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EMPIRICAL RESEARCH

The Effects of Media Violence on Anxiety in Late Adolescence

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Abstract Exposure to media violence is related to anxiety in youth, but the causality of the effect has not been established. This experimental study examined the effects of media violence on anxiety, blood pressure, and heart rate in late adolescents. We also examined whether these responses varied by previous exposure to media and real-life violence. College students (N = 209; M age = 18.74; 75 % female; 50 % Caucasian, 34 % African American, 9 % Asian, 3 % Hispanic, and 3 % other racial minorities) were randomized to view either violent or nonviolent high-action movie clips. Participants reported on their anxiety before and after watching the clips, as well as their previous exposure to violence. Measures of blood pressure and heart rate were taken at baseline and during movie viewing. Participants watching violent movie clips showed a greater anxiety increase than those watching nonviolent clips. Both groups experienced increased blood pressure and reduced heart rate during movie watching compared to baseline. Prior exposure to media violence was associated with diminished heart rate response. Additionally, students previously exposed to high levels of real-life violence showed lower blood pressure increases when watching violent clips compared to nonviolent clips. Thus, relatively brief exposure to violent movie clips increased anxiety among late adolescents. Prior exposure to media and real-life violence were associated with lower physiological reactivity to high-action and violent movies, respectively, possibly indicating desensitization. Future studies should investigate long-term anxiety and physiological consequences of regular exposure to media violence in adolescence.

Keywords Media · Violence · Anxiety · Reactivity · Late adolescents

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Introduction

Adolescents' exposure to media violence is a major public health problem in the US. The average US adolescent spends over 20 h a week watching television (Rideout et al. 2010), with 61 % of television programs and 91 % of films involving violence (Anderson et al. 2003; Worth et al. 2008). Exposure to violent media further increases in late adolescence and emerging adulthood, when youth watch close to 30 h of television a week (Center for Research Excellence 2009), receive less parental supervision (Chen et al. 2007), and have access to more violent R-rated movies (Motion Picture Association of America 2013). The detrimental effects of media violence on aggressive behavior have been well documented (Anderson et al. 2003; Huesmann and Taylor 2006), but less studied are the effects of media violence on anxiety. The depiction of violence may increase anxiety by making the world seem more hostile and crime-ridden (Morgan and Shanahan 2010; Nabi and Riddle 2008). In turn, anxiety impairs functioning through both its primary symptoms (e.g., sleep disturbances and concentration difficulties; American Psychiatric Association [*DSM-IV-TR*] 2000) and development of secondary

problems (e.g., depressive symptoms and substance use; Marmorstein et al. 2010; Starr and Davila 2011).

Exposure to media violence may be especially problematic in late adolescence. Television and other media play a major role in adolescent socialization and identity development by providing perspectives, values, ideologies, and behavior models (Arnett 1995; Gerbner 1998; Roberts et al. 2005). The socializing role of television in particular may be amplified by the large amount of time young people spend with this medium. Specifically, 18- to 24-year-olds spend more time watching television and movies than younger youth (Center for Research Excellence 2009), and they spend more time watching television and movies than interacting with parents or educators (American Academy of Pediatrics 2001). Of major concern, a substantial portion of television programs and movies contains media violence, defined as "visual portrayals of acts of physical aggression by one human against another" (Huesmann and Taylor 2006, p. 395). Thus, media violence, as conceptualized in the present study, encompasses the depiction of *intentional* acts of violence from one individual to another, rather than accidental harm. In fact, 61 % of television programs (Anderson et. al. 2003) and 91 % of the films shown on television (Worth et al. 2008) portray violence prominently. During primetime television viewing, when people are most likely to watch television (Smith et al. 2002), three to five violent acts are shown per hour (Browne and Hamilton-Giachritsis 2005). Given the high prevalence of violence on television and in movies, it is likely that late adolescents have substantial exposure to this content.

The possible effects of televised violence on anxiety also may be particularly detrimental for late adolescents attending college. Anxiety symptoms involve difficulties in concentration, worry, fatigue, irritability, and muscle aches and soreness (American Psychiatric Association [*DSM-IV-TR*] 2000), which may negatively impact academic work, relationships, and physical health. Anxiety symptoms and disorders (e.g., PTSD and GAD) are as common among college students as they are in the general population (Eisenberg et al. 2007; Schnider et al. 2007). Anxiety developed in childhood typically persists into late adolescence and adulthood (Degnan et al. 2010), but new adjustment problems also emerge for some well-adjusted youth during the late adolescent transition into emerging adulthood (Schulenberg et al. 2004). One contributing factor to the emergence of psychopathology at this time is the interruptions in social support networks that often accompany the move from home to college. Because social support and a feeling of belonging are key factors in helping college students to overcome challenges (Haussmann et al. 2007), disruptions in these supports may make it more difficult for late adolescent college students to manage stress and anxiety. Thus, late adolescence presents a vulnerable period for the continuation of preexisting anxiety symptoms as well as the development of anxiety. In turn, anxiety in college students is associated with long-term negative outcomes, such as reduced educational attainment, substance dependence, and earlier parenthood (Woodward and Fergusson 2001).

Although the causal effects of exposure to media violence on anxiety have not been studied experimentally, correlational studies have linked exposure to media violence with increased anxiety in both children and adolescents (Cooley-Quille et al. 2001; Singer et al. 1998; Valkenburg and Buijzen 2008). In one retrospective study, college students reported long-lasting fears and anxiety symptoms from a violent movie or television program they had watched in the past (Harrison and Cantor 1999). However, experimental studies are needed to establish a clear causal link between media violence and anxiety. One of few experimental studies on this topic found increased levels of state anxiety in adolescent males assigned to play a violent computer game, compared to those who were randomized to play a nonviolent computer game (Baldaro et al. 2004). However, no research has examined causal relationships between exposure to violent television shows and movies and self-reported anxiety. Studies examining related constructs found elevated heart rate and blood pressure in response to violent movie clips (Hayashi et al. 2009; Kreibig et al. 2007) that could be indicative of anxiety. However, these studies compared physiological functioning during high-action violent clips to functioning during low-action non-violent scenes or at baseline, raising questions about the cardiovascular effects being due to violence versus high action. Because low-action fear-inducing clips had the opposite effect of decreasing heart rate (Jönsson and Hansson-Sandsten 2008), level of action in violent video clips is a serious confound that needs to be controlled in experimental studies of movie violence. Furthermore, the additional use of self-reported anxiety would be a valuable contribution to the media violence literature, as adolescent self-reports of anxiety in other realms (e.g., social anxiety) have high reliability and convergent validity (De Los Reyes et al. 2012).

Exposure to media violence may increase anxiety through the experience of threat. When watching violent movies that are highly realistic, individuals may feel a sense of threat. Threats typically cause immediate fear (Bear et al. 2007), but may also generalize to other times and situations, leading to more persistent anxiety symptoms such as worry, insecurity, and tension (Grillon 2008). Physiologically, perceptions of threat activate the central nucleus of the amygdala, which triggers the bed nucleus of the stria terminalis to activate the HPA axis in the hypothalamus, from which corticotropin-releasing hormone (CRH) is secreted. Increasing CRH levels trigger the release of adrenocorticotropic hormone by the pituitary gland, which then activates

the adrenal cortex to release cortisol (Bear et al. 2007) and the adrenal medulla to release catecholamines (epinephrine and norepinephrine; Schneiderman et al. 2005). These events lead to activation of the sympathetic nervous system, also known as the fight-flight response (Kreibig et al. 2007). The release of these catecholamines causes changes in blood pressure, heart rate, and vessel constriction (Taylor 2010), leading to increased heart rate, cardiac output, vagal withdrawal, and increased blood pressure. These adaptations serve to mobilize energy resources to enable individuals to escape dangerous situations and protect themselves (Kreibig et al. 2007). Therefore, if individuals feel threatened when watching violent movie presentations, they may exhibit physiological responses, such as elevated heart rate and blood pressure from resting levels. Additionally, they may feel worried or apprehensive of encountering violence in real life, and experience other subjective symptoms of anxiety.

An important issue to consider in studying the effects of media violence on anxiety is the possibility of desensitization, where prior exposure to media or real-life violence may decrease responses to subsequent violence. For instance, youth exposed to high levels of real-life violence showed diminished levels of general anxiety and distress (Mrug et al. 2008; Ng-Mak et al. 2004). Additionally, heavy television viewing in children was associated with lower fear reactions, which may be due to desensitization to violence and other frightening events portrayed on television (Walma van der Molen and Bushman 2008). Among older adolescents, prolonged exposure to movie violence led to less self-reported sympathy for victims' suffering, also indicating emotional desensitization (Fanti et al. 2009). Emotional desensitization to violence may be accompanied by physiological desensitization. For instance, greater exposure to community violence was related to children's lower resting cortisol levels and lower cortisol response to a video of community violence (Kliewer 2006). Since cortisol reflects the activity of the HPA axis, a major stress response system, both lower basal cortisol levels and lower cortisol reactivity to violence may indicate physiological desensitization to community violence. In a study using functional magnetic resonance imaging (fMRI), exposure to movie violence was associated with decreased activation of the lateral orbitofrontal cortex (lOFC), indicating reduced connection between aggressive cues and emotional reactions that may underlie emotional and physiological desensitization to violence (Strenziok et al. 2011). Thus, higher levels of prior real-life and media violence may desensitize youth to the effects of media violence on both anxiety and physiological reactions. Over time, this desensitization may result in greater tolerance of violence and more aggressive behavior (Ng-Mak et al. 2004).

Hypotheses

Given the high amount of televised violence viewed by late adolescents and the negative effects of anxiety on long-term outcomes in college students, it is important to determine whether televised violence increases anxiety in late adolescents attending college. In addition, it is important to examine whether previous exposure to media or real-life violence attenuates potential negative effects of televised violence on youth. The primary goal of this study was to determine whether media violence affects anxiety among late adolescents, and whether this effect is moderated by previous levels of exposure to violence. To identify causal effects of media violence on anxiety while avoiding the confound of high action level, we compared the effects of high-action *violent* movie clips versus high-action *nonviolent* movie clips. It was hypothesized that movie violence would lead to higher levels of anxiety and increased heart rate and blood pressure. Additionally, we hypothesized that these effects would be attenuated in individuals with higher levels of previous exposure to real-life and media violence.

Method

Participants

Participants were college students recruited from introductory psychology classes at a mid-sized public university located in a metropolitan area in the Southeastern US. The study was approved by the university institutional review board. The sample consisted of 209 students (mean age 18.74, SD .91, range 18–22 years old) and included 75 % females and 25 % males. The sample was racially/ethnically diverse, including 50 % Caucasian, 33 % African American, 10 % Asian, 3 % Hispanic, and 4 % other race/ethnicity students.

Design and Procedure

This experimental study employed a pretest–posttest control group design. Participants were randomized into the experimental group (n = 104), which watched violent movie clips, or the control group (n = 105), which watched nonviolent movie clips. Each group watched five movie clips selected from a larger pool of scenes based on the results of a pilot study. The pilot study tested a sample of 14 violent and 11 nonviolent clips using 10 undergraduate and graduate psychology students. The clips were selected to reflect different types of violent and nonviolent scenes, with main characters being diverse in their race, age, and gender. Each of the 10 participants independently

viewed and rated each clip on level of action, violence, and engaging nature using a 5-point rating scale from 1 ("not at all") to 5 ("extremely"). For the main study, five violent and nonviolent clips were selected to maximize differences in ratings of violence, while equating the clips on level of action and engagement. Paired-samples t-tests confirmed that the violent clips were perceived as more violent than the nonviolent clips ($M = 4.56$ vs. $M = 1.40$, $t = -16.80$, $p < .001$), but had comparable levels of action ($M = 3.94$ vs. $M = 3.70$, $t = -1.14$, $p > .05$) and engagement (3.98 vs. 4.00, $t = .10$, $p > .05$).

The selected violent clips came from the following movies: *Man on Fire* (2004), depicting a street shootout being witnessed by a child; *Platoon* (1986), showing an American soldier torturing a Vietnamese civilian with a firearm; *Precious* (2009), depicting a physical fight between mother and daughter; *Leon: The Professional* (1994), showing a bloody apartment shootout scene; and *Saving Private Ryan* (1998), featuring a physical knife fight between a German and American soldier. The nonviolent clips were selected from the following movies: *Speed* (1994), with a police crew helping passengers off a bus with a bomb on board; *Twister* (1996), depicting a family taking shelter from a tornado; *Crash* (2004), showing a policeman saving a woman from a burning car; and *Castaway* (2000), with two separate scenes used, one featuring a plane crash and one depicting a man rafting through turbulent ocean waves. Although the nonviolent clips included images of danger and potential harm, typical of high-action movies, the specific scenes did not explicitly include violence using our definition of *intentional* direct harm inflicted by one character upon others. The total duration of the clips in each condition was 11 min 34 s, with each clip lasting between 2 and 3 min each. The use of a 12-min clip sequence (as opposed to a full-length movie) is consistent with previous studies showing that brief clips are sufficient to elicit effects (e.g., Kreibig et al. 2007; Strenziok et al. 2011). In the present study, the clips and all questionnaires were presented to participants on a computer using the program MediaLab (Jarvis 2010).

Participants completed the study in individual sessions. After providing written informed consent, participants were left alone to complete computer questionnaires assessing their anxiety and prior exposure to real-life and media violence. After being connected to cardiovascular monitoring equipment by a research assistant, participants sat alone quietly for 10 min while baseline cardiovascular measures were taken. Participants then watched the five violent or nonviolent high-action movie clips in random order. After the last clip, participants completed a post-test anxiety questionnaire. In order to prevent any negative effects of watching the violent movies, all participants watched a neutral clip at the end of the session. Finally, participants were disconnected from the cardiovascular monitoring equipment and debriefed. All students received class credit for their participation.

Measures

Anxiety

Anxiety was measured with the 20-item State Anxiety scale from the State-Trait Anxiety Inventory (Spielberger et al. 1970). The items asked about worry, tension, apprehension, and nervousness experienced at the current time (e.g., "I feel at ease"). Items were rated 0 ("not at all") to 3 ("very much so") and summed ($\alpha = .89$ at pre-test and .94 at post-test). Change scores were obtained by subtracting pre-test (baseline) scores from post-test scores.

Exposure to Media Violence

Prior exposure to media violence was measured with two items inquiring about the amount of time spent watching television and movies ("How many hours per week do you spend watching TV/movies?") and two items assessing the frequency of violent content in television and movies (e.g., "How often do the TV shows/movies you watch show physical fighting, shooting, or killing?"). The general media use items were rated on a 6-point scale from "no time" to "15 or more hours per week". The responses were recoded to the midpoint of each time interval (0, 1.5, 4.5, 8.5, 12.5 and 15 h a week). The media violence items were rated 1 ("almost never") to 4 ("almost always"), or 0 ("I don't engage in this activity"). The TV and movie violence items were multiplied by the amount of time spent watching each medium and summed.

Exposure to Real-Life Violence

The Community Experiences Questionnaire (Schwartz and Proctor 2000) assessed lifetime exposure to violence. The measure includes 25 items assessing both witnessing violence (e.g., "How many times have you seen somebody else get hit, punched, or slapped?") and victimization (e.g., "How many times has somebody broken in or tried to force their way into your home?"). Items were rated from 0 ("never") to 3 ("lots of times") and summed. This instrument was initially developed for use in children, but it has been modified and used in young adult populations with good validity and reliability ($\alpha = .88$; Brady 2006). All items were summed to obtain a total score for overall exposure to violence, similar to analyses in previous studies (e.g., Brady 2006, 2007). In the present study, the reliability of the scale was .86.

Cardiovascular Reactivity

Heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) were measured with a Medwave Fusion monitor. A wrist cuff containing an internal sensor was situated on participants' left wrist, with the sensor above the radial artery measuring radial pulse amplitude. Heart rate was estimated based on the number of radial pulses, and SBP and DBP were estimated based on pulse wave-form properties (Hui et al. 2009). Cardiovascular measures were taken every 30 s through baseline and video clip presentation. Baseline HR, SBP, and DBP were computed by averaging readings during the last 2 min of the 10-min baseline period to allow enough time to achieve a true baseline resting state. Response HR, SBP, and DBP readings were averaged across the 11-min video clip viewing period in order to obtain overall measurement of reactivity to the violent or nonviolent clips. To facilitate interpretation of reactivity, change scores were calculated by subtracting baseline cardiovascular measurements from measurements taken during video clip presentation.

Control Variables

Students reported on their age, gender, race, highest parental education level, and the number of movie clips from their condition they had previously seen. Race was recoded as white ("0") or non-white ("1"). Parent education was coded on a 6-point scale from 0 ("Less than high school") to 6 ("Graduate degree").

Data Analytic Plan

Univariate distributions and bivariate associations of variables were examined; outliers for HR, SBP, and DBP were truncated at 3.5 SD from the mean. Prior to subsequent analyses, assumptions of normality were tested and met for all dependent variables. Overall changes from baseline to post-test on anxiety, SBP, DBP and HR were tested with paired samples t tests. The violent and nonviolent media groups were compared on all variables using t tests and Chi squared tests. The effects of media violence on anxiety and cardiovascular functioning were tested with multiple regressions. Change scores in anxiety, HR, SBP and DBP were regressed on media violence group (coded 1 for violent and 0 for nonviolent clips), using baseline scores for the outcome, age, gender, race, parental education, and the number of clips previously seen as covariates. Baseline scores were included in regression analyses as recommended to correct for regression to the mean (Twisk and Proper 2004). The moderating effects of previous exposure to violence were examined by adding previous exposure to violence (real-life or media) to each regression in Step 2, and its interaction with group to Step 3. Because prior exposures to real-life and media violence were intercorrelated ($r = .21$, $p < .01$) but could have different effects on anxiety and cardiovascular reactivity, they were analyzed separately. Significant interactions were followed up with simple slope analyses (Aiken and West 1991).

Results

A total of 32 outliers were detected and truncated at 3.5 SD. Descriptive statistics for all variables are displayed in Table 1. Participants reported no to high levels of exposure to both real-life and media violence. On average, students experienced multiple acts of violence multiple times and watched approximately 5 h a week of violent TV or movies. The average baseline anxiety was lower compared to a normative college sample (11.81 vs. 17.62; Spielberger 1983), although a one-sample *t* test revealed that the difference was not statistically significant ($p > .05$). Participants randomized to the violent movie group had seen fewer of the clips shown and had greater increase in anxiety compared to those randomized to watch the nonviolent clips; no other differences between the two groups emerged (Table 1).

Correlations among variables, presented in Table 2, indicated that females had higher baseline heart rate, lower levels of exposure to real-life violence, and greater increase in anxiety. Non-white students had higher baseline DBP. Students who had seen more of the movies shown had lower increases in anxiety. Greater exposure to media violence was related to lower baseline anxiety and greater increases in heart rate. Exposure to real-life violence was associated with greater exposure to media violence and seeing more clips shown. Baseline DBP was positively related to both baseline SBP and HR; changes in DBP also were positively associated with changes in SBP and HR (Table 2). Individuals with higher levels of baseline anxiety, DBP, SBP and HR experienced smaller changes in the respective variables. Paired samples t-tests showed that, across the two groups, watching the video clips increased anxiety ($t = 11.02$, $p < .001$), SBP ($t = 5.69$, $p < .001$) and DBP ($t = 3.69$, $p < .001$), and it slowed HR ($t = -10.02$, $p < .001$). Anxiety increased significantly after watching the video clips in the violent group ($t = 9.50$, $p < .001$) as well as in the nonviolent group ($t = 6.26$, $p < .001$).

Results from multiple regressions revealed that viewing violent media clips increased self-reported anxiety more than watching nonviolent high-action clips, with medium effect size ($d = .50$). However, watching violent clips compared to nonviolent clips did not differentially affect SBP, DBP, or HR (Table 3). At Step 2, prior exposure to

Table 1 Descriptive statistics and comparison of movie groups across all variables

Variable	Mean (SD)	Range	Group mean (SD)		$\chi^2(1)$ or $t(208)$	p value
			Violent movie group	Nonviolent movie group		
Age	18.74 (.92)	18 to 22	18.74 (.96)	18.74 (.86)	.02	.985
Female gender, N (%)	157 (75 %)		78 (75 %)	79 (75 %)	.00	.968
Non-white, N (%)	104 (50 %)		49 (47 %)	55 (52 %)	.58	.447
Parent education level	3.23 (1.50)	0 to 5	3.19 (1.54)	3.27 (1.46)	.36	.720
Previously seen movies	2.29 (1.55)	0 to 5	1.53 (1.10)	3.05 (1.56)	8.15	<.001
Exposure to real-life violence	15.71 (9.11)	0 to 55	15.42 (9.09)	15.99 (9.17)	.45	.654
Exposure to media violence	19.26 (15.70)	0 to 120	17.86 (14.13)	20.65 (17.07)	1.29	.199
Baseline anxiety	11.81 (7.96)	0 to 39	12.01 (8.79)	11.61 (7.08)	−.36	.718
Anxiety change	7.82 (10.26)	−15 to 43	10.32 (11.08)	5.34 (8.74)	−3.60	<.001
Baseline SBP	117.64 (13.54)	83 to 158	117.25 (13.93)	118.03 (13.20)	.41	.681
SBP change	2.40 (6.10)	−19 to 23	2.16 (6.53)	2.64 (5.67)	.58	.566
Baseline DBP	63.47 (9.94)	40 to 96	63.03 (10.19)	63.90 (9.71)	.64	.525
DBP change	1.20 (4.70)	−14 to 16	.91 (4.96)	1.49 (4.44)	.90	.370
Baseline HR	77.47 (11.57)	52 to 116	76.86 (11.28)	78.07 (11.88)	.75	.452
HR change	−3.02 (4.36)	−23 to 10	−3.14 (4.37)	−2.90 (4.36)	.40	.689

Parent education was coded on a scale from 0 ('Less than high school') to 6 ('Graduate degree')

Change scores indicate the change from baseline to a time after (anxiety) or during (HR, SBP, DBP) video clip viewing

real-life violence had no effects on overall changes in anxiety or cardiovascular measures during movie watching. In contrast, prior exposure to media violence was associated with a smaller decrease in HR across both groups. In Step 3, exposure to real-life violence moderated the relationship between watching violent videos and changes in SBP and DBP. Simple slopes analyses indicated that participants exposed to high levels of real-life violence (2 SD above the mean) experienced smaller increases in DBP and SBP when watching violent clips compared to nonviolent clips (DBP: $\beta = -.33, p < .05$; SBP: $\beta = -.29, p = .065$) (Fig. 1). By contrast, students exposed to no real-life violence had somewhat greater SBP and DBP increases when watching violent clips compared to nonviolent clips, although the differences did not reach statistical significance (SBP: $\beta = .21, p = .139$; DBP: $\beta = .18, p = .213$).

Discussion

Despite older adolescents' high levels of exposure to violence in television and movies, few studies have experimentally examined the effects of televised violence on anxiety in this age group. Anxiety may be especially problematic for all late adolescents in college because it may impair their academic work. For first-year college students, anxiety may be even more problematic, as their ability to cope with anxiety may be compromised by decreased levels of social support following the college transition. In addition, it is important to understand if previous exposures to violence (both in real life and through media) makes youth differentially susceptible to the negative effects of media violence. To address these questions, this experimental study investigated the effects of media violence on anxiety in late adolescents attending college and examined whether previous exposure to violence moderated these effects. Findings indicate that watching violent movie content increases subjective anxiety in late adolescents. By itself, movie violence did not affect cardiovascular functioning. However, students' blood pressure increased and heart rate slowed when they watched high-action movie clips regardless of violent content. Additionally, cardiovascular responses to movie violence varied based on previous exposure to real-life violence. As expected, previous exposure to high levels of real-life violence was associated with attenuated blood pressure response to violent high-action clips compared to nonviolent high-action clips.

The present study builds upon findings from previous investigations, as well as provides directions for future research. This study extends previous correlational findings by establishing a causal link between exposure to violent movie content and anxiety. Moreover, the increase in anxiety following watching violent movie scenes was not attenuated by previous exposure to real-life or media violence. Among children and adolescents, exposure to real-life violence is associated with emotional distress that contributes to poor academic performance (Henrich et al. 2004; Schwartz and Gorman 2003). It is possible that with repeated exposure to media violence, the elevated anxiety experienced by late adolescents and emerging adults

Table 2 Correlation matrix

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Age	1.00													
2. Female gender[a]	−.25**	1.00												
3. Non−White[a]	.05	.15*	1.00											
4. Parent education level	−.10	−.02	−.07	1.00										
5. Previously seen movies	.12	−.12	.02	−.08	1.00									
6. Exposure to real−life violence	.04	−.26**	.03	−.03	.18**	1.00								
7. Exposure to media violence	.02	.03	.07	−.05	.10	.21**	1.00							
8. Baseline anxiety	−.04	−.02	.01	.04	.04	.10	−.20**	1.00						
9. Anxiety change	−.09	.21**	−.11	.01	−.16**	−.15*	−.04	−.20**	1.00					
10. Baseline SBP	−.04	−.02	.14*	.06	.12	.13	.03	.02	−.07	1.00				
11. SBP change	.09	−.02	.02	−.02	.04	.06	.08	.02	−.07	−.28**	1.00			
12. Baseline DBP	−.04	.02	.16*	.03	.15*	.11	.03	−.03	−.08	.94**	−.21**	1.00		
13. DBP change	.04	−.03	.05	.00	.03	.07	.05	.07	−.06	−.21**	.85**	−.22**	1.00	
14. Baseline HR	−.10	.19**	−.03	−.01	.08	−.13	−.05	.06	.04	.05	−.03	.14*	−.09	1.00
15. HR change	−.02	−.06	−.03	.08	−.07	.08	.15*	.02	−.02	−.01	.10	−.06	.17*	−.39**

* $p < .05$; ** $p < .01$

[a] Correlations with gender and race are point-biserial correlations

persists over time (Harrison and Cantor 1999), disrupting their concentration and negatively affecting academic performance. These potential long-term effects of media violence on anxiety and academic problems in late adolescents should be addressed in future studies.

Furthermore, participants' cardiovascular reactivity showed interesting changes throughout the experiment. The overall increase in blood pressure and decrease in heart rate during movie watching may be best explained by the high levels of action present in both the violent and nonviolent movie clips. The increase in blood pressure from baseline is consistent with other studies finding blood pressure increases in response to violent movie scenes (Hayashi et al. 2009; Kreibig et al. 2007). However, our results call into question previous conclusions about violent movie content's increasing cardiovascular reactivity more than nonviolent movies (Kreibig et al. 2007), as the nonviolent scenes used in previous research had low levels of action. Although replication of our results with the addition of low-action movie scenes would be helpful to verify the effects of action level, future studies of movie violence need to consider a level of action as a key confound. Additionally, long-term effects of watching high-action movies on blood pressure should be studied, as repeated exposure may lead to chronically elevated blood pressure and clinical hypertension with associated negative health outcomes (Bear et al. 2007).

The overall decrease in heart rate while watching high-action movie scenes contrasts with other studies documenting increased heart rate in response to high-action violent scenes (Hayashi et al. 2009; Kreibig et al. 2007). Decreased heart rate could reflect activation of the parasympathetic nervous system (Wright and Kirby 2003),

Table 3 Multiple regressions predicting changes in anxiety and cardiovascular functioning from prior media violence and real-life violence exposure

Predictor	Anxiety change		SBP change		DBP change		HR change	
	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2
Step 1								
Age	−.03	.16***	.07	.09**	.02	.06^{+}	−.04	.17***
Non−White	−.13^{+}		.06		.09		−.04	
Female	.21**		−.01		−.03		.01	
Parent education	.01		.02		.02		.06	
Movies seen	−.03		.06		.03		−.07	
Outcome at baseline	−.20**		−.29***		−.24**		−.40***	
Media violence	.23**		−.02		−.05		−.08	
Step 2a								
Prior exposure to real−life violence	−.07	.00	.09	.01	.08	.01	.05	.00
Step 2b								
Prior exposure to media violence	−.05	.00	.08	.01	.04	.00	.14*	.02*
Step 3a								
Media violence × prior exposure to real−life violence	−.00	.00	−.19*	.02*	−.19*	.02*	−.08	.00
Step 3b								
Media violence × prior exposure to media violence	−.08	.00	.05	.00	.05	.00	−.06	.00

$^{+}$ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

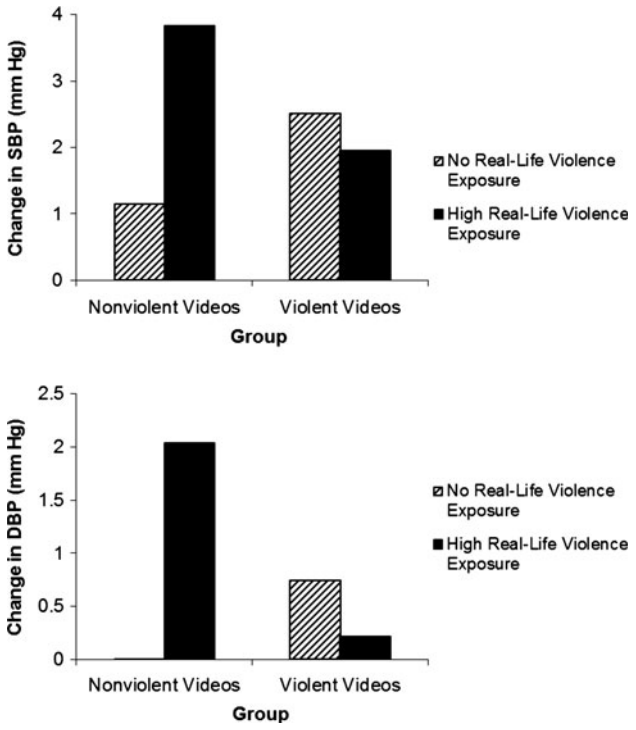

Fig. 1 Interaction between real-life exposure to violence and watching violent versus nonviolent videos on changes in SBP and DBP

which can accompany relaxation (Sakakibara et al. 1994). It is possible that through watching high-action movies for the purpose of recreation, college students may experience similar parasympathetic activation due to inhibition of the fight-or-flight response, since they are aware that the movie stimuli are not immediate threats. Future research should replicate these findings and address possible explanations for differential heart rate response to movie violence.

However, this general decrease in heart rate was diminished by previous exposure to media violence. The effect may indicate desensitization, and is consistent with experimental studies finding reduced heart rate reactivity to violent movie clips after watching violent real-life film clips (Linz et al. 1989) or playing violent video games (Carnagey et al. 2007). Interestingly, this possible desensitization extended over longer periods of time and to both violent and nonviolent high-action movies in the present study. Given the similarities between physiological responses to violent and nonviolent high-action movies, a question arises whether exposure to high-action media would produce desensitization effects akin to those observed for media violence. Therefore, it is unclear whether the overall effect of previous exposure to media violence on reducing heart rate reactivity could be attributable to media violence itself, or to the high-action nature of such violence. Further research should

compare the effects of both movie violence and action level (high vs. low).

Another physiological desensitization effect was obtained for prior exposure to real-life violence, with students exposed to high levels of real-life violence experiencing lower blood pressure increases while watching violent clips compared to nonviolent clips. In contrast to the association between previous exposure to violent media and reduced heart rate, which occurred for both violent and nonviolent movie clips, the blood pressure desensitization effect was specific only to the violent movie content and was related to previous exposure to real-life violence. Because violence shown in movies is fictitious, viewers may not interpret its consequences as seriously as those of real-life violence (Ramos et al. 2013). Thus, exposure to real-life violence may have a more powerful and specific impact on viewers' reactions to violent movie clips compared to previous media violence. Although physiological desensitization to violence may be adaptive to maintain homeostasis (McEwen and Seeman 1999), it may lead to greater tolerance of media and real-life violence, increased acceptability of violence, and more aggressive behavior (Bartholow et al. 2006; Engelhardt et al. 2011; Funk et al. 2004).

The present results must be interpreted in the context of the study's limitations. This study only examined short-term consequences of exposure to media violence. The manipulation also exposed students to only 11.5 min of violence. It is possible that longer exposure may lead to stronger effects on anxiety and cardiovascular reactivity. Also, because the sample consisted of mostly Caucasian and African American late adolescents in college, these results may not generalize to other populations of late adolescents. Similarly, previous violence exposure, self-reports of anxiety, and physiological reactivity may vary by gender. Because 75 % of the present sample was comprised of females, the results may be less generalizable to male adolescents. Future studies should replicate the findings with gender-balanced samples and address gender differences explicitly. Furthermore, previous exposure to media violence was assessed only through movies and television to match the type of violence used in the experiment and excluded prior exposure to video game violence. However, rerunning the analyses with the addition of prior exposure to video game violence did not alter the results. Another limitation of the present study is that physiological arousal could be influenced by other attributes of the video clips besides violence and action level that were not measured in the present study, such as suspense and elicited empathy. Future studies should attempt to account for these and other potential confounds.

Conclusion

The results of this study have implications for how late adolescents are affected by media violence. Perhaps the most important implication stems from the finding that relatively brief exposure to televised violence led to greater increases in state anxiety. It is possible that, with regular exposure to televised violence, college students may repeatedly experience increased state anxiety, which may disrupt their concentration and negatively affect their academic performance and other areas of functioning. Future research should investigate long-term anxiety and related consequences in relation to regular exposure to media violence among college students.

Other important implications are based on the finding that exposure to violence appears to affect cardiovascular functioning. Specifically, those exposed to high levels of real-life violence had higher levels of resting SBP and DBP compared to individuals with lower levels of exposure. It is possible that over time, chronic exposure to violence may lead to chronically elevated blood pressure and clinical hypertension, which is linked to more negative long-term health outcomes (Bear et al. 2007). The lowered BP in response to violent movies in these individuals, a likely indicator of physiological desensitization to violence, may also pose problems. Although desensitization may function as an adaptive coping mechanism, it may prevent individuals from intervening when violence takes place, lead to additional exposure to violence, and promote the use of aggressive behavior (Ng-Mak et al. 2004). The long-term effects of such desensitization clearly deserve further investigation.

The results of this study support a causal link between movie violence and increased anxiety in late adolescence. Given the large amount of violent media consumed by older youth, further research on long-term anxiety-related consequences of media violence in this population is needed. The present results also support the desensitization hypothesis, with exposure to both real-life and media violence diminishing physiological response to violent and high-action movies, respectively. The possible negative consequences of such desensitization should be elucidated by future research.

Author contributions AM conceived of the study, coordinated data collection, performed statistical analyses, and drafted the manuscript; SM provided guidance on study design, data collection, statistical analyses, and manuscript revisions; RW provided guidance on study design, use of equipment for data collection, and manuscript revisions. All authors read and approved the final manuscript.

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