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Mortal Kombat (tm): The Effects of Violent Videogame Play on Males' Hostility and Cardiovascular Responding

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ABSTRACT

We examined cardiovascular (CV) reactivity and hostility among 30 male undergraduates after either nonviolent (billiards) or 1 of 2 levels of violent videogame play. Violence varied among 2 versions of the game Mortal Kombat (MKl = less violent, MK2 = more violent)-all other factors (graphics, sound) were held equal. As expected, increased game violence elicited greater CV reactivity and higher scores on hostility measures. Subjects who played MK1 or MK2 had higher heart rate reactivity than those who played billiards. Subjects who played MK2 showed greater systolic blood pressure reactivity than those who played MKl or billiards. Finally, subjects who played MK2 scored higher on the hostility measures than those who played MKl, who in turn scored higher than those who played billiards. These results indicate that the level of videogame violence, not just violence per se, should be of concern to consumers.

The success of the videogame Mortal Kombat (tm) fueled a controversy over violence in the *$6* billion a year U.S. videogame industry (Elmer-Dewitt, 1993; Fitzgerald, 1994). Mortal Kombat was the best selling martial-arts game of 1993 (Fitzgerald, 1994). The game includes characters that can kill or be killed by electrocution, ripping out the heart, or decapitation with a quivering spinal cord attached (Elmer-Dewitt, 1993; Sandler, 1993). Entering a "secret code" intensifies the level of violence so that the graphic effects include gushing blood. When a violence warning was implemented for Mortal Kombat, there was a simultaneous increase in sales (Goldstein, 1994). Makers introduced more violent versions of Mortal Kombat to the video market in 1994 and 1995.

Concerns about the impact of interactive exposure to violence have increased over the last decade. Many parents view videogames more positively than television (Sneed & Runco, 1992), perhaps because videogames require multimodal information processing and coordinated motor responses (Braun & Giroux, 1989) or because parents are unfamiliar with game content. Spiraling videogame violence, coupled with high-quality graphics and sound, rekindles the disquietude many adults feel about the games their children are playing. This study focuses on how differing levels of videogame violence affect the hostility and cardiovascular (CV) reactions of undergraduate males.

VIDEO VIOLENCE AND AGGRESSION

The association between television violence and aggressive behavior in children is well documented (e.g., Parke & Slaby, 1983). One might expect similar effects of videogames, 71% of which contain some violence or antisocial activity (Braun & Giroux, 1989). Silvern and Williamson's (1987) findings suggest that videogames and violent TV similarly arouse children. Both increase children's aggressive behavior in comparison to a control group, but did not significantly differ from one another. However, whereas TV viewing is a passive pastime, videogame players actively mete out and receive destruction and death (Cooper & Mackie, 1986). Thus the likelihood of negative sequelae following arousing, violent videogame play seems likely. Experimental evidence indicates that playing violent games increases hostility. Anderson and Ford (1986) found that subjects who played either a highly or mildly violent videogame reported significantly more feelings of hostility on an adjective checklist than a no-videogame control group. Those who played the highly violent game were more anxious than subjects in the other two groups (Anderson & Ford, 1986). Cooper and Mackie (1986) found that girls, but not boys, displayed higher activity levels and played more with an aggressive toy after playing an aggressive videogame than after playing nonaggressive videogames. Neither Cooper and Mackie (1986) nor Winkel, Novak, and Hopson (1987) found an effect of videogame content on aggressive behavior toward others.

Schutte, Malouff, Post-Gorden, and Rodasta (1988) found evidence of a social learning effect of videogames on aggressive behavior. Children who played a jungle-themed videogame were more likely to play with a jungle toy, while children who played a violent karate videogame were significantly more aggressive (e.g., modeling karate moves) in their play. Further, Chambers and Ascione (1987) and Silvern and Williamson (1987) reported that videogame aggression increased aggression and decreased prosocial behavior.

VIDEOGAMES AND CV REACTIVITY

The relation between videogame play and CV (e.g., heart rate, systolic blood pressure, and diastolic blood pressure) reactivity is important because physiological arousal and reactivity are related to aggression and other behavior problems (e.g., Andreassi, 1980; El-Sheikh, Ballard, & Cummings, 1994; Sales, 1971; Zuckerman, 1990). Kubey and Larson (1990), who gathered data about children's day-to-day activities, found that children report significantly more arousal from videogame play than from television. Increased arousal and hostility from videogame play may in turn increase the likelihood of aggressive behavior (Schutte et al., 1988; Silvern & Williamson, 1987). And, as evidenced above, research indicates that this is the case.

Although a few studies (e.g., Winkel et al., 1987) failed to find effects of videogame play or content on CV responding, most of the published research indicates that videogames do affect CV responding. Most people demonstrate increased heart rate (HR) and blood pressure (BP) to challenging videogame play (e.g., Larkin, Manuck, & Kasprowicz, 1989; Larkin, Zayfert, Abel, & Veltum, 1982). But, Murphy, Alpert, Willey, and Somes (1988) found that some children were hyporeactive (low physiological reactivity) to a videogame challenge, whereas other children were hyperreactive (high physiological reactivity). Suarez and Williams (1990) found that negative emotions (anger, hostility) were positively correlated with CV reactivity, especially among adults with higher hostility scores. Treiber et al. (1991) found that scores on hostility measures were related to BP reactivity to videogames in children. In addition, systolic blood pressure (SBP), in particular, is significantly related to reported levels of hostility, while diastolic blood pressure (DBP) is not (Felsten & Leitten, 1993; Lawler, Harralson, Armstead, & Schmied, 1993). And, Matthews, Rakaczky, Stoney, and Manuck (1 987) found that responding to behavioral stressors, including videogames, was stable across stimuli and across time among children.

The literature cited above provides evidence that some videogames may negatively influence children's behavior. Yet, while the impact of videogame play and videogame content has been examined substantively, there has been no research on how varying levels of violent videogame play affect the player. To provide clear guidelines for videogame monitoring, we must have a better understanding of (a) the impact of various types of games and (b) the impact of varying levels of game violence. In this study, we compare a nonviolent videogame to two levels of violence within the same videogame. We examine the impact of these games on hostility and CV responding among young adult males, a population that is heavily involved in videogame play but that has not been adequately examined.

We did not use a sample of females in this study since (a) most videogames are male oriented (Braun & Giroux, 1989; Braun, Goupil, Giroux, & Chagnon, 1986), (b) boys frequent video arcades and play videogames significantly more often than do girls (Braun et al., 1986; Funk, 1993), and (c) this gender gap widens with age (Kubey & Larson, 1990) at least until the undergraduate years (Temple & Lips, 1989). Thus, although females' responses to videogame play have not been studied as extensively as males', the responses of undergraduate females to the games under investigation may have little practical application.

We chose to use CV reactivity as a dependent measure in this study because it is a good measure of arousal and because there is a relation between SBP and hostility. Even though DBP reactivity has not been strongly associated with hostility, it was included as a dependent variable in the study since the data were available. While a behavioral measure of aggression or hostility would have been ideal, we used questionnaire measures of hostility in this study due to time and space restraints.

We expected to find differences in CV reactivity (HR, SBP) and on hostility measures as a function of the level of violence in the videogame played. Specifically, we expected to find that subjects would display greater physiological arousal and higher levels of hostility with increasing game violence. In addition, we expected that levels of hostility and CV reactivity would be positively correlated, with the strongest relationship between SBP and hostility.

METHOD

Subjects

Thirty male undergraduates from Appalachian State University, a moderately sized liberal arts university, served as participants in the study. The subjects ranged in age from 18-23 (*M* = 19.53) and were primarily freshmen (*N* = 16), with some sophomores (*N* = 4), juniors (*N* = 5), and seniors *(N = 5).* One subject was African American; the remainder were Caucasian. Most of the subjects reported playing videogames on a regular basis-67% reported that they play from 1 to *5* hr per week, and 13% reported that they play from *5* to 10 hr per week. Some (20%) subjects reported that they do not play videogames on a regular basis. The subjects preferred combat (52%) and sport (45%) games over other types of videogames. Ten subjects were randomly assigned to each of three treatment conditions. Subjects received extra credit or completed a class requirement by participating. Subjects who attended a follow-up session (*N* = 27), during which additional baseline measures were gathered, received a *$5* stipend.

Measures and Materials

Videogames. A Sega Genesis (tm) computer videogame system was used for the videogame stimuli. Two videogames-a billiards game and a fighting game-were used. The billiards game, Corner Pocket (tm), is a game of skill (aiming the cue ball and shooting) that contains little action. It was used as the nonviolent videogame control. Mortal Kombat (tm), a game of skill and violent action (punching, kicking, blocking, feinting, moving), can be played at two levels of violence. Thus, there were built-in controls for difficulty, game characters, graphics, sound, et cetera, with only the level of violence varying between the two versions of Mortal Kombat. In Level 1 the combatants kick, punch, electrocute, et cetera one another until one has been killed. Level 2 contains similar actions, but the aggressive moves are accompanied by spurting blood and gore. The subjects played the game for 10 min, regardless of condition.

Physiological measures. SBP, DBP, and HR were monitored using an automatic electro-sphygmomanometer and an adult sized BP cuff positioned on the nondominant arm. One BP measure was taken to allow the subject to adapt to the cuff. Then, *2* min later, a pregame baseline was gathered. A postgame measure was taken immediately after the subject completed playing the game. Subjects returned several days later and five additional baseline measures were taken 2 min apart. The separate baseline measures were gathered because there is some evidence that it is difficult to obtain an accurate baseline on the same day as the experimental procedure (e.g., Krantz & Manuck, 1984). However, while the pregame baseline was a significant covariate, the separate baseline measures were not. So, the pregame baseline was used as the covariate in analyses.

Hostility measures. The subjects completed a hostility questionnaire following videogame play. The primary component of the hostility questionnaire was composed of items from the Adjective Checklist (ACL). The ACL contains 300 adjectives comprising 24 subscales. However, for this study we used the 75 items that comprise the defensiveness, dominance, aggression, self-confidence, nurturance, and autonomy subscales. The remaining 18 subscales, such as counseling readiness and heterosexuality, were not included in the study. The ACL is reliable *(rs* range from *.65* to *.76;* Fekken, 1984). Heilbrun (1958) demonstrated concurrent validity between the ACL and the Edwards Personal Preference Scale.

In addition, several items from the Bell Adjustment Inventory (BAI) and the Buss-Durkee Hostility Inventory (Buss, 196 1) were administered. These items were interspersed to reduce any demand characteristics. The BAI is composed of 200 yeslno response questions and includes six subscales-home adjustment, health adjustment, masculinity-femininity, emotionality, submissiveness, and hostility. Only the hostility and submission subscales were used in this study. The hostility subscale was used in data analysis, while the items from the submissiveness subscale were used as distractors. The BAI is reliable *(rs* > .80; Sarbin, 1953) and valid for use with college samples *(rs* > .80; Sarbin, 1953).

Finally, subjects answered 17 items, drawn at random, from the Buss-Durkee Hostility Inventory, a 64-item true-false measure. Since reliability and validity data on the BAI are dated, a limited number of items from the Buss-Durkee were used as a reliability check. The correlation between the two scales was *.85,p* < .001. The Buss-Durkee was not used in its entirety so that the procedure could be kept at a reasonable length. The Buss-Durkee was constructed to minimize social desirability response bias (e.g., Edwards, 1953) and its reliability and validity are well accepted (e.g., Bushman, Cooper, & Lemke, 1991).

Procedure

Upon arriving at the laboratory, subjects read and signed an informed consent form and filled out a demographic questionnaire. They were told that we were examining the effects of videogame play. Research assistants (RAs) who were blind to the hypotheses and purposes of the study ran the subjects individually. Subjects sat in a recliner in an attractive laboratory room equipped with a color TV monitor and the Sega Genesis (tm) videogame system. The RA gathered adaptation CV measures before demonstrating the randomly assigned videogame to the subject. The subject was given brief instructions for the game and was then allowed to play either Billiards, Mortal Kombat Level 1, or Mortal Kombat Level 2 for 10 min. Subjects' BP and HR were monitored again immediately after cessation of play. To decrease the possibility that the subjects would link playing the videogame with completing the hostility questionnaires, they were led to believe that they had completed participation in the videogame study. They were then invited to participate in a "second" brief study to receive further credit. All of the subjects agreed to participate in the second study and read and signed another consent form. This process was aimed at decreasing the possibility of demand characteristics. Finally, subjects completed the hostility measures. Upon completion of this session, the subjects were fully debriefed. They were scheduled to return to the laboratory so that baseline measures could be gathered.

RESULTS

Cardiovascular Data

The postgame (SBP, DBP, and HR) data were analyzed using a one-way multivariate analysis of covariance (MANCOVA), with the pregame measure as the covariate and video condition (billiards, Mortal Kombat Level 1, or Mortal Kombat Level 2) as the independent variable. (The separate baseline did not serve as a significant covariate in the analyses, whereas the pregame measure did. Thus, the pregame measure was used as a covariate in the analysis of the CV data.) With an alpha level of .05 set for all analyses unless otherwise noted, the MANCOVA was significant for video condition, Hotelling's $F(2, 42) = 3.16$, $p < .01$. The univariate follow-up test for DBP was not significant, but those for SBP and HR were and are discussed fully below. See Table 1 for means adjusted for the baseline and standard deviations.

Table 1

Means for Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Heart Rate (HR) by Video Condition

CV measure	Video condition: Billiards	Mortal Kombat Level 1	Mortal Kombat Level 2
SBP	125.70 (121.15)	126.00 (9.99)	132.20 (5.22)**
DBP	73.60 (11.48)	734.20 (12.47)	77.90 (12.10)
HR	64.10 (16.46)	72.20 (11.16)	72.30 (10.30)**

Note. All means are adjusted for baseline values. True standard deviations are in parentheses.
** $p < .01$.

Systolic *blood* pressure *(SBP).* The follow-up one-way ANOVA yielded a significant effect of video condition on SBP, $F(2, 24) = 4.88$, $p < .02$. *T* tests, rather than Tukeys, were used so that the baseline could be included as a covariate. These tests indicate that the subjects who played the most violent level of Mortal Kombat had significantly higher postgame SBP than the subjects who played either the milder level of Mortal Kombat, $t(26) = 2.89$, $p < .01$, or the billiards game, $t(26) = 2.70$, $p < .02$. The milder level of Mortal Kombat did not elicit higher SBP than the billiards game.

Table 2

Means and Standard Deviations for Buss-Durkee Hostility Inventory, Bell Adjustment Inventory, and Adjective Checklist by Video Condition

Hostility measure	Video condition: Billiards	Mortal Kombat Level 1	Mortal Kombat Level 2
Buss-Durkee	31.90 (6.97)	59.30 (7.41)	73.80 (10.62)***
Bell	31.60 (9.51)	46.70 (11.19)	81.10 (12.21)***
Adjective Checklist	1.00 (0.32)	30.00 (1.94)	63.00 (1.34)***

Note. Standard deviations are in parentheses.
*** $p < .001$.

Heart rate *(HR).* There was also a significant effect of video condition on HR, F(2,24) = 6.20, *p* < *.O* 1. In this case, both levels of Mortal Kombat-high: t(26) = 3.19, p < .01; low: t(26) = 2.80, p < .0l-were related to significantly higher HR than the billiards game. However, the two levels of Mortal Kombat did not differ significantly.

Hostility Data

The hostility (Buss-Durkee Hostility Inventory, BAUACL) data were analyzed using a one-way multivariate analysis of variance (MANOVA) with video condition (billiards, Mortal Kombat Level 1, or Mortal Kombat Level 2) as the independent variable. The MANOVA was significant for video condition, Hotelling's *F(6,* 48) = 43.24, p < ,001. Each of the univariate follow-up tests was also significant and is described in detail below. See Table 2 for means and standard deviations for each measure by each video condition.

Adjective Checklist (ACL). A one-way ANOVA indicates that subjects' scores on the ACL varied significantly depending on the videogame played, F(2, 27) = 50.95, p < .001. Post-hoc Tukeys (since covariate analyses were not used, the more stringent Tukeys were used rather than *t* tests to follow up the hostility data) show that subjects who played the more violent level of Mortal Kombat had significantly higher scores on the ACL than subjects who played the milder level of the game. Subjects who played Mortal Kombat, regardless of level, also scored higher on the ACL than did subjects who played the billiards game (all ps < *.05.)*

Table 3

Correlations Between Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Heart Rate (HR), Adjective Checklist (ACL), Bell Adjustment Inventory, and Buss-Durkee Hostility Inventory

Measure	SBP	DBP	HR	ACL	Bell	Buss-Durkee
SBP	1.00	.32*	.19	.36*	.41*	.23
DBP	—	1.00	.03	.16	.13	.13
HR	—	—	1.00	.35*	.38*	.47**
ACL	—	—	—	1.00	.73***	.82***
Bell	—	—	—	—	1.00	.85***
Buss-Durkee	—	—	—	—	—	1.00

*$p < .05$. **$p < .01$. ***$p < .001$.

Bell Adjustment Inventory. Level of videogame played also affected subjects' scores on the BAI, $F(2,27)= 52.92$, $p<$ .001. As with the ACL, Tukey tests show that the scores of subjects in each condition differed significantly from those in the other two conditions (all ps < .05).

Buss-Durkee. Consistent with the above findings, subjects' scores on the Buss-Durkee differed significantly, depending on which videogame they played, $F(2, 27) = 62.80$, $p < .001$. Tukey tests indicate that subjects who played the milder version of Mortal Kombat had significantly higher scores than those who played the billiards game. Further, subjects who played the more violent version of Mortal Kombat has significantly higher scores than did subjects who played either the billiards game or the milder version of Mortal Kombat (all ps < .05).

Correlations Between Cardiovascular Reactivity and Hostility

To calculate correlations between the CV data and scores on the hostility measures, change scores (pregame CV measure-postgame CV measure) were calculated for the HR, SBP, and DBP data. HR change from pre- to post-game was significantly positively correlated to all three hostility measures (see Table *3* for *r* and p values); hostility and HR increased concurrently. And, SBP change was significantly positively correlated to scores on the BAUACL. However, DBP change was not significantly related to any of the hostility measures. In addition, scores on all of the hostility measures were significantly positively correlated.

DISCUSSION

As expected, higher levels of videogame violence elicited greater CV reactivity and higher scores on hostility measures. Most importantly, within the Mortal Kombat game, the higher level of violence elicited greater SBP reactivity and more hostility than did the less violent version of the game. Arguably, these results could indicate that the more violence contained in a videogame, the greater the potential for negative outcomes, such as aggressive behavior. If so, videogame makers and parents should be alerted to the possible detrimental effects of videogame violence on players and adjust videogame design and monitoring of videogame play accordingly.

While, idealistically, one might hope that game makers will act responsibly with videogame production and marketing, this prospect seems unrealistic given the money-making potential of violent video products. Thus, parents, educators, and other caregivers will most likely carry the burden of ensuring that children's consumption of video products does not threaten their wellbeing. The task of educating the public without either promoting semi-hysteria among parents or creating a backlash among youngsters (i.e., enhancing the desirability of the games by making them forbidden) will be a difficult one. Nonetheless, the public should be aware of the possibility of negative sequelae of violent game play, including increased CV reactivity, hostility, behavioral aggression (Schutte et al., 1988), and activity levels (Cooper & Mackie, 1986) and decreased prosocial behavior (Chambers & Ascione, 1987; Silvern & Williamson, 1987).

Several factors not considered in the current study must be taken into account before definitive recommendations are made. First, subjects were exposed to the game for a brief time. Longer exposure could result in one of two possible outcomes: (a) sensitization whereby the effects of violent videogame play are even more pronounced or (b) desensitization whereby the player habituates to the violence of the game. Further, even extended videogame play in the laboratory might fail to replicate the effects of chronic videogame play. Future investigations could examine the effects of violent videogame play on habitual versus occasional game players. Second, developmental status should be considered. Videogame violence may have varying effects on the player as a function of developmental status. Third, more attention should be focused on gender differences in response to videogame play. Finally, we only examined self-reported hostility following videogame play. To determine if varying levels of video violence differentially affects overt behavior, direct measures of behavioral aggression and hostility should be gathered.

In addition to the findings that CV reactivity and hostility increase with the level of violence in the video game played, we also found that CV reactivity and hostility were significantly correlated. These correlations strengthen the conclusion that the noted changes are indeed the result of varying levels of videogame violence. As in the present study, SBP has often been found to correlate with measures of hostility (Diamond, 1982; Felsten & Leitten, 1993; Lawler et al., 1993). This leads to another question-Do violent videogames increase arousal, thereby increasing both CV and hostility, or do violent videogames increase hostility which in turn increases CV reactivity? In the same vein, another avenue for research on the effects of videogame violence is to examine the correlation between videogame preference and basal arousal. There is evidence that sensation seekers have lower basal arousal than those who are not sensation seekers (e.g., Sales, 1971; Zuckerman, 1990). Sensation seekers are thought to seek out stimulating activities to achieve a higher, more optimal level of arousal, while those with high basal arousal seek to decrease stimulation (e.g., Kohn, 1987; Zuckerman, 1990).

A few limitations in the study should be acknowledged. First, the sample consisted of a homogeneous, White male college population. Thus, the results might not generalize to those outside this demographic profile. Second, the sample size is relatively small and should be increased in future studies. However, the magnitude of the effects suggests that the findings are quite robust. The stimuli and measures used could also be improved. First, due to time restraints, we used only a portion of each hostility measure. In the future, it might be better to use the entire measures rather than subscales. However, the significant correlations between the hostility measures used bespeaks their reliability in this study. Second, the billiards game differed from the Mortal Kombat game not only in regard to the level of violence involved, but in regard to the level of action. Future studies should use a game that is both active and nonviolent as a control. Further, the Mortal Kombat game requires more movement than does the billiards game, creating the potential for movement artifact. However, the finding that CV reactivity and hostility differed from one level of Mortal Kombat to the other indicates that the level of violence per se, not simply action level, affected responding. However, there is no clear explanation as to why differing patterns were found in regard to HR versus SBP in terms of responding to the videogames.

The lack of significant findings for DBP is not especially surprising. CV reactivity is not a singular phenomenon. Different CV responses (e.g., SBP and DBP) are independent or at least only moderately correlated (e.g., Ballard, Cummings, & Larkin, 1993; Gunnar, 1987). In addition, SBP has more commonly been related to measures of hostility than has DBP (e.g., Lawler et al., 1993).

In summary, the data presented indicate that the level of violence, per se, in videogames has a direct impact on young adult males' CV reactivity and feelings of hostility. Thus, it is possible that males who frequently engage in violent videogame play may be at higher risk for negative outcomes, including hostile and aggressive behavior.

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