a continuous variable and the independent variable, Game Content, is a dichotomous one (non-violent vs. violent). First we analysed how the independent variable varies as a function of the moderator. We tested the linear hypothesis by adding the product of the moderator and the dichotomous independent variable to the regression equation, as described by Baron and Kenny [Baron and Kenny 1986]. On the first block, State Hostility was regressed on Game Content and Trait Aggressiveness, and on the second block, State Hostility was regressed on Game Content, Trait Aggressiveness, and Game Content X Trait Aggressiveness.

The results indicated that the interaction Game Content X Trait Aggressiveness predicted State Hostility (Fchange (1, 83) = 8.62, $p < .01$, R^2change = .09). Trait Aggressiveness functioned as a moderator for the relation between playing a violent computer game and State Hostility. The moderator variable was then dichotomised in low and high Trait Aggressiveness, according to the Median, for further analyses. After playing "Doom I", there is a tendency for aggressive participants to report higher levels of State Hostility (M = 64.53) compared to those participants low on trait aggressiveness (M = 58.28; t (45) = 1.86, p = .069).

Two MANOVAs were performed separately for the repeated measures of SCL and HRL mean scores in order to analyze if there were differences between the three phases of the experimental session (Baseline, "Tetris", and Game Condition).

The within-subjects analyses revealed significant effects for both SCL, F (2, 80) = 21.97, $p < .001$, and HRL, F (2, 77) = 7.04, $p < .01$. As confirmed by subsequent pairwise comparisons, SCL increased from Baseline (M = 6.39) to "Tetris" (M = 7.33), $p < .001$, and from "Tetris" to Game Condition (M = 7.57), $p < .05$. For HRL, there was only a significant increase from Baseline (M = 87.64) to "Tetris" (M = 92.76), $p < .01$. "Tetris" and Game Condition (M = 93.29) were similar.

SCL Baseline was entered as a covariate in the 4 (Game Condition) X 2 (Gender) X 4 (SCL average for each minute of the four minutes playing) ANCOVA, with the last factor as a repeated measure. The analysis revealed no effects for the within-subjects factor, suggesting that there were no significant differences in SCL during the time participants played the game assigned and when the SCL baseline were taken into account (covariate effect was significant, $F(1, 73) = 543.41$, $p < .001$). There were two significant main effects: a main effect of Gender, $F(1, 73) = 6.54$, $p < .05$, and of Game Condition, $F(3, 73) = 7.39$, $p < .001$. However, as Figure 1 illustrates, these effects were qualified by a significant Game Condition X Gender interaction, $F(3, 73) = 8.44$, $p < .001$. Women who played the violent game "Doom I" with a HMD had higher SCL ($M = 9.26$) compared with the women in the other three Games ($M = 7.12$, $M = 6.04$, $M = 5.99$, respectively for "Doom I" in the computer screen, "Flowers" and "Lotus"), $F(3, 26) = 11.22$, $p < .001$. In contrast, male participants who had played the "Lotus" game had a higher SCL ($M = 8.95$), compared with the other game conditions ($M = 7.89$, $M = 7.57$, $M = 6.71$, respectively for "Doom I" with a HMD, "Doom I" in the computer screen, and "Flowers"), $F(3, 46) = 5.57$, $p < .01$.

Insert Figure 1 about here

To better understand the relationship between the exposure to violent vs. non-violent games and gender, the four game conditions were combined in two groups: a group with participants who played the non-violent games and a group of participants who played the violent game through a HMD or on the computer screen. The ANCOVA performed for the combined non-violent groups, using the same covariate variable as before, yielded non-significant findings for the comparison between male and female participants. In contrast, for the violent conditions there was a significant difference between male and female participants on the SCL, F (1, 39) = 19.66, $p < .001$ (M = 8.65 and M = 11.13, respectively for male and female participants).

The same analyses conducted for SCL were performed for HRL. Thus, a 4 (Game Condition) X 2 (Gender) X 4 (HR average for each minute of the four minutes playing) ANCOVA was performed with HRL Baseline as a covariate. Pre-test HRL Baseline covariate score was significant, F (1, 67) = 42.16, $p < .001$. The within-subjects effect was not significant. There was a significant main effect of Group Condition, F (3, 67) = 7.72, $p <$ .001, no main effect of Gender, and a significant interaction between Group Condition and Gender, F (3, 67) = 2.82, $p < .001$. For female participants, those in the violent game conditions (M = 111.24 and M = 104.77, respectively for playing in the CS and with a HMD) had higher HRL compared with the non-violent game conditions (M = 88.24 and M = 80.21, respectively for those who played with "Lotus" and "Flowers"), F (3, 22) = 5.95, $p < .01$. The ANCOVA for male participants yielded non-significant findings (see Figure 1). Combining the two groups of exposure to violent and non-violent games, the two ANCOVA results showed that a statistical significance was only attained for the comparison between male and female participants on HRL within the two combined samples exposed to the violent game, F (1, 39) = 8.67, $p < .01$. As for SCL, female participants had higher HRL (M = 105.59) compared with men (M = 93.03) while playing the violent game.

The interaction effects between Group conditions and Gender for SCL and HRL can be observed in Figure 1.

Although there were no significant differences between the following variables, Game conditions on time spent with video games, Tetris performance, enjoyment, excitement, frustration, and absorption in the game, they were nonetheless included separately as covariates in the analysis of game and gender effects on the dependent variables (hostility, anxiety and heart rate and skin conductance). Furthermore, experience with the game to which they were assigned was also used as a covariate. Overall, with the exception of game frustration and game absorption, the other variables were not significant predictors in any of the analysis. Game frustration was a significant covariate in the ANCOVA with skin conductance level as the dependent variable, while Game absorption was a significant covariate when predicting heart rate levels. Nevertheless, the inclusion of these two covariates in the ANCOVAs did not alter the effects already mentioned.

Mediation Analysis. HRL was significantly correlated with State Hostility, r (80) = .24, $p < .05$ (two-tailed), but not correlated with SCL. Due to the associations found between State Hostility and HRL, mediation analyses were conducted to examine whether the predictor physiological arousal accounted for the impact of the violent game on State Hostility. Since only HRL was correlated with state hostility, we estimated a series of regression equations, following the procedures suggested by Baron and Kenny [Baron and Kenny 1986], to examine whether the predictor met the necessary criteria for mediation. State Hostility and HRL (the average mean of HRL during the four minutes of playing) are continuous variables and the independent variable, Game Content, is a dichotomous (non-violent vs. violent). Given the fact that aggressive personality moderated participant's State Hostility, we tested mediation separately for the low and high Aggressiveness groups.

Insert Figure 2 about here

As Figure 2 illustrates, for participants high on Aggressiveness, playing the violent game "Doom I" showed a significant positive relation to State Hostility (β= .49, $p < .01$, R^2change = .24), and a significant positive effect on HRL (β = .42, $p < .01$, R^2change =.18). Considering playing "Doom I" and HRL together as independent variables, HRL showed no effect on State Hostility, whereas the effect of playing with violent content remained significant (β = .45, $p < .01$, R^2change =.24). In contrast, in the low Aggressiveness group, Game Content showed no effect on State Hostility, as well as on HRL.

DISCUSSION

The main purpose of the present research was to analyse the short-term effects of playing violent computer games on affective states such as state hostility and state anxiety, and on physiological arousal (heart rate and skin conductance).

The pattern of results obtained suggests that playing violent games may have an immediate negative effect on state hostility, but not on state anxiety. Concerning the psychophysiological effects, the pattern is less clear: Despite the lack of a general arousal effect, it seems that playing violent games had more impact on female than on male participants, resulting in higher levels of arousal in this condition.

The results of state hostility are in line with previous research findings [Anderson and Bushman 2001]. Furthermore, besides the comparison between male and female participants, we also analysed whether an aggressive personality moderated the effect of playing a violent game on state hostility. We did not find a gender effect, but our results supported the assumption that playing a violent computer game may have distinct effects on people depending on their aggressiveness [Bushman 1995; Bushman and Geen 1990], which is consistent with previous research on media violence. We found that playing a violent computer game produced a marginal effect on state hostility for those participants scoring high in aggressiveness when compared with those who had low scores in the same personality trait. Yet, as Bushman [Bushman 1995] already mentioned in respect to media violence, we must also keep in mind that our findings should not be interpreted to mean that nonaggressive players are unaffected by violent computer games.

However, and contrary to our hypothesis, our findings did not reveal significant differences between playing the violent game through a head mounted display and the other game conditions. Similarly, this result was also found in the Calvert and Tan [Calvert and Tan 1994] study. The expected effect of the virtual reality device is based on the assumption that this technology enhances the immersion in the game, and somehow brings the game closer to reality. However, one possibility might be the reduced capacity of the virtual reality device, which could have not been immersive enough to enhance a higher sense of presence. Nevertheless, further research should explore the possibility that virtual devices and the consequent immersion in the games would foster fantasy and ludic experience rather than "reality" experience.

With regards to the physiological arousal effects, we were concerned that the initial impact of the first task might conceal a possible effect of game content. Therefore, in this study, an initial non-violent game was used to precede the treatment conditions. As predicted, there was an increase of both measures of autonomic activity (SCL and HRL) from baseline to the first game experience. We also expected that after a certain time of exposure to a computer game, habituation might occur, and we also found that no changes occurred on heart rate between the exposures to the first and the second game conditions. In addition, during the four minutes of playing the second game, there were no significant changes in heart rate. Regarding the skin conductance levels, we found a similar result during the playing of the second game, although there was an increase in this physiological measure from the first to the second game exposure. One explanation for the different results between heart rate and skin conductance may be the specificity of these two physiological measures. Heart rate, being supraventricular in origin, is innervated by both the sympathetic and parasympathetic nervous systems, and as noted previously skin conductance is considered to be only an index of sympathetic activity, as sweat glands are not innervated by the parasympathetic system [Bauer 1998]. In light of this, the lack of variability on heart rate levels after the first game exposure might be due to a balance between these two systems. On the other hand, skin conductance appears to reflect more directly arousal changes between the different tasks participants were exposed to [Bradley and Lang 1994].

Consistent with this differentiation, no significant association between heart rate and skin conductance levels was observed. Similarly, empirical research has shown that physiological measures of arousal, such as those contemplated in our study, do not necessarily relate to each other and are determined by a combination of personal and situational factors [Brody 1999].

The significant main effect of game condition and the significant interaction between game condition and gender for both SCL and HR, offer some support for the hypothesis of a higher impact of violent game on female participants. In fact, according to the findings of Cooper and Mackie [Cooper and Mackie 1986], our results also suggest that women are more likely to be aroused by violent computer games than men. Some authors have also pointed out that violent games could make girls more stressed [Cooper and others 1990]. On the other hand, no gender differences on arousal levels were obtained while playing the non-violent games. Research regarding electronic games usage and preferences point to some gender differences, which was confirmed by our study. Girls spend less time playing electronic games than boys do and prefer a different type of game, being less attracted to violent themes and thus avoiding games with violent content [Arriaga-Ferreira and Ribeiro 2001]. However, our study did not reveal gender differences in the enjoyment of the games they played. For Cooper and Mackie [Cooper and Mackie 1986] girls might be more susceptible to the effects of violent computer games because of their lesser experience with this technology. In fact, our study, besides showing that women spend less time with computer games, also indicates that men might be more skilled, given that male participants performed significantly better "Tetris" than women. Nevertheless, our study only revealed a higher effect of the violent computer game on female participants´ arousal. For state hostility, such effect is not specific to female participants.

Taking into consideration the overall effect of game-content, the findings of our experiment on physiological arousal do not provide a clear support for our three hypotheses. Significant differences between the four group conditions were expected. First, we hypothesized a higher arousal in groups playing action games ("Lotus" and "Doom I") compared with the non-action game ("Flowers"). Second, we expected that the violent game ("Doom I") would evoke a higher arousal in participants in comparison with the non-violent games ("Flowers" and "Lotus"), and third, we expected physiological arousal to be higher in the condition of playing the violent game through a head mounted display, compared to the condition of playing games on the computer screen. Even though, that the arousing effect of playing violent games was only present in female participants, the physiological data obtained during the exposure to the treatment conditions and the self-report feelings of excitement yielded a different pattern of results. That is, in contrast with the arousal effects of violent computer games on female participants (measured with direct measures of autonomic activity) there were no significant gender differences on self-report perception of excitement. If we assume that male participants, in general, had a larger experience with violent games than females, it could be speculated that although the physiological measures reflected this habituation effect, the self-report data did not, i.e., males still rate the games as exciting as females, despite the fact that they show a decrease in physiological arousal.

Another interesting result was the association between arousal and hostility, also found in Ballard and Wiest [Ballard and Wiest 1996] study. However, the correlation obtained was very small and could represent a spurious result. Nevertheless, as this finding could raise the possibility that physiological arousal might account for the relationship between playing a violent game and hostility, and given that small correlations may mask larger effects within special groups, a mediation analysis was conducted separately for the low and high trait aggressiveness participants. Our findings in both analyses indicate that arousal did not mediate the influence of playing a violent game on the perception of state hostility which reinforced the assumption that the effect of playing these types of games on hostility rather depends on the players' trait aggressiveness. Hence, the importance of personality as a moderator factor on the effect violent games may have on players, clearly deserves further attention in future research.

However, the hypothesis that excitatory residue, elicited by the violent computer game, might still be present immediately after playing and during the evaluation of the emotional state, and thereby be transferred, facilitating the subsequent expression of aggressive behaviour is still unanswered [Zillmann's theory of excitation-transfer]. In addition, this study does not allow us to conclude anything about the effects of violent games on behaviour. The level of state hostility was self-reported. Further, being a paper-and-pencil measure, with statements oriented to feelings of hostility, participants could have developed expectations regarding the purposes of the experiments, which in turn could have influenced, at least to some extent, the reporting of their emotional state. Also, socially desirable responses might have occurred.

As a further extension of these studies, it would also be interesting to test the General Aggression Model taking into consideration, besides aggressiveness, physiological arousal and state hostility, other possible mediator (e.g., priming of aggressive thoughts) and moderator (e.g., other individual differences) variables of aggressive behaviour. Although we analysed some important variables which were related to participants' game perceptions (e.g., degree of violence, action speed and realism) and game reactions (e.g., enjoyment with playing, absorption in the game, nausea and dizziness), additional research should include the assessment of other variables related to the interpretation of the game-world and to their game experience, such as player's motivation for playing, perception of game difficulty and their own skills. According to Grodal [Grodal 2000], the player's skills and their own assessment of the performance could be linked to the effects of games on aggressive behaviour. The player's sense of game control could also enhance the perception of realism [Grodal 2000], given the fact that games require some learning processes. Therefore, future research on this new interactive electronic entertainment should also take into consideration the different experiences participants are having when they are interacting in the game-world.

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Table I.

State Anxiety and State Hostility as a function of Group Condition and Gender.

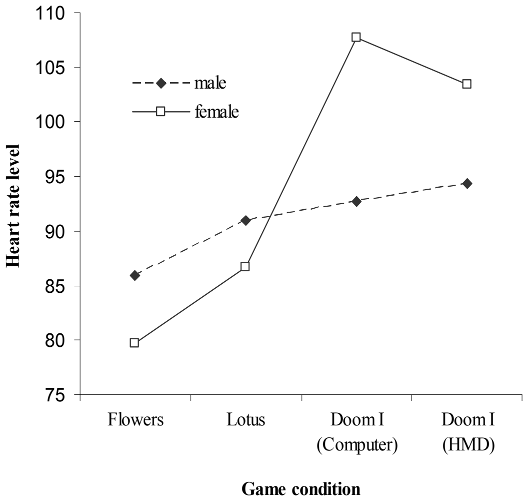
Dependent Variable: State Anxiety	*Df*	Mean Square	*F*
Covariate: Trait Anxiety	1	506,98	14,63***
Independent Variables:			
Gender	1	145,20	4,19*
Group	3	28,15	0,81
Gender*Group	3	60,17	1,74
Error	78	34,64	
Dependent Variable: State Hostility	*df*	Mean Square	*F*
Independent Variables:			
Gender	1	195,12	1,89
Group	3	319,55	3,10*
Gender*Group	3	152,32	1,48
Error	79	103,21	

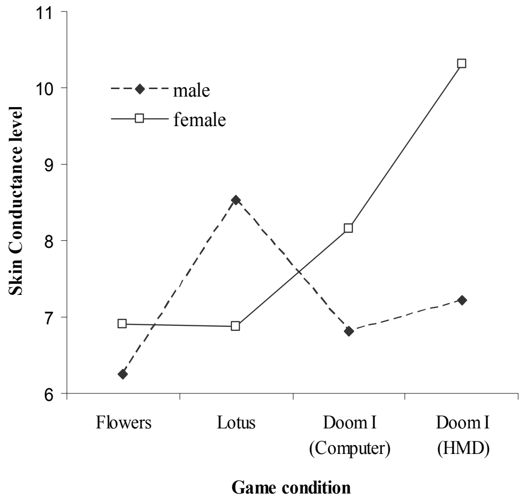
*$p < .05$; *** $p < .001$

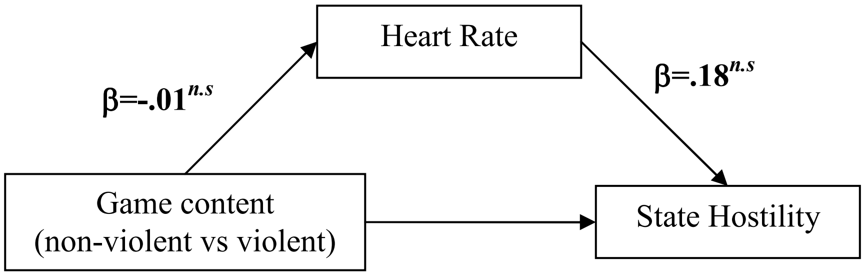
Figure Captions

Figure 1. Heart Rate Levels (left) and Skin Conductance Levels (right) during the experimental session as a function of Group Condition and Gender.

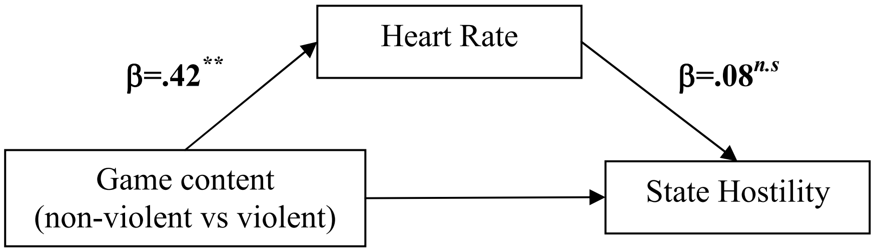
Figure 2. Results of multiple regression analyses with game content as predictor, heart rate as mediator, and state hostility as criterion, for participants with low aggressiveness (up) and high aggressiveness (down) scores.


110
105
100
95
90
85
80
75
Heart rate level
male
female
Flowers
Lotus
Doom I (Computer)
Doom I (HMD)
Game condition


11
10
9
8
7
6
Skin Conductance level
male
female
Flowers
Lotus
Doom I (Computer)
Doom I (HMD)
Game condition



β=-.08$^{n.s}$, direct effect (β=.06$^{n.s}$, total effect)



β=.45**, direct effect (β=.49**, total effect)

Note. $^{n.s}$*p* > .05; ***p* < .01. Game content was coded with 1 for the non-violent conditions and with 2 for the violent conditions. The *direct effect* corresponds to the correlation between the Game Content and State Hostility with Heart Rate included in the regression, whereas the *total effect* is the original correlation between the Game Content and the State Hostility.