Effect of music tempo in First-Person Shooter on arousal and aggression

Adnan M. Niazi[*]

Department of Electrical Engineering, Mathematics & Computer Science, University of Twente, 7500 AE, Enschede, The Netherlands

ARTICLE INFO

Article History:
Submitted on 21 April 2011

Keywords:
Tempo
Arousal
Aggression
Implicit Attitudes
Game Music

ABSTRACT

The present study used a between subjects, post-test only design to investigate the impact of background music (low tempo music vs. high tempo music) on arousal and aggression of a player playing a first person shooter video game: Counter-Strike. Arousal was measured using Skin Conductance Level (SCL) and aggression using an Implicit Attitude Test (IAT). Results indicate no significant differences in the arousal and aggression between the two conditions implying that music tempo plays no role in manipulating the arousal and aggression of a player in gaming context. The study did, however, find a significant correlation between arousal and aggression in high tempo condition, suggesting a general trend that more aroused subjects showed more aggressive cognitions. No significant correlation was found in low tempo condition.

1. Introduction

With the development of technology and popularization of electronic products, video games have become an important part of life of adolescents and adults alike. Worldwide, the video games sales is expected to top $48.9 billion in 2011 and $68 billion in 2012, making it one of fastest-growing component of the media sector worldwide.

With video games, infiltrating our lives more than even before, it's no wonder their moral, social, and psychological implications are constantly under the microscope with majority of studies focusing mainly on the relation between video games and aggression. Experimental evidence now suggests that exposure to violent video games is in fact related to an increase in aggression (see Anderson & Bushman (2001), Sherry (2007), and Anderson (2004) for meta-analyses). More specifically, violent video games can manipulate aggressive cognitions (Anderson & Dill (2000); Anderson, Carnagey, Flanagan, Benjamin & Jr. (2004); Kirsh (1998); Tamborini, Eastin, Skalski, Lachlan, Fediuk & Brady (2004)), and aggressive affect, leading to feelings of hostility (Anderson & Dill (2000); Farrar & Krcmar (2006); Tamborini et al. (2004)), and resulting in aggressive delinquency. Experimental work also found exposure to violent games to be linked to the physiological arousal (Barlett, Harris & Baldassaro, 2007).

A recent longitudinal work using late elementary and junior high school aged students in the United States and Japan showed that habitual violent video game play in early school years was predictive of physical aggression in the later years (Anderson, Sakamoto, Gentile, Ihori, Shibuya & Naito, 2008). Anderson et al. (2008) argues that violent video game exposure, leading to an increase in physical aggression across two very different cultures, is a strong testament to the power of violent video games in increasing and steering aggression, particularly in young children. In summary, experimental (e.g., Farrar & Krcmar, 2006), cross-sectional (Anderson et al., 2004), and longitudinal studies (Anderson et al., 2008) have now demonstrated that violent video games are related to increases in aggression for men (Farrar & Krcmar, 2006), women (Anderson & Murphy, 2003) and children (Anderson et al., 2008) alike.

However, meta-analyses (Sherry, 2007) have raised questions about how game features and participant characteristics may play a role in moderating or mediating aggressive outcomes. Sherry (2007), suggests that variations in game stimulus, age of the player, and amount of time the game is played, among other variables, cause different outcomes. For example, Carnagey & Anderson (2005) found that violent video games that reward violent behaviors lead to increases in hostile emotions, aggressive thinking, and aggressive behavior. Barlett et al. (2007) reports that playing a violent video game using a light gun as opposed to a traditional controller leads to more aggression. Eastin (2006) reports that a

[*]Student Number: s1029789
Email address: a.m.niazi@student.utwente.nl (Adnan M. Niazi)

gender match between self and game character can increase aggressive thoughts in female game players. Farrar & Krcmar (2006) have found that video game play with the blood feature activated can increase aggression. Thus, features of violent games can serve to heighten or dampen effects on subjects.

1.1. Video Games and Music

> *"Sometimes certain games have no or really bad music like Counterstrike, so I put on some other music"*
>
> Subject-110 (Huiberts, 2010)

One game feature that has garnered much popular interest by the video game players, but not much psychological research, is the game music. The continuing growth of the video game industry has sparked an increased interest in the music written for game soundtrack. Today's composers often work with large orchestra's producing scores that often rival film music in scale, complexity, and artistic ambition (Bennun, 2010). With game revenues outstripping those of the film industry, developers are keen more than ever before to rival the cinematic experience of Hollywood movies. The result is that, game music is becoming more and more adaptive and interactive. Instead of looping the sound over and over again, modern game music is constantly adapting itself to the game play of the player. This dynamic and adaptive music provides an immensely immersive experience, the likes of which have never been seen before. Research attributes this immersion to the *"tight linkage between visual, kinaesthetic, and auditory modalities*(Laurel, 1993), the use of realistic audio samples (Jørgensen, 2006) and spatial sounds (Murphy & Pitt, 2001). Although this study, due to lack of technical expertise, does not implement an adaptive dynamic game music scheme, it does however, implement a linear non-dynamic game music scheme. The aim of this study is to find the effect of music tempo on the physiological arousal and the aggression of a player while playing a first person shooter like Counter-Strike.

Tempo, the speed or pace of music, is perhaps the most basic component of music's temporal dimension (Duerr, 1981; Kellaris & Kent, 1993) and has long been held to be an important determinant of listeners' reactions (Hevner, 1937; Rigg, 1940). As Gundlach (1932) observed, *"It appears quite certain that many pieces of music can elicit in many auditors a fairly uniform characterization solely through factors resident within the musical structure*" (p. 642). For example, fast music tends to be perceived as more exciting and slow music as more relaxing; music pitched in major keys tends to be perceived as happier than music pitched in minor (or atonal) modalities. Theory and recent findings in musical aesthetics allow us to go beyond Bruner (1990) general proposition that "*the components of music are capable of having main as well as interactive effects on [feeling states] ...*" (p. 99). For example, one can anticipate a positive contribution of tempo to arousal. Just as the human body adapts physiologically to variations in light and temperature, variations in the auditory stimuli may also elicit analogous adaptive responses. For example, heart rate, blood pressure, breathing rate and amplitude, and other physiological manifestations of affectless arousal involuntarily increase upon exposure to fast and stimulating music (Lundin, 1985).

In addition, from an information-theoretic perspective, faster tempi produce higher rates of information and levels of informational density (Crozier, 1981), which should increase the "interestingness" of the music and thereby contribute to listeners' pleasure (Berlyne, 1974). Tempo may also contribute indirectly to pleasure via arousal in that faster music may seem more exciting. Of course, as tempo increases to a very high speed, one can expect an eventual decrement in pleasure (Holbrook & Anand, 1990). The present study, however, does not explore an extreme range of tempi (*Presto* music) that would produce such non-monotonic effects. If the results of the experiment provide a positive answer, that music tempo does indeed play a role in moderating aggression, it is envisaged that future experiments, using a similar methodology, will be designed to investigate more specific questions about the relationship between the music and aggression in all video games genres in general.

1.2. The General Aggression Model (GAM)

The 'General Aggression Model' as proposed by Anderson & Dill (2000), tries to assimilate various factors which account for aggressive behavior, in a unified model by merging together aspects of various theories that try to explain human aggression from different perspectives. It acknowledges that exposure to violent video games can increase aggression both in short term and long term. It also takes into account that personal and situational factors can influence the aggressive internal state of a human via an arousal, affective and cognitive route(Raessens & Goldstein, 2005). Playing violent video games can increase aggression by priming aggressive thoughts, increasing hostile feelings, or arousal. These three factors – cognition, affect, and arousal – are highly interrelated and activating one tends to activate the other two.

The enactment of aggression in video games is largely based on cognitive factors like knowledge structures (e.g. learning of aggressive scripts or schemas). Feelings and arousal level, which are not per se specific effects of violent video games, operate only as moderator variables. Cognition works on two information processing systems, which influence behavior in a qualitatively different way. In the implicit system, information is processed by unconscious, automatic, and intuitive processes. Using this system unconsciously leads to activation in an associative network. The resulting behavior is uncontrolled and impulsive. In the explicit system, information is processed by conscious, controlled, and reflective processes which leads to thoughtful and controllable behavior (Strack & Deutsch, 2004).Whichever system is finally used depends on whether higher-order cognitive processes are engaged or not (Berkowitz, 1993), the extent of which depends on the particular situation.

1.3. The role of music as moderator variable

Based on the GAM, Anderson & Bushman, 2001 conducted an experiment to examine the effect of violent versus non-violent games on aggressive cognitions. The arousing elements in the games were held constant, so that it can be concluded that aggressive knowledge structures were primed solely by the violent content of a game. The study unveiled that violent content in video games led to a rise in aggressive cognitions. However, the experiment leaves the question open as to what role 'arousal' plays in creating these aggressive cognitions. The current study tries to find an answer to this question by using tempo to manipulate arousal and finding its effect on aggression. Previous studies have shown that tempo is one of the features which correlates most strongly with physiological arousal (Gomez & Danuser, 2007). Carpentier & Potter (2007) reported in their experiment that fast-paced music elicits greater skin conductance level than slow-paced music. We hypothesize that high arousal, induced by the high tempo music, will intensify the effect of the violent game on aggressive cognitions. The mechanism behind this expected moderator effect of music can be explained by the 'Excitation transfer theory' by Zillerman in which the arousal caused by one stimulus (the music) amplifies the arousal response of another stimulus (aggressive action). The valence of the second stimuli will then be amplified regardless of whether the valence of the two stimuli is congruent or not. In order for this to work, two conditions have to be met. Firstly, the second stimulus should occur before the arousal from the first stimulus completely has decayed (Tannenbaum & Zillmann, 1975). Secondly, a misattribution of excitation should take place so that the experienced arousal can be fully attributed as belonging to the second stimulus (Cantor, Bryant & Zillmann, 1974). Both criteria are met in our study. The music starts parallel with the game, so an overlap of the stimuli is guaranteed. Because of the 'immersive' nature of first-person shooters, the respondents won't pay much attention to the background music and attribute it's arousal to the action in the game. Grimshaw, Lindley & Nacke (2008) describes this as *'the feeling of being encapsulated inside the game world and not feeling in front of a monitor anymore'*. According to their experiment, 'immersion' was highest in the condition where both, non-diegetic background music and diegetic game sounds were present. Their condition resembles our two conditions. So we expect a high degree of 'immersion' in our experiment.

Based on prior research, the present study assumes that a brief exposure to violent video games (situational input) temporally creates a more violent self-concept through the cognitive route. We are interested whether arousal, caused by background music, can strengthen this short-term effect through excitation transfer.

H1: The arousal will be significantly higher in the group that played the first-person shooter with fast-paced music compared to the group that played the same game but with slow paced music.

H2: The group that listens to fast-paced music while playing will show higher aggression on implicit aggressive measures compared to the group that played the same game but with slow paced music.

H3: Arousal and aggression will be correlated. Highly aroused participants will show more aggressive cognitions.

2. Method

2.1. Design

A Posttest-Only between group design was adopted for the experiment. One group played Counter-Strike with low tempo (*Adagio*) music and sound while in the other group, subjects played Counter-Strike with high tempo (*Allegro*) music and sound. This study adopts the definition of music and sound as provided by Grimshaw et al., 2008. Sound refers to all diegetic sounds originating from the game environment such as gunshot sounds, footstep sounds, ambient sounds etc. By music, we refer to the non-diegetic sound (musical soundtrack) that does not originate from the game characters but is present to provide a more immersive experience to the player.

2.2. Participants

There were 37 (22 male) participants who took part in the experiment. Around 76% of the respondents were Dutch while the remaining 24% were all German. The average age of the sample was 22.65($SD = 5.58$) years. Psychology and Communication Studies students made up for 41% and 24% of the sample respectively, and for their participation they all received 1 course credit. The remaining 35% of the participants were either University of Twente employees or friends and family from outside the UT.

60% of the respondents played video games in one form or the other. The reported weekly game usage was 4.6 ($SD = 7.22$) hours. The two most preferred game genres were *First-person Shooters* (40.5%) and *Racing Games* (32.4%). 60% of those who played games, reported to playing their games on a PC and 22% reported playing video games on an xBox 360.

All respondents listened to 2.95 ($SD = 2.29$) hours of music daily. The most popular music genres among the respondents were Rock (57%), Dance & Electronic (38%), and Pop Charts (32%)

2.3. Materials

2.3.1. Video game and Music

A portable version of *Counter-Strike 1.6* by *Valve Corporation* was used for the experiment. Because of the blood and intense violence contained in it, Counter-Strike has earned an ESRB (Entertainment Software Rating Board) rating of +M (suited only for 17+ aged audience). It was chosen for this study because surveys from 2002–2005 revealed that it was consistently the topmost game played online.

Standard distributions of the game only have diegetic sounds. Therefore, two bespoke versions of the game were designed to incorporate the high and low tempo non-diegetic music in the game. The high tempo music was 140 BPM *'TRANCEFORMED 009'* by Matt Helden(excerpt extracted from 42:47 to 53:40) and the slow tempo music was the 60 BPM *'A Rose in Haiti'* by Mykle Anthony Alexander. The Beats per minute measure for both soundtracks was determined by manual tapping in Native Instrument's *Traktor Pro*. Both tracks belong to the genre of *Electronic Music*. The high tempo track belongs to the subgenre *trance*, which is characterized by tempo values between 120 and 145 BPM. The slow tempo track belongs to the subgenre, called *Downstep/Downbeat*. Unlike trance, this subgenre is characterized by laid-back melodies. Both subgenres have clear beats. The music tracks were chosen according to the following criteria: absence of lyrics, not having a remarkably positive or negative valence, clearly identifiable BPM, electronically made and not a recent hit in the charts. In this way we ensured that both soundtracks, more or less, had the same attributes, except for their tempo. The exclusion of lyrics is important because they can transfer meaning which could influence mood. Both soundtracks were monophonic, had a bit depth of 16 *(CD Quality)*, and were sampled at 11025 *Hz*.

Participants in both conditions played as a *terrorist* against 3 *counter-terrorists*. The counter-terrorist bots were armed only with a pistol, whereas the participant, playing as terrorist had an MP5 gun and a Glock pistol. The music track started playing automatically at the beginning of the first round. The music then played uninterruptedly for the next 11 minutes of game play. The selected music tracks were digitally looped to fit the 11 minutes durations. The difficulty level was set to *Easy* and the map was set to *de_dust2on2*. The Counter-Strike settings panel was completely locked so the participants could not change any settings of the game. This ensured that every all participants played essentially the same game.

2.3.2. Video Game and PC Volume

The loudness of music has been found to contribute positively to both retrospective duration estimates and perceived pace of music stimulus (Kellaris, Mantel & Altsech, 2008). Therefore, a strict control of the audio volume was practiced to avoid introducing a confound. The participants used *Supra-aural* headphones during game play. The PC and headphone volume controls were turned to full for all the participants. The sound levels were lowered internally in the game settings. Under these conditions the participants in both conditions were subjected to music levels of 78 $\pm$ 2dB, where the $\pm$ 2dB variation accounts for the difference between Laptop soundcards and the headphones vendors. During gaming, participants used a Glock pistol and an MP5 submachine gun, the sound levels of which were set to 87dB $\pm$ 2dB and 85dB $\pm$ 2dB, respectively.

2.4. Procedure

As the participants entered the room, one of the researchers welcomed them and had some small talk. At the same time, another researcher strapped on the Q-sensor to the left hand wrist of the participant and the EDA(*Electro-Dermal Activity*) recording was started and a ten minute timer was started. The participants were then given an informed consent form. After signing the consent the participants were asked for any prior experience with playing Counter-Strike. If the participant reported no prior experience with the game, then the researcher explained the basic game controls using a printed manual. After 10 minutes elapsed, the game was started for the participant and the researcher placed a marker in the Q sensor data to mark the end of the baseline period and beginning of the gaming period. For the next 10 minutes, the participant played the game while the researcher waited outside the room. After allowing the subject to play the video game for 10 minutes, the researcher entered the room, stopped the game, placed a second marker, unhooked the sensor from the wrist of the participants, started the IAT for the participants and got out of the room. After completing the IAT test, a demographics questionnaire automatically popped up for the subjects to respond to. After filling in the questionnaire, the participants were debriefed about the experiment if they wanted to, and thanked for their participation in the experiment.

2.5. Measures

The dependent variables in this experiment are arousal, and aggression measured via skin conductance and implicit attitude test, respectively. These two dependent variables were also measured using a Likert-scale questionnaire.

2.5.1. Skin Conductance Level

Skin conductance is one of the most robust non-invasive methods of measuring physiological arousal. Skin conductance refers to how well the skin conducts electricity when an external direct current of constant voltage is applied. The detected changes in electro dermal activity (EDA) indicate processes related to sympathetic arousal. The electric properties change within seconds and are closely related to psychological processes (Figner & Murphy, 2009). We are interested in the overall arousal and excitement while the subjects play the game. Therefore, this research uses the Skin Conductance Level (SCL) which embodies the long term arousal level of the player. However, how a person feels, cannot be solely derived from the arousal level and thus not assessed in this study. Emotions are always determined by arousal level (high/low) and a corresponding valence (positive/negative). The emotional state of, for example, being happy compared to that of being upset just differ on the valence dimension. Both have a high arousal level (Barrett, 1998).

The skin conductance of the subject was measured using *Affectiva Q-Sensor*. The Q-Sensor is a wearable, wireless biosensor GSR (Galvanic Skin Response) device for galvanic skin response tests that measures emotional arousal. Besides measuring the skin conductance, it also measures the temperature and 3-axis acceleration. However, for our experiment we only used the skin conductance data. This wireless sensor was housed in a wrist band that was attached to the distant end of ulna on the left hand of the participant. The sample rate for the sensor was set to 32 *Hz*.

Affectiva, the vendor of Q-sensor, recommends that the recordings should be used after 15 minutes of hooking the sensor to the subject, but our pretests revealed that the data becomes stable and reliable after 8 minutes. Therefore, 10 minutes of baseline data was collected, the first 8 minutes of which was discarded and only the last two minutes of data were used for determining the baseline mean. The gaming interval was defined as all the data collected 10 minute after placing the first marker M1. Only the first 9 minutes of this 10 minute data was used. The last one minute was discarded to avoid the edge effects of the filter used to filter out the SCRs (Skin conductance Responses).

2.5.2. Isolating SCL from SCRs

Skin conductance level (SCL) is used in this study to investigating the effect of game music on the general long term arousal of the player. A higher skin conductance level means higher arousal and vice versa. However, the skin conductance level is masked by short term physiological responses that show up in the GSR recordings as Skin Conductance Responses (SCRs). Skin conductance responses show up various peaks in the GSR. Usually in psychological studies, the norm is to average the GSR activity over a certain period, using a sliding window filter(also called moving average filter), to smooth out the SCRs in order to get a measure for the SCL. Mathematically, a moving average filter is given as:

$$\bar{x}(n) = \frac{1}{N}\sum_{k=1}^{N} x(n-k)$$

where N in the above equation is *Window Size*. Although moving average filter smooths out the SCRs, but it can massively overestimate the SCL in the regions where there is a high SCR concentration (Figner & Murphy, 2009). It can also underestimate the SCL in certain regions of the GSR. Furthermore, because a moving average uses overlapping windows, it is computationally very slow.

Owing to the issues, associated with the moving averaging filter, we used a detrending technique for separating SCRs from SCL. This technique never overestimates the SCL, is computationally much faster than the traditional moving average filter, and yields much better quality SCRs and SCL.

The technique is based on the fact that SCRs die out very quickly and the GSR activity returns to the SCL trend. So if we could detect the minimas of SCR in small consecutive time windows, then we could interpolate these minimas to get an accurate representation of the SCL activity. Because we are detecting GSR minimas every time, in each time window, therefore by design, this technique could never overestimate SCL. This approach of baseline trend estimation by fitting a curve locally to the intensity minima works a lot faster than the moving average filter, and yields much better SCL estimation. The whole process can be divided into three steps:

Step 1: Divide the entire GSR activity into a number of non-overlapping windows. For our case, the size of the overlapping window was set to 480 samples, which at 32 *Hz* sample translates to 15 seconds of data. The rationale behind using a window size of 480 samples is that the SCRs take 10 to 20 seconds to die down to the SCL level. Therefore, selecting a window length in this range yields better results than any other window size.
Step 2: Find a global minimum point in the GSR inside each of the windows produced in the previous step.
Step 3: Linearly, quadratically, or cubically interpolate each of these consecutive points to obtain a smooth waveform that would quite accurately represent the skin conductance level without any overestimation. For our case, we used linear interpolation.

The filter was designed and implemented in Matlab® R2010b. The comparison of results between this algorithm and the traditional moving average filter are explained in Figure 1. The blue trace in this figure represents the raw unprocessed GSR activity of a subject. It contains both SCL and SCR's. The red trace shows the result of using a 5120 point moving average filter on the raw GSR. The filter removes SCR's but results in overestimating the SCL in regions of high SCR concentration. The green trace shows the SCL generated by our non-overlapping window based spline fit algorithm. This filter follows local minimas in consecutive time windows and hence, never overestimates the SCL. The window size is set to 480 samples (or 15 seconds at 32 *Hz* sampling rate). The black trace shows the SCR's obtained using our inon-overlapping window based spline fit algorithm. It was obtained by just subtracting the SCL, that we obtained using this filter, from GSR because SCR = GSR - SCL. The SCR's are very clean with no baseline SCL in it. The pink trace was obtained by subtracting the SCL obtained using the moving average filter, from the GSR. As you can see, the failure of the moving average filter to accurately detect SCL, results in a failure to produce pure SCRs. The SCR's generated by this filter contains reminiscences of the SCL in the regions where it had over or underestimated the SCL.[Note: A dc offset of -1 was added to this waveform without which the two SCR waveforms (pink and black one)overlap and the difference is difficult to observe then]Marker M1 was set when the game was started and it marks the end of the baseline duration and start of the game play. Marker M2 was set after 10 minutes of game play. Only the last two minutes of data before marker M1, was used for baselining because in these last two minutes the sensor data is reliable and stable. The last minute of the data before marker M2 was discarded to remove corrupted data produced by the edge effect of the filter. So only nine minutes of SCL activity after marker M1 was used.

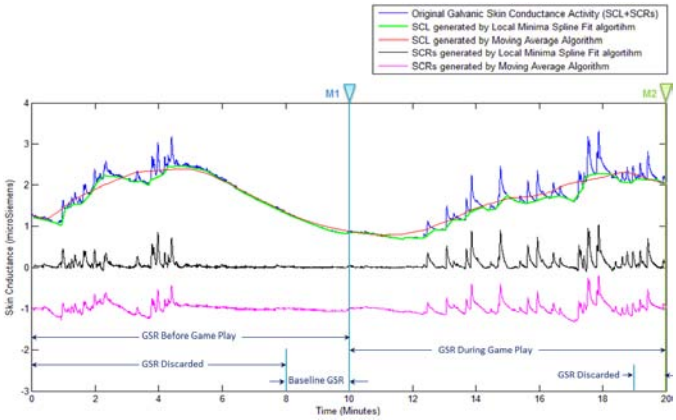


Figure 1: Comparison Result of 'Moving Average' and 'Local Minima Spline Fit' algorithm for separating SCL and SCR's

2.5.3. Normalizing SCL

Skin Conductance level, like any other psychophysiological output variables, displays marked individual differences in the maximum and often in the minimum levels of which subject is capable. Some subjects, known as *Labiles*, show a very large variation in their skin conductance, whereas some subjects known as *Stabiles*, show a very small variation their skin conductance. This was demonstrated in one of the studies done by Lykken (1968) in which one of the subjects, who was relaxing for 30 minutes had minimum skin conductance which was 2 times larger than another subject who was blowing up balloons to bursting. Surely, the first subject wasn't more aroused then the second one. Such variations in range, are generally unrelated to the underlying variable of interest, and must be corrected so as to remove their influence. Lykken, Rose & Luther (1966) introduced a method of normalizing the skin conductance to remove this inter-subject variability in the range. The method works by finding the global minimum and maximum in the skin conductance of a subject and transforming the original data into a normalized version:

$$x_N(i) = \frac{x(i) - x_{min}}{x_{max} - x_{min}}$$

Where $x(i)$ and $x_N(i)$ represent the original and normalized samples respectively. x_{min} and x_{max} are the global minimum and global maximum in the data of a subject respectively.

After the skin conductance was normalized, it was split into baseline data and gaming data with respect to the first marker. All 3840 samples, corresponding to two minutes of data collected before the first marker M1, were averaged to get the mean value for baseline skin conductance.

$$\mu_b = \textit{Mean Baseline Skin Conductance} = \frac{1}{3840}\sum_{i=1}^{3840} x_{Nb}(i)$$

All 17280 sample points, corresponding to nine minutes of data collected after the first marker M1, were averaged to get the mean value of skin conductance during gaming.

$$\mu_g = \textit{Mean Gaming Skin Conductance} = \frac{1}{17280}\sum_{i=1}^{17280} x_{Ng}(i)$$

Finally the baseline mean skin conductance was subtracted from gaming mean skin conductance to get a baseline corrected value of skin conductance during gaming.

$$\mu = \mu_g - \mu_b$$

This process of first filtering the data, normalizing it, and finding the mean skin conductance level, was repeated for the GSR data of each of the 37 respondents.

2.6. Implicit Association Test

To measure the aggressive self-concept of the subjects after playing the video game, an IAT *(Implicit Association Test or Implicit Attitude Test)* was conducted. A self-concept is the total sum of beliefs that people have about themselves and which guide the processing of self-relevant information (Brehm, Kassin & Fein, 2005). The IAT or other implicit measures are useful for assessing aggressiveness for three primary reasons. First, explicit measures such as self-reports tap only into processes involved in the explicit information processing mode. Second, the IAT has been demonstrated to have incremental validity over and above explicit measures. Studies have shown that the IAT has reliability around 0.80 for internal consistency, and 0.60 for test-retest stability as well as good construct and predictive validity (Dasgupta & Greenwald, 2001; Greenwald & Farnham, 2000). Finally, aggressive behavior is typically socially undesirable and reports of such are therefore subject to social desirability biases, so the predictive validity of explicit measures for aggressive behavior is questionable. Implicit measures may help to improve the prediction of aggressive behavior. This is due to the hard-to-control spontaneous associations which such tests reveal (Bluemke, Friedrich & Zumbach, 2010).

The Implicit Association Test (IAT) is a computer based sorting task that indirectly measures the strength of the association between two contrasted target categories (e.g., *Me* versus *Others*) and two bipolar attribute categories (e.g., *Peaceful* versus *Aggressive*) via a computerized classification task(Richetin & Richardson, 2008). The IAT obliges the respondents to identify stimulus items and categorize them into one of these four superordinate categories. Association strengths are measured by comparing the speed of categorizing members of the superordinate categories in two different sorting conditions (Nosek, Greenwald & Banaji, 2005;Uhlmann & Swanson, 2004).

The IAT's procedure has 7 blocks, with block 3 & 4 and 6 & 7 providing the most critical data(Nosek et al., 2005).

Block 1–(Target Compatible Practice) involves *Learning The Concept Dimension*. The respondents sort items from two different concepts into their superordinate categories (e.g., 'I' for *Me* and 'they' for *Others*). Categorizations are made using two different keys on a computer keyboard that are mapped to the superordinate categories (e.g., the 'E' key for *Me* and the 'I' key for *Others*) and stimulus items appear sequentially in the middle of the computer screen(see Table 1). Respondents perform 20 trials with these sorting rules.

Block 2–(Attribute Practice) involves *Learning The Attribute Dimension*. The respondents perform the same task with the same two keys but now sort items representing two poles of an attribute dimension (e.g., Violent for *Aggressive* and Friendly for *Peaceful*). Respondents perform 20 trials with these sorting rules.

Block 3–(Compatible Test 1) involves *Learning Concept-Attribute Pairing*. In this step, the two sorting tasks of block 1 and 2 are combined such that, on alternating trials, respondents are identifying a stimulus as *Me or Peaceful* and then a word as *Others or Aggressive*. In this case, one key ('E') is the correct response for two categories *(Me or Peaceful)* and the other key ('I') is the correct response for the other two categories *(Others or Aggressive)*. Respondents perform 20 trials with these sorting rules in this block (often referred to as the *Practice* block).

Block 4–(Compatible Test 2) is exactly similar to the block 3, but in this block, 40 trails are done instead of 20. This block is often referred to as the *Critical* block). The latencies of the responses generated in this critical block are used in the calculating the final IAT *D* score.

Block 5–(Target Incompatible Practice) involves *Learning Reversed Concept Dimension*. In this stage of the task, only stimulus items for the target concepts (*Me* and *Others*) are sorted for 20 trials, but this time the key assignment is reversed. In the present example, items in *Others* category would now require an 'E' key response and items in the *Me* category would require an 'I' key response.

Block 6–(Incompatible Test 1) involves *Learning Reversed Concept-Attribute Pairing*. In the fifth stage of the task, respondents sort items from both the attribute and target concept categories again, except that the response key assignments now require *Others or Peaceful* items to be categorized with one key and *Me or Aggressive* items to be categorized with the other key, the opposite association from the earlier block. Respondents sort stimulus items with this response assignment for the next 20 trials. This is the practice block.

Block 7–(Incompatible Test 2) is exactly similar to the block 6, but in this block 40 trails are done instead of 20. This block is also referred to as the *Critical* block). The latencies of the responses generated in this critical block are used in the calculating the final *D* score.

The IAT effect is calculated using latency data from Steps 3 & 4 and 6 & 7. In the above example, sorting the stimulus items faster when *Me or Aggressive* (and *Others or Peaceful*) share a response key than the reverse pairings indicates a stronger association strength between Me and Aggressive (and *Others or Peaceful*), which means that the respondent is more aggressive than peaceful.

The IAT was designed in Inquisit™ 3.0.4.0 by Millisecond Software. Because the IAT uses quite a lot of complex adjectives in each category, it is imperative that implicit attitude test be carried out in the respondents' native language. Because almost all the participants were either Dutch or German, therefore the IAT was designed in three different languages: English, German, and Dutch (refer to Tabel A.2 to see all the stimuls words used in all the three languages). Before starting each IAT, instructions appeared on screen that asked user to select their native language. Once the choice was made, the IAT started in that language. An ITI (Inter Trial Interval) of 250 ms was used. Furthermore, the compatible blocks (2, 3 & 4) and incompatible blocks (5, 6 & 7) were administered in counterbalanced order across the sample to control for block order effects.

2.6.1. Calculating IAT D Score

Greenwald, Nosek & Banaji (2003) described in detail the scoring algorithm for calculating the IAT effect. It involves calculating the difference in average response latency between the two sorting conditions and dividing by the standard deviation of all latencies for both sorting tasks. Thus, the IAT score (called D) is a calculation of effect size for an individual's responses in the task. The IAT D score is related to *Cohen's d*.

Before the *D* score for a subject is calculated, all the trails having a latency greater than 10,000 ms are discarded (Lane, Banaji, Nosek & Greenwald, 2007). After cleaning the data from these outliers, the following calculations are done on the remaining trails to calculate the IAT *D* score:

Step 1: Find the mean response latency μ_3, of all the trails in block 3. Similarly, the mean response latency i.e. μ_4, μ_6, μ_7 for block 4, 6 & 7 respectively, are calculated.

Table 1: Different Blocks of an Implicit Association Test (IAT)

Block	Category Labels	Stimulus Items	Category Labels
Block 1:	**Me**		**Others**
Learning The Concept Dimension	●	I	○
(20 Trials)	○	Them	●
Block 2:	**Aggressive**		**Peaceful**
Learning The Attribute Dimension	○	Friendly	●
(20 Trials)	●	Violent	○
Block 3: *Practice Block*	**Me**		**Others**
Learning Concept-Attribute Pairing	**or**		**or**
(20 Trials)	**Aggressive**		**Peaceful**
&	●	I	○
Block4: *Critical Block*	●	Violent	○
Doing Concept-Attribute Pairing	○	Them	●
(40 Trials)	○	Friendly	●
Block 5:	**Others**		**Me**
Learning Reversed Concept Dimension	●	Them	○
(20 Trials)	○	I	●
Block 6: *Practice Block*	**Me**		**Others**
Learning Reversed Concept-Attribute Pairing	**or**		**or**
(20 Trials)	**Peaceful**		**Aggressive**
&	●	I	○
Block 7: *Critical Block*	○	Violent	●
Doing Reversed Concept-Attribute Pairing	○	Them	●
(40 Trials)	●	Friendly	○

Schematic description and illustration of an Implicit Association Test. The IAT consists of series of 7 discrimination tasks. There are 20 trials in each block except for block 4 and 7, which contain 40 trials each. The black dots indicates the correct response and the white dots represents a wrong response. Block 3 & 6 are referred to as 'Practice Blocks' and Block 4 & 7 are referred to as 'Critical Blocks'. The response latency data collected during these performing the Practice and Critical Blocks, is used to calculate the IAT D score. The compatible blocks (2,3 & 4) and incompatible blocks (5,6 & 7) were administered in counterbalanced order across the sample to control for block order effects.

Step 2: Calculate the pooled standard deviation of the latencies $\sigma_{pooled(3,6)}$ in the practice blocks 3 and 6.

Step 3: Calculate the pooled standard deviation of the latencies $\sigma_{pooled(4,7)}$ in the critical blocks 4 and 7.

Step 4: Divide the difference of mean latencies of practice blocks 3 and 6 by their pooled standard deviation to get the D score for practice blocks.

$$D_{practice} = \frac{\mu_6 - \mu_3}{\sigma_{pooled(3,6)}}$$

Step 5: Divide the difference of mean latencies of critical blocks 4 and 7 by their pooled standard deviation to get the D score for critical blocks.

$$D_{critical} = \frac{\mu_7 - \mu_4}{\sigma_{pooled(4,7)}}$$

Step 6: Calculate the IAT D score by averaging the D score for practice and critical blocks.

$$D = \frac{D_{practice} + D_{critical}}{2}$$

The resulting IAT score (called D) ranges from -2 to +2. Positive IAT scores indicate a peaceful self-concept and negative scores an aggressive self-concept (Greenwald & Farnham, 2000).

2.7. Self-Report Measures

Besides obtaining general demographics data, the following explicit self-report measures were also obtained by asking the subjects to give a self-evaluation on a 7-point-Likert Scale.

1. How aggressive are you feeling?

2. How interesting the music was while you were playing the game?
3. How arousing was the music while you were playing the video game?

The response value 1 for the above three question are translated as 'very arousedŠ, 'very interestingŠ, and 'very arousingŠ respectively. Whereas, a response value of 7 means 'very calm', 'very boring', and 'very relaxing' respectively for the three question mentioned above.

3. Results

3.1. Distribution of the data

Kolmogorov Smirnov test was carried on all relevant data to test for the normality of data. The IAT D score ($Z = 0.46$; $p = 0.98$), skin conductance data ($Z = 1.03$; $p = 0.22$), and the two Likert scale questions: *'How aggressive the subjects felt after gaming?'* ($Z = 1.29$; $p = 0.07$), and *'How interesting the music was while you were playing the game?'* ($Z = 1.05$; $p = 0.22$), all turned out to be normally distributed. Only the third Likert scale question *'How arousing the music was when playing the video game?'* ($Z = 1.418$; $p = 0.036$) had a non-normal distribution.

None of the variables above contained outliers, where an outlier was defined as a point in a data set which is located more than *1.5 X Interquartile Range* above the third quartile or below the first quartile (Moore & McCabe, 2005).

3.2. Differences between the two conditions

A *two-sided independent sample t-test* with an alpha of 0.05 was used to compare the group which listened to fast-paced music ($n = 18$) with the group which listened to low-paced music ($n = 19$). The t-test reveals that the two conditions do not differ significantly from each other in their skin conductance level ($T = -1.100$; $p = 0.279$), their IAT score ($T = -0.107$; $p = 0.916$), and their self-reported aggressive feeling measure ($T = -1.475$; $p = 0.15$). However, the group that listened to high tempo music found the music more interesting as compared to the group that listened to the low tempo music ($T = -3.19$; $p = 0.003$).

To compare the two groups on their self-reported arousal on a 7-point Likert scale (where 1 stands for being 'very aroused' and 7 for 'very relaxed'), a *Mann-Whitney U test* with an alpha of 0.05 was used. The test indicated that self-reported arousal was greater for the group that listened to high tempo music ($Mdn = 2.5$) compared to the group that listened to the low tempo music ($Mdn = 5$) and ($U = 68.5$, $p = 0.007$).

Hypotheses 1, i.e. *'The arousal will be significant higher in the group which played video game with high tempo music'* cannot be confirmed fully. For skin conductance, which is an indicator for arousal, we found no differences. However, the hypothesis is true when looking at the self-reported arousal of the subjects. Hypothesis 2, i.e. *'The group which listens to high tempo music while playing will show higher aggression on implicit aggressive measures'* could not be confirmed. The indirect assumption behind the hypothesis was that the high BPM condition would score lower on the IAT-test, as a consequence of the high arousal. Hypothesis 2 thus has to be rejected. This result is not entirely surprising because the two conditions did not differ significantly in their arousal (i.e. skin conductance level) as well.

3.3. Correlation between Arousal and Aggression

According to the excitation transfer theory, the arousal produced whilst listening to music should get transferred to the in-game actions and that would consequently have amplified the violent acts in the game. This should have been reflected in the IAT-score. We neither found a difference in bodily arousal nor on the IAT scores between the groups. The arousal we measured is thus unrelated to the music.

Nevertheless, it would be interesting to see if the arousal level while gaming and the aggressive affect is correlated in any way to the IAT score. We handle the following allocation of correlations:

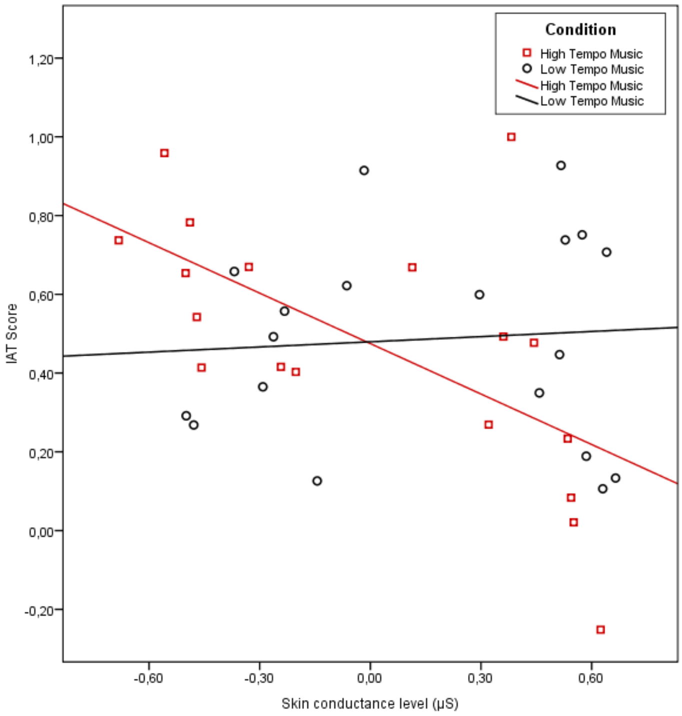
$r \leq 0.30$	Low Correlation
$0.30 < r < 0.60$	Moderate Correlation
$r \geq 0.60$	High Correlation

For aggressive effect, the correlation with the IAT ($r = 0.32$) was moderate positively significant ($\alpha < 0.05$). Arousal was measured directly via skin conductance and indirectly via self-indication. We are most interested in the first one, because it is the direct measure of arousal. A Pearson correlation between SCL and IAT-score was conducted, once for all subjects ($n = 37$) and once for each condition apart. There is a moderate negatively significant correlation ($r = -0.31$) between SCL and IAT score ($\alpha < 0.05$) in general. When splitted into two groups, it reveals that there is a strong negative significant correlation ($r = -0.62$) between IAT scores and SCL in the high-tempo group, whereas there is no significant correlation in the low tempo group (α 0.01). Probably this is an artifact. In the fast-paced condition were by chance more subjects with more extreme skin conductance. That could explain why the correlation just became significant in that condition (see Figure 2). Contrary to the skin conductance, self-indicated arousal shows no significant correlation with IAT-score. Hypothesis 3 i.e. *'Arousal and aggression will show correlation. Highly aroused participants will show more aggressive cognitions'* is confirmed partly.

4. Discussion

The present study attempted to investigate the potential role of arousal as a moderator for aggressive cognitions. It was

Figure 2: Correlation between SCL and IAT-score



Note: The circles and squares represent participant data in low and high tempo conditions respectively. The red and black lines show the linear fit to data in high and low tempo conditions respectively.

hypothesized that high tempo music will induce high levels of arousal which will consequently result in higher aggressive tendencies and vice versa. The results revealed that music tempo plays no role whatsoever in modulating arousal in the gaming context. This is sharp in contrast to various music studies where the tempo of music was shown to modulate the arousal and pleasure. The only possible explanation to this contrast is that those studies used music in standalone form and didn't couple the music with a videogame. The complex gameplay coupled with various other factors (discussed below), might have contributed to the complete masking of the effect of the tempo on arousal. To find if this was the case, a further experiment should be conducted on our two chosen soundtracks. But this time, only the music should play and not the video game. If our low tempo soundtrack results in low arousal and high tempo music results in high arousal effect, then it would confirm our hypothesis that video games do have an influence in masking the arousing effects of music.

The study did, however, find a significant correlation between arousal and aggression, showing a general trend that more aroused subjects showed more aggressive cognitions and vice versa. This result is inline with the *Excitation transfer theory*. Arousal seemingly, was transferred to the violece in game actions and reflected in the IAT scores.

4.1. Limitations of the study

The study failed to corroborate existing studies about the effect of music tempo on arousal. There could be several possible explanations to it. It may be because the low tempo music was not really low tempo at all. Tempo is very difficult thing to measure. We tried to measure it using five different professional DJ softwares and each one of them gave different BPM readout. Ultimately, it was decided to resort to manual counting by tapping the beats in Native Instruments' Traktor Pro software. However, this technique of manual tapping the beats, requires one to have a good background in music to correctly recognize and register a beat as shown by one of the studies done by McAuley & Semple (1999). So it could be that the lack of formal musical background, led to wrong estimates of BPM using the manual tapping technique, resulting in wrong estimates of the tempo. Future studies should use soundtracks that have their tempo ratings verified by a musical expert.

A further limitation of this study is that the subgenre of the low and high tempo music are not exactly the same. A study by Kellaris & Kent (1993) shows that genre, has moderating effect on the tempo and arousal. It could be a reason that subgenre of the low tempo music was so overpowering and arousing compared to the high tempo music that it completely masked the effect of tempo and in effect, the study started measuring the effect of subgenre rather than the effect of tempo, as originally intended. Future studies should keep the genre, subgenre, tonality, and texture of the music the same while manipulating the tempo. Keeping these parameters the same, while manipulating the tempo is a very difficult task. It can be done in certain software packages, but it completely destroys the musical aesthetics and fidelity of the soundtrack in the process. Human ear can easily detect that the tempo of the original soundtrack has been doctored. However, a study by Richards, Fassbendera, Bilginb & Thompson (2008), advocates the use of a software Ableton Live by DAW (Digital Audio Workstation). In that study, the tempo of a music track was varied by as much as 21-26% and the doctored soundtracks were presented to three musical experts who were unable to detect any irritating distortions and manipulations. Future studies should therefore explore the use of this software. An alternative could be to compose the low and high tempo music tracks using professional musicians who can change tempo while keeping the genre, texture, and tonality more or less the same.

One shortcoming of our game music design is that it's *Non-Dynamic Linear Sound* i.e. it loops over and over again and is unaffected by players' input and game play. Modern video games use *Adaptive Non-diegetic Sounds* i.e. music tracks that occur in reaction to the gameplay. The adaptive non-diegetic music provides a more immersive experience to the player. Future studies should incorporate this kind of adaptive music to mimic modern games.

The IAT used for the experiment has many flaws. To start with, a more personalized IAT(Craeynest, Crombez, Haerens & De Bourdeaudhuij, 2007b) should have been used. Using categories like 'Me' and 'Others' may seem very vague and ambiguous to some of the participants, resulting in large response latencies and thereby, a false IAT *D* score. This became apparent during our study also when two of the German participants were unsure about the categories. The word *'Sie'*, e.g. is translated as *'they'* in English. But *'Sie'* can also mean *'you'* in some contexts of German language. This ambiguity resulted in the German participants being unsure as to whether they should classify *'Sie'* to the *'Me'* category or the *'Others'* category. In future studies, it would be wise to use a personalized IAT in which *'Me'* and *'not Me'* or *'like me'* and *'not like me'* categories are used (Craeynest, Crombez, Haerens & Bourdeaudhuij, 2007a). This reduces any ambiguity associated with using words like *'Me'* and *'other'*. An even better choice would be to use violent and peaceful images in a *Pictorial Attitude-Implicit Association Test* (PA–IAT) which yields much better results and less ambiguity for subjects (Slabbinck, De Houwer & Van Kenhove, 2011).

A further reason why our IAT failed is because the adjectives used to define the *'Aggressive'* and *'Peaceful'* states had no or weak relationship to the actions in the actual game. For example, for 'Aggressive' category, we used adjectives like *'Hateful'* and *'Harmful'* which have a very weak relation to the actions in the video game. Future research should use words like *'Kill'*, *'Decimate'* or *'Mutilate'* that have a bit more relation to the video game actions. Similarly, in the *'Peaceful'* category we used words like *'Cheerful'* and *'Loving'*, which looking back, seems preposterous. We should have used words like *'Rescue'* or *'Liberate'* that have a bit more relation to Counter-Strike actions because one of the mission in Counter-Strike could have been to rescue a hostage from terrorists.

The general experimental conditions might also have played a role. The experiments were conducted using three different laptops (one of which had very low resolution), two different computer mice, and two different headphones. These differences could have had an impact on the variables under investigation. Future studies should be conducted such that participants in each condition are exposed to the same experimental factors.

No statistical power analysis was carried out before the actual experiment. Had it been conducted,, it would have better prepared us for the expected outcomes of the experiment. The number of participants we finally decided upon was rather based on a wild guess, when it should have been decided on the basis of the statistical power analysis. Future studies should estimate the effect size beforehand and on the basis of the statistical power analysis decide on the number of participants, and if the number of participants indicated by the statistical power analysis is too large, then a different study should be done altogether.

Lastly, the present study did not use any control group. Using a control group could have given a bit more insight into the effect of music on arousal and aggression during gameplay. The decision to not use a control group was based entirely on the concerns of scarcity of potential participants and the difficulty associated with conducting a large number of experiments. Future studies should include a control group as well.

5. Acknowledgment

I could not thank Sabine Ströfer enough for helping me with the statistical analysis and introduction portion of this article. I would also like to thank all the friends & family and students, who gave their valuable time and energy to participate in this study.

References

Anderson, C. A. (2004). An update on the effects of playing violent video games. *Journal of Adolescence*, *27*, 113–122.

Anderson, C. A., & Bushman, B. J. (2001). Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: A meta-analytic review of the scientific literature. *Psychological Science*, *12*, 353–359.

Anderson, C. A., Carnagey, N. L., Flanagan, M., Benjamin, A. J., & Jr., E. J. (2004). Violent video games: Specific effects of violent content on aggressive thoughts and behavior. *Advances in Experimental Social Psychology*, *36*, 199–249.

Anderson, C. A., & Dill, K. E. (2000). Video games and aggressive thoughts, feelings,and behavior in the laboratory and in life. *Journal of Personality and Social Psychology*, *78*, 772–790.

Anderson, C. A., & Murphy, C. R. (2003). Violent video games and aggressive behavior in young women. *Aggressive Behavior*, *29*, 423–429.

Anderson, C. A., Sakamoto, A., Gentile, D. A., Ihori, N., Shibuya, S. Y., & Naito, M. (2008). Longitudinal effects of violent video games on aggression in japan and the united states. *Pediatrics*, *122*.

Barlett, C. P., Harris, R. J., & Baldassaro, R. (2007). Longer you play, the more hostile you feel: Examination of first person shooter video games and aggression during video game play. *Aggressive Behavior*, *33*, 486–497.

Bennun, P. (2010). Bleep Bleep Bloop: Music and Video Games *(BBC Radio 4)*. Last broadcast on Tue, 15 Feb 2011, 13:30 on BBC Radio 4. http://www.bbc.co.uk/programmes/b00yj887.

Berkowitz, L. (1993). *Aggression: Its Causes, Consequences, and Control*. New York, NY, England: McGraw-Hill Book Company.

Berlyne, D. E. (1974). *Studies in the new experimental aesthetics: Steps toward an objective psychology of aesthetic appreciation*. Washington, DC: Hemisphere.

Bluemke, M., Friedrich, M., & Zumbach, J. (2010). The influence of violent and nonviolent computer games on implicit measures of aggressiveness. *Aggressive Behavior*, *36*, 1–13.

Brehm, S. S., Kassin, S., & Fein, S. (2005). *Social psychology*. (Sixth ed.). Boston: Houghton Mifflin.

Bruner, G. C. (1990). Music, mood, and marketing. *Journal of Marketing*, *54*, 94–104.

Cantor, J. R., Bryant, J., & Zillmann, D. (1974). Enhancement of humor appreciation by transferred excitation. *Journal of Personality and Social Psychology*, *15*, 470–480.

Carnagey, N. L., & Anderson, C. A. (2005). The effects of reward and punishment in violent video games on aggressive affect, cognition, and behavior. *Psychological Science*, *16*, 882–889.

Carpentier, F., & Potter, R. F. (2007). Effects of Music on Physiological Arousal: Explorations into Tempo and Genre. *Media Psychology*, *10(3)*, 339–363.

Craeynest, M., Crombez, G., Haerens, L., & Bourdeaudhuij, I. D. (2007a). Do overweight youngsters like food more than lean peers? assessing their implicit attitudes with a personalized implicit association task. *Food Quality and Preference*, *18*, 1077–1084.

Craeynest, M., Crombez, G., Haerens, L., & De Bourdeaudhuij, I. (2007b). Do overweight youngsters like food more than lean peers? Assessing their implicit attitudes with a personalized Implicit Association Task. *Food Quality and Preference*, *18*, 1077–1084.

Crozier, J. B. (1981). Advances in intrinsic motivation and aesthetics. chapter Information theory and melodic perception: In search of the aesthetic engram. (pp. 433–461). NewYork: Plenum.

Dasgupta, A. G., & Greenwald, A. G. (2001). Exposure to admired group members reduces automatic intergroup bias. *Journal of Personality and Social Psychology*, *81*, 800–814.

Duerr, W. (1981). The voices of time. chapter Rhythm in music: A formal scaffolding of time. (pp. 180–201). Amherst: University of Massachusetts Press.

Eastin, M. (2006). Video game violence and the female game player: Self- and opponent-gender effects on presence and aggressive thoughts. *Human Communication Research*, *32*, 351–372.

Farrar, K., & Krcmar, M. (2006). Measuring state and trait aggression: A short,cautionary tale. *Media Psycholog*, *8*, 127–138.

Figner, B., & Murphy, R. O. (2009). The Handbook on Process Tracing Methods, The Society of Judgment. chapter Using skin conductance in judgment and decision making research: A hands-on approach. New York, NY: Psychology Press.

Gomez, P., & Danuser, B. (2007). Relationships Between Musical Structure and Psychophysiological Measures of Emotion. *Emotion by American Psychological Association*, *7*, 377–387.

Greenwald, A. G., & Farnham, S. D. (2000). Using the implicit association test to measure self-esteem and self-concept. *Journal of Personality and Social Psychology*, *79*, 1022–1038.

Greenwald, A. G., Nosek, B. A., & Banaji, M. R. (2003). Understanding and using the Implicit Association Test: I. An improved scoring algorithm. *Journal of Personality and Social Psychology*, *85*, 197–216.

Grimshaw, M. N., Lindley, C. A., & Nacke, L. E. (2008). Sound and immersion in the first-person shooter: Mixed measurement of the player's sonic experience. Audio Mostly - A Conference on Interaction with Sound.

Gundlach, R. A. (1932). A quantitative analysis of lndian music. *American Journal of Psychology*, *44*, 133–145.

Hevner, K. (1937). The affective value of pitch and tempo in music. *American Journal of Psychology*, *49*, 621–630.

Holbrook, M. B., & Anand, P. (1990). Effects of tempo and situational arousal on the listener's perceptual and affective responses to music. *Psychology of Music*, *18*, 150–162.

Huiberts, S. (2010). *CAPTIVATING SOUND: THE ROLE OF AUDIO FOR IMMERSION IN COMPUTER GAMES*. Ph.D. thesis Utrecht School of the Arts and University of Portsmouth.

Jørgensen, K. (2006). On the functional aspects of computer game audio. Piteå,Sweden: Audio Mostly.

Kellaris, J. J., & Kent, R. J. (1993). An exploratory investigation of responses elicited by music varying in tempo, tonality, and texture. *Journal of Consumer Psychology*, *2*, 381–401.

Kellaris, J. J., Mantel, S. P., & Altsech, M. B. (2008). Decibels, Disposition, and Duration: The impact of musical loudness and internal states on time perceptions. *Advances in Consumer Research*, *23*, 498–503.

Kirsh, S. J. (1998). Seeing the world through mortal kombat-colored glasses. Violent video games and the development of a short-term hostile attribution bias. *Childhood*, *5*, 177–184.

Lane, K. A., Banaji, M. R., Nosek, B. A., & Greenwald, A. G. (2007). Implicit measures of attitudes: Procedures and Controversies. chapter Understanding and using the Implicit Association Test: IV. What we know (so far). (pp. 59–102). New York: Guilford Press.

Laurel, B. (1993). *Computers as theatre*. New York, Addison Wesley.

Lundin, R. W. (1985). *An objective psychology of music*. (3rd ed.). Krieger Publishing.

Lykken, D. (1968). Some properties of skin conductance and potential. *Psychophysiology*, *5*, 253–268.

Lykken, D., Rose, R., & Luther, B. (1966). Correcting psychophysiological measures for individual differences in range. *Psychological Bulletin*, *66*, 481–484.

Matt Helden (). TRANCEFORMED 009. Retrieved April 14, 2011, 5:00 PM. http://tinyurl.com/6yqfzks.

McAuley, J. D., & Semple, P. (1999). The effect of tempo and musical experience on perceived beat. *Australian Journal of Psychology*, *51*, 176–187.

Moore, D. S., & McCabe, G. P. (2005). *Introduction to the Practice of Statistics*. W. H. Freeman and Company.

Murphy, D., & Pitt, I. (2001). Spatial sound enhancing virtual story telling. In O. Balet, G. Subsol, & P. Torguet (Eds.), *Virtual Storytelling Using Virtual Reality Technologies for Storytelling* (pp. 20–29). Springer Berlin / Heidelberg volume 2197 of *Lecture Notes in Computer Science*.

Mykle Anthony Alexander (). A Rose in Haiti. Uploaded: Sun, Jun 20, 2010, 12:33 PM. http://ccmixter.org/files/mykleanthony/27229.

Nosek, B. A., Greenwald, A. G., & Banaji, M. R. (2005). Understanding and using the Implicit Association Test: II. Method variables and construct validity. *Personality and Social Psychology Bulletin*, *31*, 166–180.

Raessens, J., & Goldstein, J. (2005). *Handbook of computer game studies*. Cambridge: The MIT Press.

Richards, D., Fassbendera, E., Bilginb, A., & Thompson, W. F. (2008). An investigation of the role of background music in ivws for learning. *ALT-J, Research in Learning Technology*, *16*, 231–244.

Richetin, J., & Richardson, D. S. (2008). Automatic processes and individual differences in aggressive behavior. *Aggression and Violent Behavior*, *13*, 423–430.

Rigg, M. (1940). Speed as a determiner of musical mood. *Journal of Experimental Psychology*, *27*, 566–571.

Sherry, J. L. (2007). Mass media effects research: Advances through meta-analysis . chapter Violent video games and aggression: Why canŠt we find effects?. (pp. 245–262). Lawrence Erlbaum.

Slabbinck, H., De Houwer, J., & Van Kenhove, P. (2011). A pictorial attitude IAT as a measure of implicit motives. *European Journal of Personality*, *25*, 76–86.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review*, *8*.

Tamborini, R., Eastin, M. S., Skalski, P., Lachlan, K., Fediuk, T. A., & Brady, R. (2004). *Journal of Broadcasting and Electronic Media*, *48*, 335–357.

Tannenbaum, P. H., & Zillmann, D. (1975). Advances in experimental social psychology. chapter Emotional arousal in the facilitation of aggression through communication. (pp. 149–192). New York: Academic volume 8.

Uhlmann, E., & Swanson, J. (2004). Exposure to violent video games increases automatic aggressiveness. *Journal of Adolescence*, *24*, 41–52.

Appendix A.

Table A.2: Stimulus Words used in the Implicit Association Test (IAT)

English	German	Dutch
Peaceful	**Friedlich**	**Vredig**
Good-natured	Gutmütig	Goedaardig
Friendly	Wohlwollend	Vriendelijk
Calm	Ruhig	Rustig
Harmonious	Harmonisch	Harmonieus
Kind	Freundlich	Aardig
Cheerful	Fröhlich	Vrolijk
Loving	Liebevoll	Liefdevol
Gentle	Sanftmütig	Zachtaardig
Aggressive	**Aggressiv**	**Agressief**
Hateful	Gehässig	Hatelijk
Hostile	Feindselig	Vijandig
Harmful	Verletzend	Schadelijk
Furious	Wütend	Woedend
Violent	Gewalttätig	Gewelddadig
Offensive	Angreifend	Aanvallend
Harsh	Barsch	Bruut
Angry	Verärgert	Boos
Me	**Mich**	**Mij**
I	Ich	Ik
My	Mein	Mijn
Mine	Mir	Mij
Self	Ich	Zelf
Myself	Ich selbst	Mezelf
Others	**Andere**	**Anderen**
They	Sie	Zij
Them	Ihnen	Ze
Their	Ihr	Hun
Others	Andere	Anderen
Theirs	Ihre	Jullie

The table list all the stimulus words used in the target and attribute categories in English, German and Dutch Languages.