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Killing Non-Human Animals in Video Games: A Study on User Experience and Desensitization to Violence Aspects

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ABSTRACT

Violent video games are often associated to negative effects such as desensitization to violence. However, while aggression can concern any living being, experiments in the literature have especially focused on games that require the player to aggress human (or anthropomorphic) beings. To extend the investigation of violent video games, this paper considers a video game genre (Whac-a-Mole) in which the victims of aggression belong to non-human animal species. The study investigates User Experience aspects (in terms of players' affect) as well as desensitization to violence aspects of a Whac-a-Mole game and a non-violent version of the same game, using Affect Grids and physiological measures (Facial EMG, SCL, HR, and BVPA). To obtain a high level of control on confounding factors, the modified game for the non-violent condition of the study replaces only the violent content of the original game with non-violent content, leaving all other game features constant.
Well-known findings about desensitization to violence in violent video games were not found in this study, and player's affect results also suggest that the violent element of the Whac-a-Mole game cannot be straightforwardly replaced by a non-violent one without possibly weakening the User Experience. The paper discusses possible reasons for the obtained results and suggests additional research steps to better clarify the role that the virtual victims' species might play as a factor in violent video games studies.

Keywords: *Violent video games, User Experience, Physiological measures, Desensitization to violence, Whac-a-Mole games.*

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1. Introduction

The classic *Whac-a-Mole* arcade game is the first example of a popular genre (*Whac-a-Mole games*) in which a specific violent element (i.e., aggression towards non-human animal species) seems to be central to the user experience (UX). In the Whac-a-Mole arcade game, plastic moles pop up from the game cabinet, and players

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have to hit each mole using a soft mallet to force it back into the cabinet. The more moles the player hits, the higher the score. Subsequent Whac-a-Mole games employed various non-human animal species besides moles. As video game technology progressed over the years, this game genre moved to computers and, more recently, to handheld consoles (e.g., Nintendo DS) and mobile phones (e.g., Apple iPhone), which are well suited for quick, on-the-go gaming sessions afforded by this genre.

Several experiments in the literature have contrasted violent and non-violent video games, concluding that playing violent video games results in negative effects such as an increase in aggressive feelings, cognition and behavior (e.g., Anderson & Dill, 2000; Anderson, et al., 2004), desensitization to violence (e.g., Bartholow, Bushman, & Sestir, 2006; Carnagey, Anderson, & Bushman, 2007; Engelhardt, Bartholow, Kerr, & Bushman, 2011), anxiety (e.g., Anderson & Ford, 1986), and negatively valenced high-arousal affect (e.g., Ravaja, Turpeinen, Saari, Puttonen, & Keltikangas-Järvinen, 2008),

However, while aggression is defined as behavior directed towards the goal of harming other living beings (Baron, Byrne, & Branscombe, 2009), the experiments in the literature have mainly focused on games that – unlike Whac-a-Mole games – require the player to aggress human (or at least anthropomorphic) beings. This paper starts to investigate Whac-a-Mole games, focusing on (i) the possible effects of their violent element, and (ii) the possibility of effectively replacing their violent element with a non-violent one. To do so, we study the UX (in terms of players' affect) of a Whac-a-Mole game that requires the player to kill insects and a modified version of the same game in which the violent element is replaced by a non-violent one, using questionnaire-based as well as physiological measures. Moreover, we study possible desensitization to violence effects after playing both games.

An issue that characterizes experimental comparisons of violent and non-violent video games in the literature concerns confounding variables (Adachi & Willoughby, 2011). The violent and non-violent game conditions are typically based on completely different video games (e.g., Arriaga, Esteves, Carneiro, & Monteiro, 2006; Carnagey et al., 2007; Sestir & Bartholow, 2010), such as a First-Person-Shooter (FPS) in the violent condition vs. a puzzle game in the non-violent condition. To address this issue, some studies try to match violent and non-violent video games on additional dimensions other than violent content (e.g., enjoyment and arousal) or try to employ multiple video games for both the violent and non-violent conditions to mitigate the stimulus sampling problem (Wells & Windschitl, 1999). Unfortunately, the violent and non-violent conditions can differ in a very large number of aspects (e.g., sounds, music, pace, difficulty, environment in which the game takes place, structure of the game levels, nature and timing of game events, sequence and type of actions required to the player, motor actions on the game controls, etc.). With so many game characteristics not held constant between conditions, one cannot rule out that unaccounted for variables – instead of violent content – can be responsible for the differences obtained, as discussed in depth by (McMahan, Ragan, Leal, Beaton, & Bowman, 2011). To face this methodological issue, in our experiment we changed the source code of the studied violent video game, producing a non-violent version of the same game that differs only in the nature (violent or non-violent) of the player's action.

The paper is organized as follows. In Section 2, we briefly review the negative effects of violent video games reported by the literature and we introduce how physiological measurements are being used in video game studies. The two versions of the game employed in our study are described in Section 3. Then, Sections 4 and 5 describe in detail the experiment and its results, while Sections 6 and 7 critically discuss the results and present conclusions and future work.

2. Related Work

2.1 Effects of Violent Video Games on Aggressive Feelings, Thoughts and Behaviors

Many studies in the literature have associated violent content in video games to aggressive feelings, thoughts and behaviors (Anderson et al., 2010; Boyle, Connolly, & Hainey, 2011). In most of these studies, participants typically played a violent or a non-violent game, and the aggression elicited by playing the game was later measured through subjective questionnaires or specific post-play tasks. In some cases, physiological measurements were also employed, as we summarize in the following.

In (Anderson & Dill, 2000), authors recruited participants who, during mass testing questionnaire sessions, scored low or high in the *Caprara Irritability Scale* (CIS) (Caprara et al., 1985). The participants were asked to play a violent game (a FPS) or a non-violent one (a graphic adventure), letting them believe that they were competing against a second player over a network. After the gaming session, their aggressive behavior was measured using a version of the *Competitive Reaction Time Task*

(CRTT) (Taylor, 1967). In this post-play task, participants have to press a button as quickly as possible in response to an audio stimulus and are led to believe that they should react faster than a competitor. Out of 25 time trials, the CRTT makes the real player win 13 times and the simulated player 12 times. At the end of each time trial, the loser receives an aversive punishment (e.g., loud noise), the intensity of which is supposedly set by the opponent. Prior to each trial, each participant sets the punishment level (e.g., the intensity and duration of the noise) that will be delivered to the opponent if the participant wins the trial. The punishment level is used as a measure of aggressive behavior. Participants who obtained higher scores in the CIS as well as participants who played the violent video game showed greater aggressiveness in the CRTT. Two physiological measurements (heart rate, blood pressure) were also analyzed, but did not provide significant results.

Anderson et al. (2004) obtained similar relations between violent video game exposure and aggressiveness in subsequent experiments concerning five violent video games (three FPSs, a combat driving game, a fighting game) and five non-violent video games (a pinball game, a strategy game, a puzzle game, a racing game, and a graphic adventure). They employed the tests and physiological measurements previously mentioned as well as the *Word Completion Task* (WCT) (Anderson, Carnagey, & Eubanks, 2003). This task provides a list of 98 words with letters missing in strategic positions (e.g., *explo_e*), in such a way that half of these words can be completed to form a non-aggressive word (*explore*) or an aggressive one (explode), while the other half do not lend themselves to aggressive completions. Participants were given 3 minutes to complete as much of the WCT as they could. An *accessibility of aggressive thoughts* score was calculated for each participant by dividing the number of aggressive word completions by the total number of completions. Authors observed that violent video games in general increased the accessibility of aggressive thoughts, and that trait hostility and trait aggression positively correlated with aggressive behaviors carried out during the experimental tasks.

Sestir and Bartholow (2010) analyzed the effects of violent and non-violent video games on aggressive thoughts and behaviors, but also on prosocial outcomes. They carried out three experiments in which participants had to play two FPSs as violent games or two puzzle games as non-violent games, and their aggression-related feelings were subsequently assessed using the *Interpersonal Reactivity Index* (IRI) (Davis, 1983), the CIS, the *Aggression Questionnaire* (AQ) (Buss & Perry, 1992), an aggressive affect scale developed by Anderson, Deuser, and DeNeve (1995), the

WCT, the CRTT, and the *Story Completion Task* (SCT) (Rule, Taylor, & Dobbs, 1987) which assesses participants' reactions to potential conflict situations by requiring them to complete a series of story stems. To evaluate the temporal stability of acute game exposure effects, in the first two experiments the aggression-related outcomes were assessed either immediately or after a brief delay. Reported differences indicate that violent game exposure increases aggression, while non-violent video game exposure decreases aggressive thoughts and feelings as well as aggressive behavior. In the analysis of prosocial outcomes, exposure to non-violent games with no explicit prosocial content increased prosocial thoughts, relative to both violent game exposure and, on some measures, a no-game control condition.

Anderson and Dill (2000) hypothesized that violent video games and aggressive behavior are related because users tend to learn aggression-related scripts by playing violent video games and then act them in real-life situations. Bushman and Anderson (2002) corroborated this hypothesis by using the SCT: in their experiment, the number of aggressive responses in the fictional stories was greater for participants who previously played a violent video game.

Anderson and Carnagey (2009) examined the impact of excessive violence in sports video games in three experiments. Participants' exposure to violent games and in particular to violent sports video games were assessed with a version of the *Video Game Questionnaire* (VGQ) (Anderson & Dill, 2000), in which the exposure to violent games is obtained by combining the time spent to play five of the participant's favorite games and a subjective rating of their violence content. Participants' aggressive feelings were evaluated using a subset of the AQ. After playing a randomly assigned violent or non-violent sports game, participants rated it using a video game evaluation questionnaire (Anderson & Dill, 2000) and completed the (i) *Word Pronunciation Task* (WPT) (Anderson et al., 2003), in which the reaction time to pronounce aggressive and non-aggressive words is measured; (ii) the *State Hostility Scale* (SHS) (Anderson et al., 1995); (iii) the *Attitude Towards Violence in Sports Questionnaire* (ATVS), originally created for the experiment and (iv) the CRTT. During these three phases, cardiovascular measurements were recorded (blood pressure and pulse). Results show that violent sport games increase aggressive affect, cognition and behavior, as well as attitude towards violence in sports; no differences were observed with regards to the effects of violent and non-violent sport games on the cardiovascular measures. Unlike most studies in the literature, violent and non-violent games were similarly competitive in this study: this allows to exclude a difference in game competitiveness as a possible explanation for the obtained results. However, Adachi and Willoughby (2011) point out that it does not allow one to conclude that the results are uniquely related to the aggressive elements of the considered games, because the games were not equated on other important dimensions such as difficulty and pace of action.

Instead of comparing violent and non-violent games, Barlett, Harris, and Bruey (2008) concentrated on a specific aspect of the portrayal of violence that is used in some video games. They carried out an experiment in which participants played the same violent fighting game with four different levels in the amount of blood displayed on the screen (maximum, medium, low and off), while their heart rate (HR) was recorded to assess physiological arousal. Before the gaming session, participants' trait aggression and aggressive feelings and thoughts were assessed with the AQ and the SHS, while aggressive behavior was calculated as the ratio of total weapon time (i.e., how long the participant used a weapon during the gaming session) to total gaming time. Results show that participants in the maximum and medium blood conditions had a significant increase in hostility and arousal with respect to participants in the other two conditions. Furthermore, those in the maximum and medium blood conditions used character's weapon significantly more than the other participants.

However, it must be noted that the literature is not unanimous about the impact of violent video games on aggression. In his meta-analytic review, Ferguson (2007) reasons that the research work on violent video games is subject to a publication bias, i.e., the studies showing significant effects of violent content on aggression appear to be over-represented in the literature (Boyle et al., 2011). Once corrected for publication bias, Ferguson claims that studies of video game violence could not provide support for the hypothesis that violent video game playing is associated with higher aggression (Ferguson, 2007).

2.2 Effects of Violent Video Games on Desensitization to Violence

Some studies in the literature have focused on possible negative effects that playing violent video games could have in terms of desensitization to violence, using physiological measurements. In Bartholow, Bushman and Sestir (2006), *electroencephalography* (EEG) signals were recorded from participants while they were watching a series of images taken from the International *Affective Picture System* (IAPS) (Lang, Bradley, & Cuthbert, 1999). Afterwards, participants performed a variant of the CRTT. Smaller amplitude values of *P300* signals (which measure brain responses to relevant task-related stimuli) were observed in violent video game players and participants with aggressive traits, assessed using the VGQ, the CIS and the AQ. A new study (Engelhardt et al., 2011) based on P300 measures has linked desensitization to violence with increased aggression. Participants were randomly assigned to a gaming session with violent (three FPS and a third-person action game) or non-violent games (two platform games and two sports games). After the play session, the P300 component of the event-related brain potential was recorded from participants while they were watching neutral and violent images taken from the IAPS used as stimuli for the P300 responses, to assess desensitization effects. Finally, participants completed a CRTT, to measure the level of aggressiveness. Authors report that for participants whose prior exposure to violent video games was low, playing violent video games caused a reduction in the brain's response to violent images, and an increase in aggressive behaviors. This recent finding links violence desensitization with findings on increased aggression reported in the previous section, providing evidence that desensitization to violence can account for changes in aggression.

The study described in (Carnagey et al., 2007) used instead HR and *electrodermal activity* (EDA) signals. Participants played a randomly assigned violent or non-violent video game, chosen among four violent games (a FPS, a fighting game, a violent racing game and an action game) and four non-violent games (a puzzle game, a strategy game, a platform game and a pinball game). Afterwards, they watched real-life violence episodes (courtroom outbursts, police confrontations, shootings and prison fights) recorded on video. Participants who previously played a violent video game had lower HR and EDA while viewing the violent video footages, suggesting desensitization to violence.

2.3 Physiological Measurements and Video Game UX

Facial electromyography (EMG) as well as other physiological measurements such as EDA and cardiovascular activity are increasingly used in the literature to study video game play, not only for assessing negative effects such as desensitization to violence, but to measure how players experience a game in terms of positive and negative affect, a fundamental aspect of the game UX (Mandryk, Inkpen, & Calvert, 2006).

In general, facial EMG can be employed to estimate players' positive and negative feelings. Andreassi (2007) reports about psychophysiology studies which reveal that

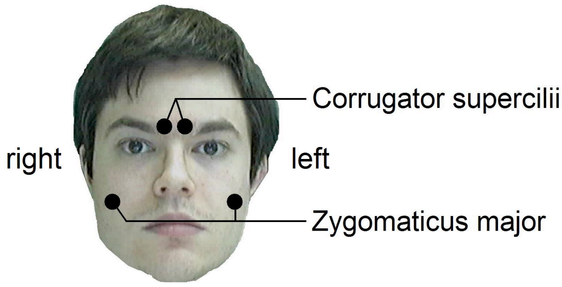


Figure 1. Location of left and right corrugator supercilii (CS) and zygomaticus major (ZM).

unpleasant or negative stimuli elicit a rather consistent activity of left and right *corrugator supercilii* (CS) muscles, which are responsible for frowning, while pleasant and positive stimuli increase activity of left and right *zygomaticus major* (ZM), which are responsible for smiling. Cacioppo, Martzke, Petty, and Tassinary (1988) also showed that CS data can be used as an index of specific negative emotions such as sadness and fear. Figure 1 illustrates a typical EMG sensor placement to measure the activity of CS and ZM muscles.

CS activity is also positively associated to the degree of exerted mental effort (Waterink & van Boxtel, 1994) and seems to increase with the perception of obstacles to a goal (Pope & Smith, 1994). Several studies have also demonstrated that CS activity is related to negative emotional responses (e.g., tension and frustration) of computer users (Hazlett, 2003; Branco, Firth, Encarnação, & Bonato, 2005; Riseberg, Klein, Fernandez, & Picard, 1998;). On the other hand, ease of mental processing is positively associated to ZM activity (Winkielman & Cacioppo, 2001). The studies reported in (Andreassi, 2007; Bradley & Lang, 2007) show that these facial muscles respond also to the mere experience of positive and negative affect (especially ZM and CS, respectively), without resource mobilization.

Correlations between facial EMG measures and positively or negatively-valenced emotion were observed in players of a non-violent car racing video game (Hazlett, 2006). ZM activity was greater during positive events (e.g., overtaking opponents' cars or winning a race) than negative events (e.g., being overtaken or hit by another car), while CS activity was greater during negative events, consistently with the findings summarized in the previous section. However, when considering violent video games such as FPSs, physiological data can highlight more complex reactions: Ravaja, Turpeinen, Saari, Puttonen, and Keltikangas-Jrvinen (2008) observed that killing human opponents in a commercial FPS elicited a fall of ZM activity as well as an increased EDA, suggesting high-arousal negative feelings rather than the pleasant feelings that can result from winning and success. On the contrary, the wounding and death of the player's own character elicited an increase of ZM activity and EDA as well as a decrease of CS activity, which could be possibly explained by a transient relief from (stressful) engagement. The study focused on the tonic level of EDA, i.e. *skin conductance level* (SCL), which is the relatively stable component of the signal, typically used to measure the level of EDA during a given period of time (Andreassi, 2007).

Nacke and Lindley (2009) tried to characterize terms used in the game UX literature – such as immersion, boredom, fun, and flow (Csíkszentmihályi, 1990) – in terms of physiological measurements of player's arousal and valence. To this purpose, they designed three levels of a FPS characterized respectively by boredom (weak enemies, repetitive and overly simplistic environment, no surprises), immersion (complex and appealing environment, strong as well as weak enemies) and flow (single game mechanic, level of increasing difficulty). Participants played the three levels while facial EMG and SCL data were recorded. Results show that challenging situations (which mainly characterized the flow level) elicited high-arousal positive affect in players. Drachen, Nacke, Yannakakis, and Pedersen (2010) found instead some correlations between physiological measures (HR and EDA) and gameplay experience components measured with the *Game Experience Questionnaire* (GEQ) (IJsselsteijn, Poels, & de Kort, 2008), which assesses 7 dimensions of the video game UX (flow, challenge, competence, tension, negative affect, positive affect, sensory and imaginative immersion). In particular, authors found (i) a positive correlation between HR and tension, HR and negative affect, EDA and negative affect; (ii) a negative correlation between HR and several GEQ dimensions (competence, immersion, flow, challenge, and positive affect).

Other studies addressed the same topic by correlating physiological data and subjective emotion assessment. In Mandryk, Inkpen, and Calvert (2006), cardiovascular and respiration data as well as EMG (measured on the jaw) and EDA were first recorded while participants were playing a commercial hockey video game against the computer or a friend. After the gaming session, a subjective questionnaire was proposed to rate how boring, challenging, easy, engaging, exciting, frustrating and fun each of the two conditions was.

Authors observed that playing the game with a friend elicited greater EDA values and that physiological results were correlated with questionnaire scores: EDA was positively related to fun and negatively related to frustration; jaw EMG activity was positively related to boredom as well challenge, but was negatively correlated with ease.

a b

Figure 2. Screenshots of the violent Whac-a-Mole game: (a) the wood ants are walking on the chair; (b) two ants are squashed. Note the wood shavings on the floor.

3. The Considered Video Games

Our experiment employs one of the recent Whac-a-Mole video games for the iPhone, in which the aggressed animals are insects (wood ants) that the player has to squash using her fingers. To choose the game, we initially analyzed games rated for frequent/intense violence in the Apple App Store. The company that produces one of them consented to give us access to the game programming code for the purpose of this study.

The considered game shows a realistic 3D model of a chair at the center of the screen (see Figure 2). Players can rotate the chair by performing swiping gestures on the screen or by touching two rotation buttons at the bottom of the screen. By swiping the screen from right to left (resp. left to right) or by touching the left (resp. right) rotation button, the chair rotates clockwise (resp. counterclockwise) by 90°. A vertical bar on the left side of the screen indicates the status of the chair: at the beginning of a level, the bar is full and green, indicating that the chair is in perfect conditions. Wood ants appear randomly on the chair, walk on it for a few instants and then bite it, producing a munching sound and leaving wood shavings on the floor (Figure 2a). The more the chair is damaged, the more the left bar drains and turns gradually to red (Figure 2a), pulsating more and more frequently.

Figure 3. *Game Over* screen with the broken chair.

When the left bar is empty, the chair breaks down and the game is over (Figure 3).

To successfully complete a level, players have to squash ants by touching them with fingers on the screen. The blue bar placed on the right side of the screen grows when insects are killed. To successfully complete a game level, the player has to entirely fill the blue bar before the ants damage too much the chair leading to its break down. Every time an ant is killed, the game plays a crushing sound, and the image of the insect changes to realistically represent a squashed ant, which disappears after a few seconds (Figure 2b). At the top of the screen, two blue ovals show respectively the number of ants killed during the gaming session (i.e., the total score) and the current game level. The higher the game level, the more frequently ants appear on the chair.

To create a non-violent version of the studied game, we changed the game programming code to remove the violent element. The change we made was to replace ants with abstract geometric shapes of the same size, eliminating the need to do harm to virtual living beings in order to progress in the game. More specifically: (i) live ants were replaced by purple rectangles (Figure 4a), (ii) the biting ant animation was replaced by a quick pulsating rectangle animation, and (iii) squashed ants were replaced by fading animations of a gray rectangle (Figure 4b). Any other detail of the game, including sound, remains identical.

a b

Figure 4. Screenshots of the non-violent Whac-a-Mole game. (a) two purple rectangles appear; (b) the users has touched the two rectangles and a new rectangle is appearing.

4. Method

Our study follows a between-subjects design with game (violent and non-violent) as the independent variable, and concentrates on measuring possible differences in affect during gameplay as well as desensitization to violence after gameplay. In this section, we describe in detail the experiment.

4.1 Participants

The evaluation involved a sample of 42 participants (32 M, 10 F) recruited among graduate and undergraduate students with various educational backgrounds (computer science, literature and philosophy, physiotherapy, natural sciences). Age ranged from 20 to 39, (M = 25.1, SD = 3.77).

We employed the VGQ (Anderson & Dill, 2000) to assess individual differences in the time participants spend on violent video games: the version of the questionnaire we used asks participants to indicate no more than five of their most preferred video games, played during the last two years, and rating them in the 1-5 range with respect to how often they played each game and its perceived degree of violence. A VGQ score, in the 0-25 range, is calculated as the average of the product, for each game, of the time spent playing it and its degree of violence, subjectively assessed by the participant. To assess individual differences in physical aggressiveness and anger traits of participants, we employed the corresponding sets of items (16 items in total) from the AQ (Buss & Perry, 1992) on a five-level Likert scale. The AQ scores can range from 16 to 80. Finally, we assessed participants' attitudes towards insects, using two items ("I find insects disgusting" and "It can happen that I intentionally squash an insect") on a five-level Likert scale (1 = Not at all typical of me, 5 = Very typical of me).

The means for the above mentioned individual differences were very similar in the two groups. More specifically, mean AQ score was 33.19 (SD = 7.02) in the non-violent and 33.10 (SD = 6.65) in the violent game condition, while mean VGQ score was 5.82 (SD = 4.74) in the non-violent and 5.41 (SD = 4.25) in the violent game condition. Means for the first item concerning attitudes towards insects in the two groups were respectively 2.71 (SD = 1.45) and 2.57 (SD = 1.29), while for the second item they were 2.95 (SD = 1.47) and 2.71 (SD = 1.55). For each of the four pair of means, a *t*-test indicated that the reported small differences between the two groups of participants were not statistically significant.

4.2 Materials

The games were run on an Apple iPhone 3GS equipped with a 3.5'', 320 x 480 pixels screen. During the gaming session, the device was lying on a table, and participants were seated on a chair.

To record participants' physiological data, we employed six sensors: four EMG sensors for facial EMG, coupled with disposable electrodes; an IR photoplethysmograph (PPG) for measuring blood volume pulse (BVP), recorded on the distal phalanx of the middle finger; two electrodes for EDA, placed on the intermediate phalanges of the index and the ring fingers (Figure 5). The signals were recorded with a Thought Technology Procomp Infiniti encoder and stored on a PC.

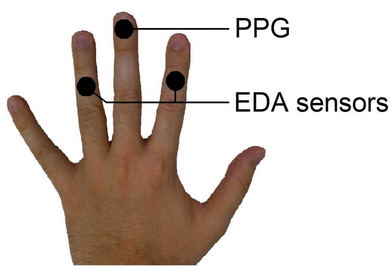


Figure 5. Position of PPG and EDA sensors during the experiment.

A second computer was used to show participants two video footages taken from movies, respectively showing: (i) a man intentionally squashing ants with increasing anger, (ii) a man savagely beating another man, even after the latter falls down bleeding.

As in the other studies summarized in Section 2, we used facial EMG data to determine the elicited emotional valence, and SCL, HR and BVPA measurements to assess the arousal level. For subjective emotion assessment, we employed *Affect Grids* (AGs, Figure 6) (Russell, Weiss, & Mendelsohn, 1989), which are also based on emotional valence and arousal. In AGs, participants choose one of the 81 grid cells to indicate how they feel. For example, if a participant is experiencing pleasant feelings, (s)he can mark a cell on the right half of the grid; if a participant is depressed, (s)he can mark a cell near the bottom-left corner. From the position of the marked cell, two values in the 1-9 range are obtained: perceived level of arousal (*arousal-sleepiness* score, or *A score*) and pleasantness (*pleasure-displeasure* score, or *P score*).

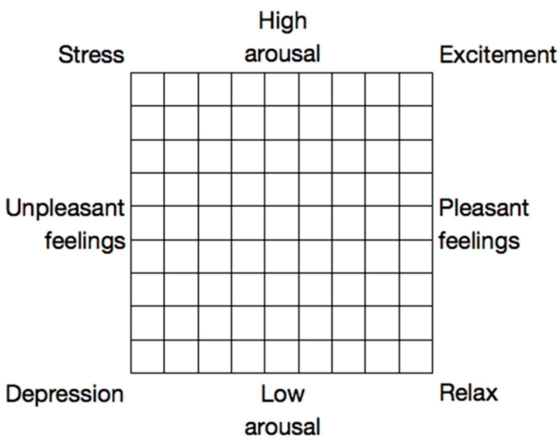


Figure 6. The AG template used in our study.

4.3 Procedure

Participants were informed that the goal of the study was to evaluate the UX of a video game, and consented to have physiological signals recorded during the experiment. They were also clearly informed that all the experimental data was going to be collected and analyzed anonymously for research purposes, and asked if they consented to participate in the experiment. Then, they filled the previously described questionnaires. On the basis of the results of the questionnaires, participants were assigned to one of the two conditions to balance gender, time spent playing violent video games, physical aggressiveness and anger trait, and attitude towards insects. Participants were seated and the skin of their forehead and cheeks was cleaned using a pad of cotton wool and alcohol, then the EMG sensors were applied following the electrodes placement recommended by Fridlund and Cacioppo (1986), depicted in Figure 1. PPG and EDA electrodes were applied to the fingers (middle finger, index finger and ring finger respectively) of the non-dominant hand. Once the sensors were in place, participants were asked to relax for about three minutes to record the baseline for the physiological signals, i.e. the signals' values that can be observed when participants are in a resting state. When analyzing data, baseline values have to be subtracted from the data recorded during the experimental conditions, to separate the physiological responses to experimental stimuli from the intrinsic physiological differences among participants. During baseline recording, we asked participants to keep the non-dominant hand on the table or on the lap as steady as possible to reduce possible recording artifacts caused by arm movement. During baseline recording, a video with relaxing images and music was shown in a dim light. Participants could close their eyes and only listen to the music if they preferred.

After baseline recording, participants filled a pre-play AG indicating the emotion felt at that moment, and then played the assigned game for 10 minutes with their dominant hand, while they sat comfortably.

We presented the games to participants as follows:

- *Violent game*: "In this game, ants move on a chair. When they bite, they chop away wood from the chair. You have to squash them with your fingers to prevent the chair from breaking down".
- *Non-violent game*: "In this game, purple rectangles move on a chair. When they flash, a piece of the chair falls off. You have to touch them with your fingers to make them disappear and prevent the chair from breaking down".

At the end of the gaming session, participants filled a post-play AG, indicating again the emotions felt at that moment. Then, they watched the two violent videos described in the Section 4.2. Before each video, participants were asked to relax for a minute, so that physiological parameters could revert to a rest state. After seeing the two videos, participants were allowed to remove all the sensors and were asked to fill two AGs, indicating the emotions felt while watching each of the two videos.

Finally, participants were debriefed and thanked for their participation.

4.4 Measures

For each participant, we calculated the following physiological measures in the gameplay phase and in each of the two video watching sessions:

- *Mean activity of left ZM*, *right ZM*, *left CS* and *right CS*: mean values of the root mean square (RMS) transformation of the four facial EMG signals, averaged over one second epochs. A notch filter (band-stop filter), centered on the 50 Hz frequency, was applied to remove typical AC interference caused by electronic devices. As discussed in the Related Work section, the activity of left and right *zygomaticus major* (ZM) and *corrugator supercilii* (CS) is related respectively to positive and negative valence of emotions;
- *Mean HR* and *mean BVPA*: to assess elicited arousal, BVP values allow one to derive HR, and *blood volume pulse amplitude* (BVPA, which is related to the change in blood volume caused by the cardiac circle). To obtain the two mean values, signal was averaged over five second epochs to reduce artifacts caused, for example, by hand movements. Epochs are here longer than those used for muscle activity, because HR and BVPA are subject to slower variations. Various studies in the literature positively correlated HR to emotional activity and arousal (e.g., Mandryk & Atkins, 2007), while an increase in the BVPA indicates decreased sympathetic arousal, e.g. when a person relaxes (Picard, 1995);
- *Mean SCL*: the mean value of SCL measured during the task.

The subjective participants' reports acquired with the four AGs were used to obtain the following measures for each participant:

- *P score delta and A score delta*: the difference in P score, and the difference in A score, between the post-play and pre-play AGs. This was calculated to assess if the participant perceived a change in affect after playing the assigned game.
- *Video watching AG scores*: the P score and A score reported by the participant, for each of the two videos.

4.5 Possible Outcomes

The findings on violent video games reported in the literature and summarized in Section 2 would suggest that desensitization should be observed in players of the violent Whac-a-Mole game, who should show a reduction in physiological responses (as well as subjectively reported arousal) during violent video watching with respect to players of the non-violent version of the game. Moreover, since studies in the literature have shown that carrying out aggressive actions in video games elicits anxiety in players (Anderson & Ford, 1986) and, more generally, negatively-valenced high-arousal affect (Ravaja et al., 2008), the violent element of the studied Whac-a-Mole game could have similar negative effects on UX, resulting in increased CS activity (i.e., an increase in intensity of negatively-valenced emotions) as well as decreased ZM activity (i.e., a decrease in intensity of positively-valenced emotions) and increased EDA (i.e., an increase in arousal) during gameplay with respect to the non-violent version of the game.

However, we should take into account that, unlike the studies on violent video games in the literature in which aggression concerns human or anthropomorphic animals, our study concerns a non-human and non-anthropomorphic animal species, which is a considerable difference that can change affective reactions of players. Indeed, aggressive behaviors towards animal species such as insects are much more socially tolerated than aggression towards humans (Martens, Kosloff, Greenberg, Landau, & Schmader, 2007). It is also more difficult to empathize with such species. Therefore, the outcomes of the study might not replicate those of the current violent video game literature.

For the reasons above, our study is exploratory in nature and is aimed at starting an investigation of possible analogies and differences between the effects of Whac-a-Mole video games and those reported for other violent game genres in the literature, as well as the possibility of effectively replacing the violent element in Whac-a-Mole games with a non-violent one.

5. Results

For conciseness, in the following we will refer to the violent game condition as *VG* and to the non-violent game condition as *NVG*.

Before proceeding with statistical analysis, baseline values were subtracted from the physiological means to remove individual differences. Interquartile Range (IQR, i.e., the difference between first and third quartiles) was employed to find outliers among the resulting data as recommended in (Tukey, 1977). For each set of data, extreme outliers, i.e., the values in the data set which were smaller than $Q1 - 3 \cdot IQR$ or greater than $Q3 + 3 \cdot IQR$ (where $Q1$ is the first quartile and $Q3$ the third quartile), were removed. Considering the gaming session data, there was one extreme outlier in both conditions for right CS data, two in the right ZM data set for the VG condition, and three in the right ZM data set for the NVG condition.

Considering the watching of the first video, there was one extreme outlier in the right CS data set for the NVG condition, and two in the right ZM data set for the NVG condition. Considering the watching of the second video, there were two extreme outliers in the right CS data set for the VG condition, and two for both conditions in the right ZM data set.

The right ZM data for one participant in the experiment had to be discarded due to a poor application of the sensor to the skin.

For each physiological variable, we used the Shapiro and Wilk (1965) normality test to check if data followed a Gaussian distribution. When data was normally distributed, or a mathematical transformation (logarithm or square root) could be applied to make the distribution more symmetric (Cohen, 2000), *t*-tests were performed. For those physiological data which could not be normalized, and for AG scores, we performed non-parametric analysis (Mann and Whitney's *U* test). To estimate the effect size for significant differences reported by t-tests, we employed Cohen's *d* (Cohen, 1988). Finally, we carried out a correlation analysis between AQ and VGQ scores, as it has been proposed in the literature (Anderson & Dill, 2000).

In the following sections, we describe the results in detail.

5.1 Facial EMG

Mean activities of left CS and right CS recorded during the gaming session were normally distributed. To obtain a normal distribution for left ZM and right ZM data, we applied a square root and a logarithmic transformation respectively. Figure 7 shows the untransformed mean values of facial EMG data recorded during the gaming session.

The difference between the mean activity of left ZM during the gaming session for the VG condition ($M = 1.78$, $SD = 2.95$) and the NVG condition ($M = 0.14$, $SD = 1.61$) was statistically significant ($t(40) = 2.23$, $p < 0.05$), and the effect size was medium to high ($d = 0.69$). The difference between the mean activity of right ZM during the gaming session for the VG condition ($M = 2.00$, $SD = 2.87$) and the NVG condition ($M = 0.36$, $SD = 1.39$) was statistically significant ($t(35) = 2.246$, $p < 0.05$), and the effect size was medium to high ($d = 0.73$).

For the mean activity of left CS and right CS, the differences between VG and NVG were smaller (left CS) or negligible (right CS) and could not reach statistical significance.

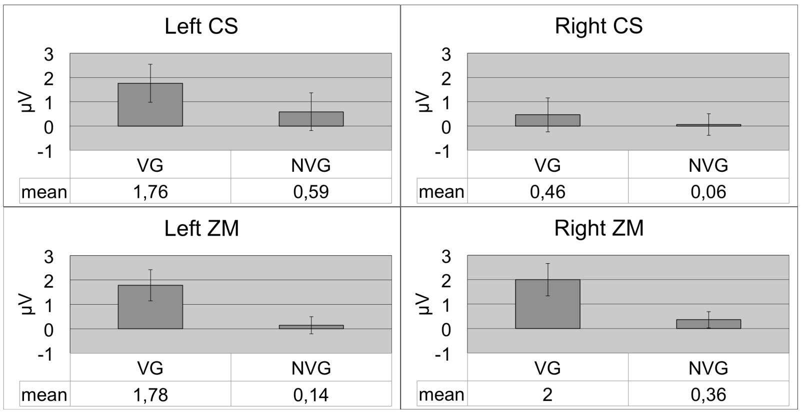


Figure 7. Mean CS and mean ZM activity recorded during the gaming session, after baseline subtraction. Error bars indicate standard error of the mean.

For the mean activity of left CS and right CS, the differences between VG and NVG were smaller (left CS) or negligible (right CS) and could not reach statistical significance.

Facial EMG data recorded while participants watched the violent videos showed only very small and not statistically significant differences between the VG and the NVG

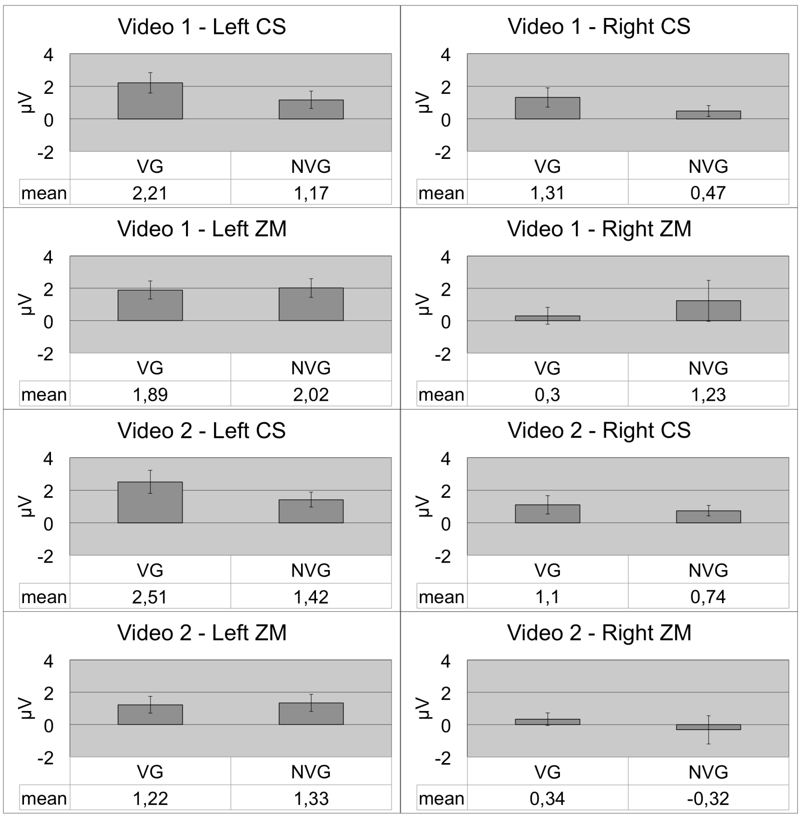
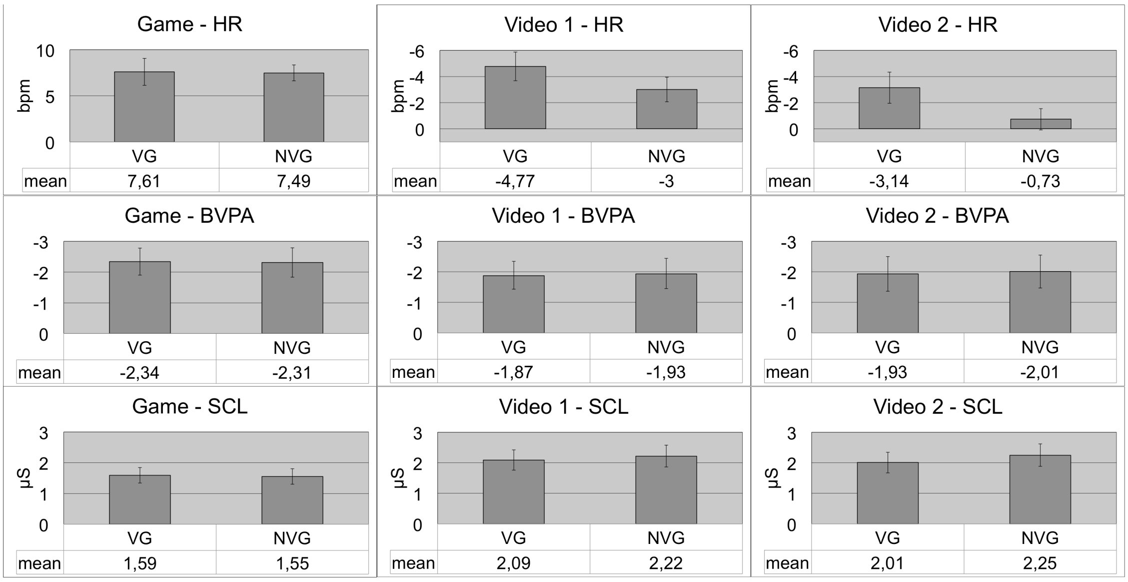


Figure 8. Mean CS and mean ZM activity recorded while watching the two videos, after baseline subtraction. Error bars indicate standard error of the mean.

groups (Figure 8). According to Andreassi (2007), the generally lower muscle activity in right CS and right ZM indicates that the motor cortex in the left brain hemisphere (which controls those muscles) exerted less control in the emotional experience, consistently with the fact that the right brain hemisphere (which controls left CS and left ZM) is more involved in spontaneous emotional reactions.

5.2 HR, BVPA, and SCL

Mean HR, mean BVPA and mean SCL recorded during the gaming session with VG and NVG as well as while participants were watching the two violent videos (Figure 9)



were almost identical and produced no statistically significant differences.

Figure 9. Mean HR, BVPA, and SCL values after baseline subtraction, recorded during the gaming session as well as while users were watching the two violent videos. Error bars indicate standard error of the mean.

5.3 AG Scores

The analysis of P score delta and A score delta, as well as video watching AG scores, found almost identical or only slightly different values between the VG and NVG groups, and none of the differences reached statistical significance.

5.4 Correlation Analysis

Spearman's test detected a positive correlation between VGQ and AQ scores ($\rho(42) = 0.403$, $p < 0.01$), also illustrated in Figure 10.

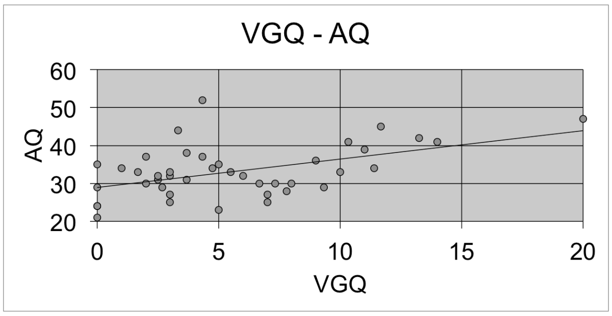


Figure 10. Scatterplot of VGQ and AQ scores. The regression line is also outlined.

6. Discussion

6.1 Players' Affect During Game Play

During the gaming session, activity of left ZM as well as right ZM was significantly higher in VG than NVG, while no statistically significant differences were detected in left and right CS activity. This indicates that the affect elicited by the violent Whac-a-Mole game in which participants killed ants was more positively valenced than the non-violent one which replaced ants with abstract geometric shapes. This result seems to suggest that the violent element in the Whac-a-Mole game is important for the game UX, and cannot be replaced by a non-violent element in a straightforward way.

A social aspect that could be considered to explain this result is that, as previously mentioned, violent behaviors against insects (and also moles, the animals used in the classic Whac-A-Mole game) tend to be socially tolerated (or in some cases even encouraged), making them less emotionally loaded (or even pleasant). Whac-a-Mole games could thus be successful because they allow players to engage in violent acts against species that do not elicit the same physiological responses (and the corresponding affect) that have been instead highlighted in killing or wounding virtual human beings (e.g., Ravaja et al., 2008): hitting and killing species such as insects and moles is unlikely to (consciously or unconsciously) evoke taboo or moral stigma. From this point of view, it would be interesting to repeat the experiment with animal species to which people feel emotionally closer such as dogs, cats, and domestic birds.

Both games elicited instead a similar cardiovascular and EDA activity, with no statistically significant differences between the two groups. Killing ants, therefore, seems to have little effect on the arousal level elicited by the games, a different outcome compared to traditional research on the desensitizing effects of violent video games (e.g., Carnagey et al., 2007). Two factors might play a role in explaining this result: (i) the above mentioned general attitudes towards some animal species might have mitigated the arousal effects of killing insects; (ii) while the literature on violent video games has so far focused on desktop PC and console games, our participants played a game on a mobile phone, which might not be able to provide rich sensory stimulation at the intensity of a desktop system, making it possibly more difficult to emotionally arouse players. However, previous research (Arriaga et al., 2006; Arriaga, Esteves, Carneiro, & Monteiro, 2008) explored if the effects of playing violent video games (in terms of arousal and aggressive thoughts and behavior) could be mediated by the type of employed devices, considering a typical computer screen vs. a virtual reality head-mounted display (supposed to provide a stronger sense of immersion in the experience), and finding no significant differences. Since people increasingly play video games on mobile devices, it would be interesting to contrast typical desktop gaming hardware also with mobile devices to further explore if the employed devices might play a role in determining the effects of violent video games on players, as well the possible impact of the platform on the UX.

6.2 Desensitization to Violence

The physiological data collected while participants watched violent video footages showed no significant differences between players of the violent and the non-violent Whac-a-Mole game. These results seems to suggest that repeated aggressive behavior against ants in VG did not result in different desensitizing effects to violence against insects or human beings with respect to NVG.

These results differ from those in the literature, presented in Section 2, which highlighted desensitizing effects of playing violent video games. This difference could also be explained by the factors discussed in Section 6.1, i.e., social tolerance towards violence against animals such as insects and moles or lower level of immersion provided by mobile devices with respect to desktop PCs.

6.3 Correlation Analysis

The positive correlation between previous exposure to violent video games (VGQ score) and aggressive traits (AQ score) is consistent with the literature on violent video games (Anderson & Dill, 2000).

6.4 Limitations of the Study

Some limitations of our study should be considered when analyzing the obtained results. First of all, the statistical power of the study is reduced by the number of participants (42), which is small for a between-subjects study focused on aggressive behaviors and desensitization to violence (where hundreds of participants are not uncommon, e.g., Carnagey et al., 2007). The size of the data set might have hidden possible desensitization effects of the violent video game. Furthermore, while males and females were equally distributed between the two conditions, the larger number of males (32) with respect to females (10) makes the comparison of our study with the literature more difficult: in classical violent video game studies, such as those by Anderson and Bushman (e.g., Carnagey et al., 2007), gender is typically well balanced.

Finally, the violent condition of our study concerned only violence on insects. Adding a third condition to the experiment in which the game would require to aggress virtual humans might help in comparing the effects of performing aggressive actions against human and non-human animals, allowing us to better contrast our findings with the existing literature.

7. Conclusions and Future Work

The experiment presented in this paper suggests that previous literature findings about effects (in terms of affect during play and subsequent desensitization to violence) of performing aggressive actions against virtual humans and anthropomorphic beings in video games may not necessarily generalize to aggressive actions towards non-human animal species. The act of killing (virtual) insects in the violent version of the Whac-a-Mole game seemed to be no more desensitizing than the non-violent one. Moreover, it appeared to be more entertaining, considering the higher left ZM and right ZM activity during game play, which also indicates that replacing the violent element of Whac-a-Mole games could not be a straightforward game design task. It is worth remembering that, by using two versions of the same game that differed only in the action performed by the player (violent and non-violent), we could achieve a level of control on possibly confounding variables which can only be found in very few other papers in the literature (Bluemke, Friedrich, & Zumbach, 2010; Hartmann, Toz, & Brandon, 2010).

Widespread social tolerance of aggressive acts against some animal species and difficulty to empathize with those species could be possible factors that explain the obtained results. It must be noted that, exactly like insects, moles (the animals used in the classic Whac-A-Mole arcade game) are also a socially tolerated target of unnecessary human violence (a simple Web search produces thousands of sites devoted to teach mole killing techniques or promote specific products and services to the purpose), despite appeals for a change in attitude toward moles by animal rights associations (Baird, 2009). A reason for the success of Whac-A-Mole games might thus be that they allow players to engage in violent acts against species that do not elicit the negative physiological responses (and affect) that the literature has instead highlighted for acts of killing or wounding virtual human beings.

Notwithstanding the limitations of the exploratory study discussed in this paper (see Section 6.4), the presented results suggest that further research in this field may lead to interesting findings. An increased number of participants in future studies may allow us to obtain more solid information about the desensitization effects of the considered violent video game genre, and to better compare our results with the existing literature. Furthermore, a more balanced gender distribution will allow us to explore differences in the effects of violent video game play in males and females, with regards to both UX and desensitization to violence.

As discussed in Section 6.1, it would also be important to create and study additional versions of the Whac-a-Mole game which would require to harm or kill animals to which people feel emotionally closer, such as dogs, cats or other domestic pets. Also, as highlighted in Section 6.4, the introduction of a condition in which the player is required to kill virtual humans could allow to better compare our results with the existing literature on aggressive behavior and desensitization to violence towards human beings.

The insect-killing version of the game used in our experiment would lend itself also to study possible transfer of players' violent behavior from games to the real world. Studies of insect killing in the real world have shown that killing an insect fuels subsequent killings (Martens et al., 2007; Martens & Kosloff, 2012). The insect-killing paradigm followed in those studies could be adapted, moving the initial killing actions from the real world to the game world, while keeping the subsequent killing actions in the real world. An advantage of following the paradigm by Martens et al. is that it allows one to conduct an experiment on killing in the real world without actually killing any animal, because it manages to lead participants to believe (falsely) that they are killing insects.

Finally, we plan to evaluate the effects on player's physiology of different devices which should provide a greater sensory stimulation, e.g., by comparing large LCD monitors and surround sound vs. a mobile device to explore the possible role of the employed devices on the effects of violent video games.

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