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Aggressive and non-violent videogames: short-term psychological and cardiovascular effects on habitual players

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Summary
The purpose of this study is to evaluate the short-term effects on several physiological (arterial pressure and heart rate) and psychological (anxiety and aggressiveness) indexes of playing violent and non-violent videogames in young adults. The study was carried out on a sample of 22 male participants. Subjects invited to participate in the study were recruited from a videogame leisure club. Before and during playing either a violent or non-violent computer game, blood pressure and heart rate were measured. Before and after the game session, the subjects completed the State-Anxiety Inventory-Y (STAI-Y) and the Buss–Durkee Hostility Inventory. The results of the study showed a range of short-term effects of playing violent and non-violent videogames on arterial pressure and on the state anxiety of subjects, but not on hostility measurements. More specifically, the group that played the violent videogames showed a significant increase in the state anxiety score at the end of the game, as compared to the pre-game self-evaluation, and an increase in the systolic blood pressure while the subjects were playing as compared to pre- and post-game values. A decrease in diastolic blood pressure after playing any game was also found. Copyright © 2004 John Wiley & Sons, Ltd.

Key Words
hostility; anxiety; blood pressure; heart rate; videogames

Introduction

The increasingly widespread use of videogames among young people has led to many studies into their potential negative psychological effects. Research into progress in school and personality of young videogame players has partly eased some general worries. Owning videogames does not in fact seem to have negative effects on aggressive human behaviour (Creasey & Myers, 1986; Ellis, 1984; Gibb, Bailey, Lambirth, & Wilson, 1983; Van Schie & Wiegman, 1997), and using them seems rather to encourage the development of cognitive skills (Greenfield, 1994; Greenfield, Brannon, & Lohr, 1994), even though playing for many hours a day does have a nega-

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tive effect on progress in school (Anderson & Dill, 2000).

A more complex debate concerns the possible elicitation of aggressive behaviour by violent videogames given that correlational research (Bushman & Anderson, 2001) does not agree on the problem of direction of the relationship, and even laboratory research has produced contradictory data. Several experimental studies into the short-term effects of violent videogames do suggest that this type of game tends to suppress the pro-social response and increase negative thoughts or the frequency of aggressive play in children (Chambers & Ascione, 1987; Irwin & Gross, 1995; Kirsh, 1998; Silvern & Williamson, 1987). However, other research has not found that the content of videogames influences aggressive behaviour (Cooper & Mackie, 1986; Graybill, Strawniak, Hunter, & O'Leary, 1987). While an elicitation of aggressive thoughts and behaviour has been found in adolescents and young adults (Anderson & Dill, 2000; Anderson & Ford, 1986; Ballard & Weist, 1996; Calvert & Tan, 1994), others report the absence of a relationship between using videogames and aggressive behaviour (Winkel, Novak, & Hopson, 1987), or a reduction in aggressiveness, in the case of moderately violent videogames (Scott, 1995). It is no surprise, therefore, that authors who have written reviews of literature (Dill & Dill, 1998; Emes, 1997; Griffiths, 1997) agree that further research into this matter is necessary.

In particular, we have followed the suggestion given by Ballard and Weist (1996), who concluded that, although taking a stand on behalf of the negative potentialities of these games, further research into habitual videogame players is required inorder to determine whether long-term exposure leads to desensitization effects. This problem has also been posed indirectly by Anderson and Dill (2000), whose study found that, after playing, women are more likely to behave aggressively, offering the explanation of their reduced familiarity with the use of videogames.

Because video games elicit strong emotional reactions and given that emotions are associated with subjective as well as physiological modifications, in the present study heart rate and blood pressure were measured to determine whether playing a game content determines different autonomic nervous systems changes.

The purpose of this study is, therefore, to evaluate the short-term effects on several physiological indices of cardiovascular functioning (arterial pressure and pulse) and on psychological state (anxiety and aggressiveness) following violent and non-violent videogames in young adults who have played habitually for several years.

Method

Subjects

The study was carried out on a sample of 22 male subjects between 20 and 29 years of age, who have played videogames habitually for more than 5 years and who at the time of the study claimed to spend at least 1 hour a day playing against the computer or against fellow players. All subjects were members of a leisure club for young videogame enthusiasts.

Stimuli

Two videogames known to all the subjects were chosen as stimuli. The chosen violent videogame was 'Unreal Tournament' (Epic Games copyright, 1999). The game consists in moving through a very detailed three-dimensional labyrinth, where three other players, guided by the computer fight with each other and with the player. The setting is seen through the eyes of the player. The initial weapon is a pistol and other weapons (machine-guns, laser rifles, missile launchers) can be picked up along the way; each time a target is hit there are yells of pain and splashes of blood. The game was set to 'Death match', i.e. both the player and the other three characters gain one point for each hit and the player to accumulate the most points in the preset time wins.

The chosen non-violent videogame was 'Puzzle Bobble' (Taito copyright, 1995) due to its non-violent aim and fire characteristics. The game consists in aiming and throwing coloured balls onto other coloured balls at the top of the screen, so as to eliminate balls of the same colour by placing them near each other and prevent them from building up which would lead to the end of the game. The game is organized into levels of increasing difficulty.

Measures

The State-Trait Anxiety Inventory-Y (STAI-Y) and the Buss–Durkee Hostility Inventory (BDHI)

in the respective Italian versions (Di Maria & Di Nuovo, 1984; Spielberger, 1989) were used for the psychological evaluation.

The STAI-Y is a well-known anxiety self-evaluation questionnaire including 40 items, with a Likert scale from 1 to 4, grouped into one trait anxiety scale and one state anxiety scale.

The BDHI is an aggressive behaviour self-evaluation questionnaire that includes 75 items grouped into eight sub-scales (physical aggressiveness, indirect hostility, irritability, negativism, resentment, suspiciousness, verbal hostility, feelings of guilt), which provide both partial scores and an overall score.

For the psychophysiological evaluation, the heart rate and arterial pressure were measured by means of a Mark of Fitness model MF-80 digital wrist sphingomanometer.

Procedure

The experiment consisted of two sessions 15 days apart, one dedicated to acquiring basic information and familiarization with the research instruments, and the other dedicated to the actual experiment. In the first session, subjects were informed of the research procedure, which was presented as having the aim of collecting physiological data and, after having given their consent, they compiled the trait STAI-Y and a brief questionnaire about personal details and the time they spent playing videogames on a daily basis during the previous week. Their arterial pressure and pulse were then measured, in a sitting position, every 5 minutes for a total of three times and the average of the three measurements was taken as the basal value. At the end, the subjects were randomly assigned the violent (group 1) or non-violent (group 2) videogame.

In the second session, subjects were called two at a time into the leisure club and asked to sit in front of a computer. The game they were to play, was explained to them as well as the duration of the game (20 minutes). Before beginning, three measurements of cardiovascular indexes were made, one every 5 minutes and the average of the three measurements was taken as the 'pre-game value'. Subjects were then requested to complete the STAI-Y state anxiety scale and the BDHI. Afterwards, the game began. During the game, arterial blood pressure and pulse were measured after the fifth, tenth and fifteenth minute, and the average of the three measurements was considered as the 'value during play'. At the end of the game session, the subjects once again completed the STAI-Y state anxiety scale and the BDHI. The three phychophysiological measures were then taken at intervals of 5 minutes and the average of the three measurements was taken as the 'post-game value'.

Design and statistics

Data taken in the first session from subjects who had been assigned the violent videogame were compared with those from subjects assigned to the non-violent game. For the data collected in the game session, a bifactorial design was used, with one factor fitted between the subjects (violent game versus non-violent game), and one factor fitted within the subjects (pre-game values, values during play and post-game values for the physiological measures; pre-game values and post-game values for the psychological measures). A MANOVA (SPSS-10 package) was used for the statistical analysis of the data.

Results

The comparison between the pre-evaluation data of the two groups of subjects did not result in any significant differences regarding either cardiovascular measures (arterial blood pressure and heart rate), or psychological measures (trait anxiety), and the average time spent playing videogames daily (Table I). In addition, for both groups, there was no significant difference between the first pre-evaluation session in the pre-game situation and in the experimental session for cardiovascular measures.

Table II shows the data concerning the experimental session. The MANOVA of the physiological measurements made during the experimental session showed a significant difference between the systolic blood pressure values in the three pre-, during and post-game measurements ($F = 9.092$; df = 2, 19; $p = 0.002$), giving higher pressure values while playing compared to the other two time points (pairwise comparisons, $p = 0.05$), and a significant interaction between the time variable and the type of game ($F = 4.580$; df = 2, 19; $p = 0.024$). This reflected an effect present only in the group of subjects that used the violent videogame (Figure 1). No significant differences were found between the average heart rate values in the three measure-

Table I. Pre-evaluation mean of the two groups for the time spent playing the game, trait anxiety and cardiovascular measures.

	Game-time	STAI-Y-trait	SBP	DBP	HR
GROUP 1	118.82 ± 50.81	39.8 ± 9.9	123.5 ± 7.9	67.2 ± 0.4	77.1 ± 8.2
GROUP 2	117.27 ± 45.90	37.9 ± 6.7	124.4 ± 6.9	68.5 ± 5.7	78.4 ± 9.3

Note: SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate.

Table II. Means (standard deviations in parentheses) of the two groups during the experimental session for the BDHI total score and for each of the eight subscales and the cardiovascular measures.

		BDHI									STAI–Y State	SBP	DBP	HR
		PA	IH	I	N	R	S	VH	FG	TOT				
Group 1	Pre-game	6.6 (2.2)	5.1 (2)	6.7 (2.6)	3.1 (1.2)	3.7 (1.6)	3.3 (1.3)	8.7 (2.1)	3.7 (2.5)	41.2 (12.5)	33.7 (10.3)	122.2 (7.9)	68.8 (7.6)	72.2 (6.8)
	Game											128.3 (7.9)	70.1 (7.9)	79.5 (8.9)
	Post-game	7.0 (2.2)	5.2 (1.8)	6.9 (2.3)	3.0 (1.2)	4.2 (1.9)	4.0 (2.2)	9.3 (1.3)	3.2 (2.0)	43.2 (11.2)	38.9 (10.1)	122.2 (9.9)	66.5 (9.1)	76.7 (8.6)
Group 2	Pre-game	5.4 (2.6)	4.6 (1.6)	5.6 (2.6)	3.0 (1.3)	2.6 (1.9)	3.2 (1.6)	8.3 (2.4)	2.4 (1.8)	35.4 (11.3)	33.7 (10.1)	121.1 (5.5)	67.8 (9.4)	78.3 (11.2)
	Game											120.4 (6.3)	65.3 (9.9)	80.8 (13.6)
	Post-game	5.3 (2.5)	4.4 (1.9)	5.6 (3.0)	3.0 (0.9)	2.8 (1.9)	3.0 (1.8)	8.0 (2.4)	2.6 (1.6)	35.0 (11.6)	33.3 (7.5)	118.5 (5.5)	63.0 (11.4)	80.0 (9.3)

Note: PA, physical aggressiveness; IH, indirect hostility; I, irritability; N, negativism; R, resentment; S, suspiciousness; VH, verbal hostility; FG, feelings of guilt; TOT, total.

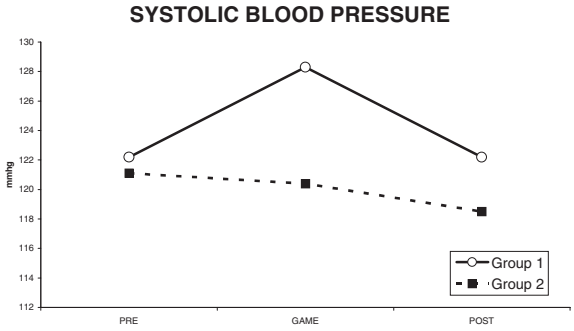

Figure 1. Systolic blood pressure of the two groups (group 1: violent videogame; group 2: non-violent videogame) in the pre-game, game, and post-game periods.

ments, whereas a significant effect was found in the time variable for diastolic blood pressure (F = 3.386; df = 2, 19; p = 0.04), regardless of the type of videogame, giving a reduction after the game as compared to the pre-game measurement (pairwise comparisons, p = 0.01).

The MANOVA of the psychological measurements showed a significant difference between pre-game state anxiety values as compared to post-game values (F = 7.012; df = 1, 20; p = 0.015) and a significant interaction between the time variable and the type of game (F = 9.289; df = 1, 20; p = 0.006), which showed an increase in state anxiety only after playing the violent videogame (Figure 2). However, there were no significant differences between the pre- and post-game values in the BDHI scales.

Discussion

The results of our study showed a diverse short-term effects of playing a violent compared to a non-violent videogame on arterial pressure and on the state anxiety of subjects, but not on hostility measurements. More specifically, the group that played a violent videogame showed a significant increase in state anxiety score at the end of the game as compared to the pre-game self-

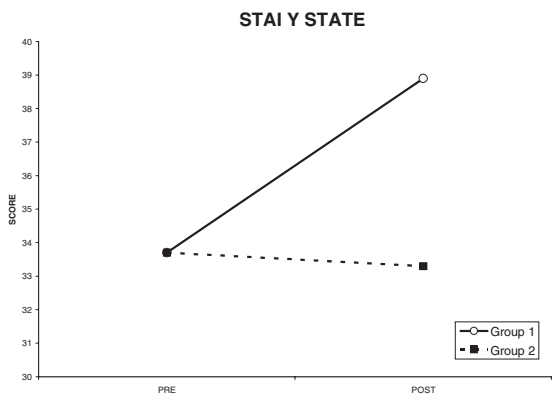

Figure 2. State anxiety scores of the two groups (group 1: violent videogame; group 2: non-violent videogame) before and after the game.

evaluation. They also showed an increase in systolic blood pressure while they were playing as compared to pre- and post-game values and a decrease in diastolic blood pressure after playing as compared to levels before playing. By contrast, the group who played the non-violent game showed a decrease only in diastolic blood pressure after the game as compared to the pre-game values. Neither group showed significant effects on the pulse or on the scores in the BOHI scales.

The possible elicitation of aggressiveness by violent videogames is still a controversial topic (Dill & Dill, 1999). As far as short-term effects are concerned, two recent and well-devised laboratory studies carried out by Ballard and Weist (1996) and by Anderson and Dill (2000) found effects of violent videogames on hostility scores and cardiovascular reactivity in the former, on thought accessibility and aggressive behaviour, but not on hostility scores in the latter. In both cases, the researchers concluded on the relative risk that playing violent videogames can have on the increase on hostility in subjects by the end of the game.

Although our data shows a range of effects of playing a violent videogame rather than a non-violent game, it does not fully support this concern with regard to habitual, expert players. The effects we found in our sample are limited, on a psychological level, to an increased anxiety score at the end of the game, without significant variations in hostility scores, and on the physiological side, to an increase in systolic blood pressure only while playing with a rapid return to pre-game values once the game was over. Therefore, even though a grim concern of the present research is the relatively small sample size (and its implications for the generalization of results), we conclude that while playing a violent videogame, rather than the non-violent game, there is a physiological activation (perhaps connected to increased motor activity) while playing and an increased emotional involvement which remains after the end of the game. It should also however be pointed out that Ballard and Weist (1996) in their study used a small, selected number of items in the BDHI, and that Anderson and Dill (2000) showed effects of playing the violent videogame on indirect hostility measurements and only in players who subsequently to the game had lost a competitive test of reaction times. These methodological differences may give different conclusions from ours. Nevertheless, we feel it is important that all our players finished the game successfully or, in other words, they were not frustrated by their lack of skill. A similar study by Anderson and Dill (2000), which shows that having played a violent videogame produces effects on aggressive behaviour only after frustration, supports our findings.

Actually, whilst the games in our research differed in terms of violence, they also seemed to differ in terms of level of excitement, intellectual stimulation, interest and competitive drive. Because of its active, creative nature, video game play could be expected to have particularly strong relationship between simple frequency of video game use and lower empathy. In fact, relationships between lower empathy and social maladjustment and aggression in youth have also been found (Boldizar, Perry, & Perry, 1989; Cohen & Strayer, 1996). Moreover, the use of experienced videogame enthusiasts as opposed to inexperienced players as a sample may add additional information.

However, much more work is needed to identify who is at most risk for negative impact and under what conditions negative outcomes are most likely. Future research should examine relationships between several indices of empathy, social maladjustment and desensitization and all potential sources of violence exposure in real-life and in the media, and should address causality.

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