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Title

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Permalink

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Journal

Psychological science, 24(9)

ISSN

0956-7976

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Publication Date

2013-09-01

DOI

10.1177/0956797612460406

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Peer reviewed

Mental- and Physical-Health Effects of Acute Exposure to Media Images of the September 11, 2001, Attacks and the Iraq War

Psychological Science
24(9) 1623–1634
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sagepub.com/journalsPermissions.nav
DOI: 10.1177/0956797612460406
pss.sagepub.com


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Abstract

Millions of people witnessed early, repeated television coverage of the September 11 (9/11), 2001, terrorist attacks and were subsequently exposed to graphic media images of the Iraq War. In the present study, we examined psychological- and physical-health impacts of exposure to these collective traumas. A U.S. national sample ($N = 2,189$) completed Web-based surveys 1 to 3 weeks after 9/11; a subsample ($n = 1,322$) also completed surveys at the initiation of the Iraq War. These surveys measured media exposure and acute stress responses. Posttraumatic stress symptoms related to 9/11 and physician-diagnosed health ailments were assessed annually for 3 years. Early 9/11- and Iraq War-related television exposure and frequency of exposure to war images predicted increased posttraumatic stress symptoms 2 to 3 years after 9/11. Exposure to 4 or more hr daily of early 9/11-related television and cumulative acute stress predicted increased incidence of health ailments 2 to 3 years later. These findings suggest that exposure to graphic media images may result in physical and psychological effects previously assumed to require direct trauma exposure.

Keywords

September 11, Iraq War, terrorism, media, television, acute stress symptoms, posttraumatic stress symptoms, physical health

Received 1/26/12; Revision accepted 8/14/12

Mass media turn local disasters into national and global events. This widespread exposure generates an outpouring of philanthropy (Chochinov, 2005). But the media also transmits the negative impact of disasters to people far beyond those directly exposed (Vasterman, Yzermans, & Dirkzwager, 2005; Wright, Ursano, Bartone, & Ingraham, 1990). In such cases, vicariously experienced events can become collective traumas. For example, although tens of thousands of individuals directly witnessed the September 11 (9/11), 2001, terrorist attacks, millions more viewed the attacks and their aftermath via the media. Indeed, a survey conducted in 2012 found 9/11 to be the most impactful event experienced by television viewers over the past 50 years, almost twice as impactful as the second-ranked

event (Bauder, 2012). When war was initiated in Iraq 18 months after 9/11, international media provided unprecedented graphic images of hostilities.

The potentially detrimental mental-health impact of media exposure to violence or disasters has concerned many commentators. Research conducted among children after the Oklahoma City bombing (Pfefferbaum et al., 2001) and the 1990 Gulf War (Cantor, Mares, &

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Oliver, 1993) found relations between television exposure and trauma-related symptoms. Television exposure to 9/11 and psychological symptomatology were associated in cross-sectional studies among New York residents (Ahern et al., 2002; Bernstein et al., 2007) and in U.S. national samples (Butler et al., 2009; Schlenger et al., 2002; Schuster et al., 2001). The impact of 9/11 even crossed the Atlantic: London schoolchildren who witnessed the attacks on television reported posttraumatic stress symptoms and functional impairment during the 6 months following 9/11 (Holmes, Creswell, & O'Connor, 2007), and authors speculated that the observed decline in subjective well-being in the United Kingdom after 9/11 resulted from extensive worldwide media coverage of the attacks (Metcalf, Powdthavee, & Dolan, 2011).

Exposure to traumatic events may affect physical as well as mental health (Schnurr & Green, 2004), even among individuals indirectly exposed to collective stressors (Holman et al., 2008; Shedd et al., 2004). Among women who were pregnant during 9/11, population studies documented deleterious birth outcomes across the United States (Bruckner, Catalano, & Ahern, 2010) and The Netherlands (Smits, Krabbendam, de Bie, Essed, & van Os, 2006), and Iraq War media coverage predicted harmful physical- (and mental-) health outcomes among a sample of Iraqi refugees in the United States (Kira et al., 2008).

Researchers have emphasized the need for longitudinal examination of the media's role—and of graphic images specifically—in mental-health outcomes following traumatic events (Cantor, 2002; Putnam, 2002; Vasterman et al., 2005). Although experimental research has demonstrated that exposure to traumatic film images can induce intrusive emotional memories (Holmes & Bourne, 2008), the extant body of cross-sectional data collected outside the laboratory cannot clarify whether distress increases exposure or vice versa. Only prospective longitudinal studies can begin teasing apart the direction of this relationship. We speculate that repeated exposure to vivid traumatic images in the media may result in a stress response (Bovin & Marx, 2011) sufficient to trigger physiological processes that increase the risk of developing health ailments over time (McEwen, 1998; Schnurr & Green, 2004)—physiological processes distinct from the known associations between media exposure and health-risk factors, such as a sedentary lifestyle and poor dietary choices (Hancox, Milne, & Poulton, 2004).

We conducted a 3-year longitudinal study of mental- and physical-health outcomes among a national probability sample of Americans primarily exposed to the 9/11 attacks through the media. Our study included assessments of respondents' mental- and physical-health history collected before the attacks, media exposure, and acute stress responses collected immediately after 9/11

and at the initiation of the Iraq War, and three annual follow-up assessments. We hypothesized that repeated exposure to graphic media content would be associated with increased acute stress symptoms, subsequent post-traumatic stress, and physical-health ailments over time, controlling for potential confounds (demographics, pre-9/11 mental and physical health, and lifetime adversity). We also examined whether repeated media exposure to collective traumas has a cumulative effect on health.

Method

Sample and procedures

Data were collected via Internet-based surveys using a sample drawn from a national probability panel of the U.S. population recruited using stratified random-digit-dial telephone sampling and maintained by Knowledge Networks (Silver, Holman, McIntosh, Poulin, & Gil-Rivas, 2002; Silver et al., 2006). To ensure representation of all population segments, Knowledge Networks provides Internet access, or other compensation (e.g., points for merchandise) if the household is already Web enabled, in return for the completion of 3 to 4 monthly surveys. The panel follows the distribution of U.S. Census population counts on demographic variables. Survey responses are confidential, with identifying information never revealed by Knowledge Networks. Panel members receive notice in their password-protected e-mail account that a survey is available for completion. Surveys are self-administered, accessible for a designated period, and can be completed only once.

Media exposure and acute stress symptoms were assessed 9 to 14 days after 9/11 for the majority of the sample and 8 to 18 days after the Iraq War began for the entire sample. Self-reports of physician-diagnosed mental and physical ailments were assessed before 9/11 and 1, 2, and 3 years after 9/11. Posttraumatic stress symptoms related to 9/11 were also assessed 1, 2, and 3 years after 9/11. The study design and dates of survey administrations are described in Table 1. The survey administered in the weeks following the 9/11 attacks was fielded to 3,496 individuals; 78% completed it ($n = 2,729$), with more than 75% doing so within 9 to 14 days after the attacks. For each annual follow-up, responses were obtained only from available respondents from the original sample of 2,729 (some respondents had died or left the Knowledge Networks panel and declined further participation). For the Year 1 follow-up survey, responses were received from 2,033 individuals out of 2,729 who were contacted (74.5%). For the Year 2 follow-up survey, responses were received from 1,571 individuals out of 2,123 who were contacted (74%, or 57.6% of the original sample of 2,729). For the Year 3 follow-up survey,

Table 1. Study Design: Measures Collected at Each Time Point of the Study

Measure	Pre-9/11 survey (<i>N</i> = 2,592)	September 2001 Post-9/11 survey (<i>N</i> = 2,729)	September– October 2002 Annual Survey: Year 1 (<i>N</i> = 2,033)	March 2003 Iraq War Survey (<i>N</i> = 1,349)	September– October 2003 Annual Survey: Year 2 (<i>N</i> = 1,571)	September– October 2004 Annual Survey: Year 3 (<i>N</i> = 1,771)
Acute stress	—	X	—	X	—	—
Media exposure	—	X	X	X	—	—
Physician-diagnosed mental health	X	—	X	—	X	X
Physician-diagnosed physical health	X	—	X	—	X	X
Posttraumatic stress symptoms	—	—	X	—	X	X

Note: Prior to September 11 (9/11), 2001, Knowledge Networks administered a health survey. Responses to the post-9/11 survey were obtained between September 20 and October 4, 2001. Data for the Year 1 post-9/11 follow-up survey were collected between September 20 and October 24, 2002. Data for the Year 2 post-9/11 follow-up survey were collected between September 12 and October 31, 2003. Data for the Year 3 post-9/11 follow-up survey were collected between September 12 and November 2, 2004. The Iraq War survey was fielded between March 27 and April 6, 2003.

responses were received from 1,771 individuals out of the 2,242 who were contacted (79%, or 64.9% of the original 2,729). Data for the Iraq War survey were collected over 10 days from a random subset ($n = 1,800$) of the respondents from the Year 1 follow-up survey. All procedures for this study were approved by the institutional review boards of the University of California, Irvine, and the University of Denver.

Measures

Demographics. Age, sex, marital status, ethnicity, education, and annual household income were provided by Knowledge Networks. Missing income values were imputed using a mean income score for the respondent's census block.

Direct exposure to the 9/11 attacks. On recruitment into our study, participants were asked about their degree of exposure to and loss from the 9/11 attacks. Individuals were grouped into three mutually exclusive categories (with priority placed on the highest level of exposure reported). The first category was direct exposure—being in the World Trade Center or Pentagon during the attacks, seeing or hearing the attacks in person, or having a close relationship with someone in the targeted buildings or airplanes. The second category was live media exposure—watching the attacks live on television. The third category was no live exposure—seeing or learning of the attacks only after they occurred.

Media exposure to the 9/11 attacks. Media exposure to the 9/11 attacks was assessed at the first wave of data

collection with the following question: “Since the terrorist attack, about how much time each day have you spent watching news footage about this on TV? Please give your best estimate for the *first seven days* after the attack.” A categorical variable was used (less than 1 hr per day, 1 to 3 hr per day, and 4 or more hr per day).

Media exposure to the Iraq War. Media exposure to the Iraq War was assessed starting a week after the Iraq War began by asking respondents to indicate on a 5-point scale how frequently they had seen 16 progressively aversive war images (e.g., military equipment, bombs exploding, injured/dead soldiers). These items were modeled after items on the Escobar Combat Intensity Scale (Escobar et al., 1983). The mean of these items served as an index of war-related media exposure. Scale items were also analyzed individually to identify the specific images associated with outcomes. In addition, respondents provided the average number of hours per day they spent watching war-related television coverage. These items were coded similarly to the items related to 9/11-related television watching (less than 1 hr per day, 1 to 3 hr per day, and 4 or more hr per day).

Acute stress responses to the 9/11 attacks and the Iraq War. Acute stress symptoms were assessed after 9/11 using a modified version of the Stanford Acute Stress Reaction Questionnaire (SASRQ), which measures symptoms of acute stress disorder (ASD; see Cardena, Koopman, Classen, Waelde, & Spiegel, 2000, for reliability and validity information). Respondents reported whether they experienced or did not experience stress symptoms related to 9/11. Following criteria from the fourth edition

of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV; American Psychiatric Association, 1994), we created two scores—mean acute stress symptoms and high versus low acute stress—using ASD Criteria B (three or more dissociative symptoms), C (one or more reexperiencing/intrusive symptoms), D (one or more avoidance symptoms), and E (one or more arousal/anxiety symptoms); respondents meeting all four criteria were coded as having high acute stress. Because most respondents did not meet DSM-IV Criterion A (direct exposure) and symptom duration was not assessed, respondents were not assumed to have ASD. Acute stress responses to the Iraq War were assessed using the original SASRQ focused specifically on reactions to the war. Items were classified so that symptoms experienced at least “sometimes” on the 6-point scale were considered positive. Continuous and dichotomous acute-stress indices were computed as described above. A cumulative index of collective acute stress was created from the dichotomous 9/11-related and Iraq War-related acute-stress scores (0 = never had high acute stress, 1 = had high acute stress after either 9/11 or the beginning of the Iraq War, 2 = had high acute stress after both events).

Posttraumatic stress symptoms related to 9/11. The PTSD Checklist Civilian (PCL-C), a reliable 17-item screening tool for posttraumatic stress disorder (PTSD), was administered annually to assess prior-week 9/11-related symptoms of posttraumatic stress (see Weathers, Litz, Herman, Huska, & Keane, 1993, for reliability and validity information). A standardized mean score and dichotomous index of high versus low posttraumatic stress using DSM-IV PTSD Criteria B (one or more reexperiencing symptoms), C (three or more avoidance symptoms), and D (two or more arousal symptoms) were created. For dichotomous scores, only symptoms that were reported as being at least moderately distressing were considered positive (i.e., 2 on a scale from 0 to 4); respondents meeting all three criteria were coded as having high posttraumatic stress. Because we did not assess all DSM-IV criteria (e.g., duration of symptoms) and most respondents were not directly exposed, they were not assumed to have PTSD.

Pre- and post-9/11 physical- and mental-health status. Prior to 9/11, Knowledge Networks administered a health survey assessing physician-diagnosed mental- and physical-health ailments. This survey was modeled after and validated against the U.S. Centers for Disease Control and Prevention’s National Center for Health Statistics annual National Health Interview Survey (NHIS; U.S. Department of Health and Human Services, 2000). Respondents reported whether a physician had ever diagnosed them with any of 35 physical-health ailments

(e.g., asthma, hypertension) or mental-health ailments (i.e., anxiety disorder, depression) and provided smoking status, height, and weight (to calculate body mass index, or BMI). The number of pre-9/11 physician-diagnosed physical-health ailments (0–33) and mental-health ailments (0–2) were computed as baseline assessments. Three follow-up health surveys, patterned after the pre-9/11 assessment, were administered to all available respondents annually (Holman et al., 2008). Missing-at-random tests for physician-diagnosed ailments were non-significant ($ps > .10$), so missing data were imputed within age groups using expectation-maximization methods (Little & Rubin, 1987). Respondents’ tendency to somatize was also assessed annually using the Brief Symptom Inventory 18 somatization subscale (Derogatis, 2001).

Adverse life events. At the time of recruitment and annually, participants reported whether they had experienced any of 37 stressful events (other than 9/11; e.g., physical assault). The number of lifetime and post-9/11 adverse events was computed.

Overview of analyses

The base sample for this report included respondents with 9/11-related exposure and acute stress data ($N = 2,189$). The analysis predicting 9/11-related acute stress used this full sample. As all subsequent analyses included data from the Iraq War survey, only Iraq War-survey respondents with 9/11-related exposure and acute-stress data ($n = 1,322$) were used.

Stata data analysis and statistical software (Version 10.0; StataCorp, College Station, TX), which handles weighted complex longitudinal survey data and provides necessary standard-error adjustments, was used for analyses. Data were weighted to adjust for differences in probabilities of selection and nonresponse. Poststratification weights were calculated using demographic combinations to make the weighted sample cells match the data from the U.S. census (U.S. Census Bureau, 2001) and Knowledge Networks panel.

Predictors of low versus high acute stress following 9/11 and the initiation of the Iraq War were examined with survey logistic regression. We used separate survey linear and Poisson regressions to examine media variables as predictors of posttraumatic stress and physical-health ailments at 2 and 3 years after 9/11, controlling for pre-9/11 health. Generalized estimating equations (GEEs) were then used to test predictors of posttraumatic-stress scores and physician-diagnosed physical ailments in multivariate models over time (2–3 years after 9/11). GEE explicitly models the contribution of time to longitudinal outcomes and minimizes the number of tests conducted, thereby strengthening our confidence in estimating the

unique contribution of media viewing. Temporally separate assessments of predictors (before 9/11, 2–3 weeks after 9/11, 12 and 18 months after 9/11) and outcomes (2–3 years after 9/11) prevented confounding from simultaneous measurement. This allowed prospective evaluation of 9/11- and Iraq War–related media exposure and cumulative event-related acute stress in relation to the onset of posttraumatic stress symptoms and health ailments. Analyses were repeated using continuous mean acute stress symptoms reported after 9/11 and the Iraq War; findings were consistent with those reported here. Individual regression and GEE analyses produced similar findings unless indicated.

Because the rates of meeting DSM–IV PTSD-related Criteria B, C, and D were minimal (< 5% of the sample), the analyses addressing predictors of posttraumatic stress symptoms used continuous posttraumatic-stress scores. The physical-health outcome was tested for overdispersion (Cohen, Cohen, West, & Aiken, 2003) to assess whether it violated assumptions about dispersion of residuals, thereby inflating goodness-of-fit tests and erroneously reducing standard errors. A Poisson distribution was specified because the physical-health variables were not overdispersed.

Blocks of variables were tested for inclusion in the models: (a) demographics, (b) pre-9/11 physician-diagnosed physical- and mental-health status, (c) lifetime or post-9/11 exposure to adversity, (d) 9/11-related exposure, (e) hours per day of 9/11-related television watching in the week after 9/11, (f) hours per day of Iraq War–related television watching and frequency of exposure to war-related images in the week following initiation of the war, and (g) cumulative 9/11- and Iraq War–related acute stress (0, 1, 2). For physical health analyses, health-risk factors (BMI, smoking) and annual assessments of somatization were also tested for inclusion in the models. For parsimony, except for theoretically relevant variables (e.g., pre-9/11 health), nonsignificant variables ($p > .05$) were removed from the models. All continuous variables were standardized for the analyses, and categorical variables were dummy coded (0, 1). Dummy-coded variables were not standardized for ease of interpretation; hence, the coefficients reported are technically not standardized betas. The tables present adjusted odds ratios (AORs) or adjusted incident rate ratios (AIRRs) as relative effect sizes for predictors. Posttraumatic stress symptoms were standardized so coefficients represent the amount of standard-deviation-unit change in posttraumatic stress predicted by each one-unit change in predictors. Two models are presented for each outcome: (a) key media-exposure variables as predictors of outcomes, adjusted only for pre-9/11 mental or physical health, and (b) a fully adjusted model with covariates. For GEE analyses, a third model was used to test cumulative

acute stress as a mediator of media-exposure effects on outcomes.

Results

Attrition analysis

We used logistic regression to examine whether participants ($N = 2,189$) differed from people who dropped out after the initial data collection ($N = 540$). Participants were older (mean age = 48.7 years vs. 40.9 years), $t(2717) = 9.88$, $p < .001$, less likely to be African American (8.5% vs. 12.9%; odds ratio, or OR = 0.64, $p = .003$), and more highly educated (27.2% vs. 21.0% with some college; OR = 1.40, $p = .005$) than nonparticipants. It is important to note that participants did not differ from nonparticipants in terms of pre-9/11 health, 9/11-related media exposure, or 9/11-related acute stress.

We also examined whether participants from the base sample ($N = 2,189$) who completed the Iraq War survey ($n = 1,322$) differed from participants who did not complete the Iraq War survey ($n = 867$) using logistic regression. Iraq War–survey participants were older (mean age = 52.9 years vs. 42.7 years; OR = 1.03, $p < .001$), somewhat poorer (OR = 0.98, $p = .04$), and less educated (38.5% vs. 32.1% with only a high school education; OR = 1.29, $p = .009$) than nonparticipants. No differences were found between groups in terms of pre-9/11 health, lifetime or recent adversity, 9/11-related media exposure, or 9/11-related acute stress.

Media exposure to 9/11 and the Iraq War

The 9/11 attacks. Few respondents were directly exposed to the 9/11 attacks; 63% reported watching them as they occurred live on television, and 33% reported no live exposure. In the week following 9/11, 0.7% of the sample reported watching no 9/11-related television news coverage, 13% reported less than 1 hr per day, 42% reported 1 to 3 hr per day, and 44% reported 4 or more hr per day.

The Iraq War. Only 6.4% of war-survey respondents reported never seeing media images of war. Nineteen percent reported seeing images rarely, 55% reported seeing them sometimes, and nearly 20% reported seeing Iraq War images often ($M = 2.45$, $SD = 0.73$, on a 5-point Likert scale ranging from *never* to *all the time*). In the week following the start of the Iraq War, 3.0% of the sample reported watching no war-related television, 21.7% reported watching less than 1 hr per day, 55.6% reported watching 1 to 3 hr per day, and 19.7% reported watching 4 or more hr per day.

Table 2. Results of Survey Logistic Regression Models Examining Predictors of High Acute Stress in the Weeks Following the September 11 (9/11), 2001, Terrorist Attacks

Predictor	Model 1			Model 2		
	Adjusted odds ratio	95% CI	<i>p</i>	Adjusted odds ratio	95% CI	<i>p</i>
Pre-9/11 mental-health ailments	1.37	[1.20, 1.56]	< .001	1.28	[1.12, 1.47]	< .001
9/11-related TV watching in week after 9/11 4 or more hr per day	1.57	[1.15, 2.14]	.004	1.51	[1.10, 2.07]	.011
Pre-9/11 adverse life events	—	—	—	1.17	[0.99, 1.37]	.054
Age	—	—	—	0.75	[0.63, 0.89]	.001
Gender	—	—	—	1.49	[1.08, 2.05]	.016

Note: $n = 2,184$. The reference group for hours of 9/11-related TV watching was less than 4 hr of daily 9/11-related TV watching in the week following the attacks. Gender was coded 0 for male and 1 for female. All models were significant—Model 1: $F(2, 2182) = 16.67, p < .001$; Model 2: $F(5, 2179) = 10.03, p < .001$. CI = confidence interval.

Acute stress responses to 9/11 and the Iraq War

9/11-related acute stress. Overall, 11.85% of respondents (weighted; $N = 2,189$) reported high levels of 9/11-related acute stress symptomatology. Watching 4 or more hr per day of 9/11-related television predicted a 51% increased likelihood of reporting high 9/11-related acute stress after we controlled for pre-9/11 mental health, demographics, and lifetime trauma (Table 2).

Iraq War–related acute stress. When the Iraq War began, 7.3% of respondents (weighted; $n = 97$ out of 1,322) reported high acute stress. In bivariate analyses, watching 4 or more hr of war-related television (OR = 3.13, 95% confidence interval, or CI = [1.69, 5.80], $p < .001$) and frequency of seeing war-related images (OR = 1.58, 95% CI = [1.14, 2.19], $p = .006$) both were associated with war-related acute stress symptoms. However, only the frequency of seeing war-related images remained a significant predictor of high acute stress when we adjusted

for pre-9/11 mental health, recent adversity, and 9/11-related acute stress and posttraumatic stress (Table 3). More frequent exposure to war-related media images predicted a 40% increased likelihood of high war-related acute stress. Two specific images were strongly associated with war-related acute stress symptoms in the multivariate analyses: images of allied prisoners of war (AOR = 1.48, 95% CI = [1.12, 1.95]) and images of dead Iraqi children (AOR = 1.50, 95% CI = [1.17, 1.92]).

Media exposure and 9/11-related posttraumatic stress symptoms

After adjusting for pre-9/11 mental health, we found that early 9/11-related television watching was associated with posttraumatic stress symptoms at both 2 and 3 years after 9/11—1 to 3 hr per day at 2 years: $b = 0.24, p < .01$; 1 to 3 hr per day at 3 years: $b = 0.20, p = .059$; 4 or more hr per day at 2 years: $b = 0.52, p < .001$; 4 or more hr per day at 3 years: $b = 0.43, p < .001$. When Iraq War–related

Table 3. Results of Survey Logistic Regression Models Examining Predictors of High Acute Stress at the Start of the 2003 War in Iraq

Predictor	Model 1			Model 2		
	Adjusted odds ratio	95% CI	<i>p</i>	Adjusted odds ratio	95% CI	<i>p</i>
Pre-9/11 mental-health ailments	1.37	[1.10, 1.70]	.006	1.18	[0.90, 1.54]	.231
Frequency of Iraq War–related media exposure	1.54	[1.12, 2.13]	.008	1.40	[1.03, 1.91]	.033
Adverse life events from 2001 to 2002	—	—	—	1.34	[0.96, 1.86]	.086
9/11-related posttraumatic stress						
Acute stress (2001)	—	—	—	3.41	[1.54, 7.54]	.002
Posttraumatic stress at first anniversary	—	—	—	7.61	[2.79, 20.74]	< .001
Gender	—	—	—	2.35	[1.22, 4.51]	.010

Note: $n = 1,300$. Gender was coded 0 for male and 1 for female. All models were significant—Model 1: $F(2, 1298) = 8.61, p < .001$; Model 2: $F(6, 1294) = 9.55, p < .001$. 9/11 = September 11, 2001. CI = confidence interval.

media exposure was included, however, 9/11-related television watching was no longer a significant predictor of posttraumatic stress symptoms 3 years after 9/11.

We used GEEs to examine whether 9/11- and war-related media exposure independently predicted 9/11-related posttraumatic stress symptoms over time (2–3 years after 9/11) and tested whether this relationship was mediated by cumulative high acute stress (Table 4). Both 9/11- and war-related media exposure predicted posttraumatic stress symptoms after we controlled for pre-9/11 mental health (Table 4, Model 1). After adjusting for significant covariates, we found that watching 1 or more hr per day of early post-9/11 television coverage, watching 4 or more hr per day of war-related television coverage, and frequent viewing of Iraq War images all predicted increases in posttraumatic stress over 3 years following 9/11 (Table 4, Model 2). When testing cumulative acute stress as a mediator, both media exposure and acute stress significantly predicted 9/11-related posttraumatic stress (Table 4, Model 3). Given that 9/11- and war-related television watching and frequent exposure to Iraq War images all predicted high acute stress, results suggest that media-image exposure is independently and indirectly associated with posttraumatic stress, in part through acute stress responses to media exposure. Although 15 of 16 Iraq War images were associated with 9/11-related posttraumatic stress symptoms 2 to 3 years after 9/11, two images remained significant in multivariate analyses: soldiers engaged in battle ($b = 0.06$, 95% CI = [0.01, 0.12], $p = .031$) and dead U.S./Allied soldiers ($b = 0.17$, 95% CI = [0.09, 0.26], $p < .001$).

Media exposure and physical ailments

We used GEE to examine media exposure as a predictor of physical-health ailments 2 to 3 years after 9/11 and whether this relationship was mediated by cumulative acute stress (Table 5). Watching 1 to 3 hr per day of early 9/11-related television predicted a 24% increase, whereas watching 4 or more hr per day predicted a 33% increase in reports of physical health ailments 2 to 3 years after 9/11 (Table 5, Model 1), even after we adjusted for pre-9/11 physical health. After adjusting for covariates (including somatization), we found that watching 1 to 3 and 4 or more hr of 9/11-related television coverage predicted a 20% and 21% increase, respectively, in reports of physician-diagnosed physical-health ailments 2 to 3 years later (Model 2). However, acute stress did not reach significance, which suggests that it does not mediate the association between media exposure and physical health (Model 3). Neither the index nor individual war-related media-exposure items were associated with physical ailments 2 to 3 years after 9/11, perhaps reflecting the time lag required for development of health problems.

Possible alternative explanations for findings

We examined whether our findings could be accounted for by individual differences in overall television watching. Thirty-five percent of the sample ($n = 774$) completed a survey of television viewing habits before 9/11; a portion ($n = 1,147$) completed a similar survey before the Iraq War. The typical number of hours of television watched before the attacks and 9/11-related television exposure in the week following 9/11 were only moderately related ($n = 774$; $r = .30$, $p < .001$), and hours of daily television watched before the Iraq War was modestly associated with war-related television watching during the war ($n = 1,147$; $r = .20$, $p < .001$). However, neither pre-9/11 nor prewar television watching was significantly associated with 9/11-related acute stress, posttraumatic stress, or Iraq War-related acute stress. Pre-Iraq War television watching was weakly associated with reports of physician-diagnosed physical ailments 2 to 3 years after 9/11 (incident rate ratio = 1.04, 95% CI = [1.01, 1.06]). However, the effect size for 9/11-related television watching remained robust after adjusting for pre-Iraq War television watching.

Perhaps people who watch one collective trauma (the 9/11 attacks) tend to watch another (the Iraq War) and tend to be exposed to more media content generally. However, early post-9/11-related television exposure was only modestly associated with media exposure at initiation of the Iraq War ($r = .29$, $p < .001$). Alternatively, maybe respondents who watched television right after 9/11 continued to expose themselves to 9/11-related vivid images chronically, and continued exposure produced the documented effects. We tested this hypothesis with data collected around the first anniversary of 9/11. Immediate post-9/11 television exposure was only moderately associated with 9/11-related anniversary television exposure ($r = .27$, $p < .001$). After adjusting for hours of 9/11-related anniversary television watching, we found that early post-9/11- and war-related television exposure remained robustly associated with our outcomes. Indeed, both early 9/11-related and 9/11-related anniversary television watching were significant predictors of posttraumatic stress symptoms 2 to 3 years after 9/11 in the fully adjusted model.

Finally, another plausible explanation for the effects of media exposure over time is that chronic stressors (e.g., unemployment) or personality traits are driving the effects. We examined occupation at the start of the study (employed full time vs. employed part time, unemployed, retired, and homemaker, respectively) and neuroticism as possible third-variable explanations for our findings. Although occupation was associated with 9/11- and war-related television watching, it was not associated with

Table 4. Results of Models Using Generalized Estimating Equations to Predict Posttraumatic Stress Symptoms 2 to 3 Years Following the September 11 (9/11), 2001, Terrorist Attacks

Independent variable	Model 1			Model 2			Model 3		
	<i>b</i>	95% CI	<i>p</i>	<i>b</i>	95% CI	<i>p</i>	<i>b</i>	95% CI	<i>p</i>
Time	0.05	[-0.02, 0.11]	.142	0.05	[-0.01, 0.11]	.114	0.05	[-0.01, 0.11]	.136
9/11-related TV watching in week after 9/11									
1 to 3 hr per day	0.14	[-0.02, 0.30]	.094	0.19	[0.04, 0.34]	.012	0.17	[0.02, 0.33]	.029
4 or more hr per day	0.29	[0.12, 0.47]	.001	0.31	[0.14, 0.47]	< .001	0.27	[0.10, 0.44]	.002
Iraq War-related media exposure									
4 or more hr of TV per day	0.39	[0.17, 0.62]	.001	0.35	[0.15, 0.55]	.001	0.28	[0.11, 0.45]	.001
Frequency of Iraq War-image exposure	0.18	[0.08, 0.28]	< .001	0.17	[0.09, 0.26]	< .001	0.15	[0.08, 0.23]	< .001
Pre-9/11 mental-health ailments	0.15	[0.06, 0.24]	.001	0.10	[0.02, 0.17]	.016	0.06	[-0.01, 0.13]	.072
9/11 exposure									
Live TV vs. no live TV	—	—	—	0.05	[-0.07, 0.17]	.409	0.00	[-0.11, 0.11]	.978
Direct exposure vs. no live TV	—	—	—	0.44	[0.11, 0.77]	.009	0.37	[0.03, 0.71]	.032
Hispanic/Latino ethnicity	—	—	—	0.42	[0.13, 0.71]	.004	0.35	[0.09, 0.61]	.009
Adverse life events									
Pre-9/11 adverse life events	—	—	—	0.08	[-0.02, 0.17]	.115	0.07	[-0.02, 0.16]	.122
Adverse events from 2002 to 2004	—	—	—	0.20	[0.12, 0.28]	< .001	0.17	[0.09, 0.24]	< .001
Cumulative acute stress	—	—	—	—	—	—	0.38	[0.30, 0.45]	< .001

Note: $N = 1,244$. Coefficients represent the degree of change in posttraumatic stress symptoms (in standard-deviation units) associated with a one-unit change in the independent variable. The reference group for hours of 9/11-related TV watching was less than 1 hr of daily 9/11-related TV watching in the week following the attacks. Gender was coded 0 for male and 1 for female. The reference group for ethnicity consisted of European American, African American, and other ethnicities combined. The reference group for direct 9/11 exposure was no live exposure. All models were significant—Model 1: Wald $\chi^2(6, N = 1,244) = 50.72, p < .001$; Model 2: Wald $\chi^2(11, N = 1,244) = 93.73, p < .001$; Model 3: Wald $\chi^2(12, N = 1,244) = 179.37, p < .001$. CI = confidence interval.

Table 5. Results of Models Using Generalized Estimating Equations to Predict Physician-Diagnosed Physical-Health Ailments Reported 2 to 3 Years Following the September 11 (9/11), 2001, Terrorist Attacks

Independent variable	Model 1			Model 2			Model 3		
	AIRR	95% CI	<i>p</i>	AIRR	95% CI	<i>p</i>	AIRR	95% CI	<i>p</i>
Time	1.89	[1.80, 1.98]	< .001	1.89	[1.80, 1.99]	< .001	1.89	[1.80, 1.99]	< .001
9/11-related TV watching in week after 9/11									
1 to 3 hr per day	1.24	[1.06, 1.46]	.009	1.20	[1.04, 1.38]	.014	1.19	[1.03, 1.37]	.018
4 or more hr per day	1.33	[1.12, 1.57]	.001	1.21	[1.05, 1.40]	.008	1.21	[1.04, 1.39]	.011
Pre-9/11 health									
Mental-health ailments	—	—	—	1.00	[0.96, 1.03]	.820	0.99	[0.96, 1.03]	.699
Physical-health ailments	1.12	[1.10, 1.14]	< .001	1.30	[1.24, 1.37]	< .001	1.31	[1.24, 1.38]	< .001
Ex-regular smoker	—	—	—	1.10	[1.01, 1.19]	.030	1.10	[1.01, 1.20]	.025
Demographics									
Age	—	—	—	1.21	[1.16, 1.26]	< .001	1.21	[1.16, 1.27]	< .001
Gender	—	—	—	1.08	[1.00, 1.18]	.055	1.08	[0.99, 1.17]	.070
Adverse life events									
Pre-9/11 adverse life events	—	—	—	1.09	[1.04, 1.15]	.001	1.09	[1.03, 1.14]	.001
Adverse events from 2002 to 2004	—	—	—	1.06	[1.02, 1.10]	.002	1.05	[1.01, 1.09]	.006
Other									
Somatization	—	—	—	1.07	[1.03, 1.11]	< .001	1.06	[1.02, 1.10]	.001
Cumulative acute stress	—	—	—	—	—	—	1.04	[0.99, 1.09]	.091

Note: $N = 1,260$. Adjusted incident-rate ratios (AIRRs) represent the rate of physical-health disorder occurrence in the exposed group divided by the rate of physical-health disorder occurrence in the unexposed group (reference group) after adjusting for covariates in the model. The AIRR shows whether an exposure was “preventative” (< 1), “causative” (> 1), or unrelated to ($= 1$) the rate of physical-health disorder outcome in the exposed population compared with the unexposed population. The reference group for hours of 9/11-related TV watching was less than 1 hr of daily 9/11-related TV watching in the week following the attacks. Gender was coded 0 for male and 1 for female. The reference group for ethnicity consisted of European American, African American, and other ethnicities combined. All models were significant—Model 1: Wald $\chi^2(4, N = 1,260) = 824.44, p < .001$; Model 2: Wald $\chi^2(12, N = 1,260) = 1,082.88, p < .001$; Model 3: Wald $\chi^2(12, N = 1,260) = 1,099.87, p < .001$. CI = confidence interval.

acute stress at either time point or posttraumatic stress symptoms 2 to 3 years after 9/11. Physical-health findings were equally strong with occupation in the model. Neuroticism (measured by the Ten-Item Personality Inventory; Gosling, Rentfrow, & Swann, 2003) was not associated with 9/11-related television watching, the frequency of seeing media images of the war, or physical health 2 to 3 years after 9/11. Although neuroticism was associated with Iraq War-related television watching and posttraumatic stress, all findings remained robust when it was included in the model. Although another unmeasured or untested third variable may have been driving both media exposure and ongoing difficulties, we tested many plausible confounds (pre-9/11 mental health, 9/11-related loss, prior adversity, recent adversity), and the effects of media exposure remained robust.

Discussion

This study strongly suggests that widespread media coverage of terrorism and war can have negative mental- and physical-health consequences over time. Both frequency and content of media exposure appear to have powerful effects beyond those of direct trauma exposure and acute stress response. It is important to note that acute stress itself appears to be associated with media exposure, and the effects of acute stress responses to media images may accumulate across exposure to multiple events (cf. Maldonado et al., 2002).

Basic research on emotion and physiology has found that viewing even static images of threat or harm to strangers reliably leads to physiological arousal consistent with a stress response (Bradley & Lang, 2007). Media coverage of 9/11 and the Iraq War featured such images prominently. In the week after 9/11, the visual images of the attacks repeatedly included images of planes hitting buildings, buildings on fire, and people jumping from buildings. The visual images of the war were far more variable, but our fine-grained analysis of media content revealed that images of threat or harm specifically predicted psychological outcomes, a finding consistent with the assertion that the content of media images is important for understanding their impact (Ahern et al., 2002; Schlenger et al., 2002). Moreover, both 9/11 and the Iraq War made shared national identity highly salient for Americans, potentially giving the witnessed images greater power than other images in which harm or threat occurs to "strangers."

Distinctive features of our study strengthen our confidence that media images played a unique role in predicting outcomes. Our design was prospective (physical- and mental-health ailments were collected before 9/11) and longitudinal (allowing examination of change over time; Michels, 2002). Studies rarely begin within days of a

collective trauma. Yet we assessed acute stress and media exposure in most respondents 9 to 14 days after 9/11 and 8 to 18 days after the start of hostilities in Iraq. We examined several alternative explanations for our results (demographics, lifetime and ongoing exposure to adversity). Adjusting for potential confounds did not substantially reduce the effect of media exposure on subsequent physical and mental health.

Several limitations of the current study must nonetheless be acknowledged. We did not maintain our full sample over the course of our multiwave longitudinal study, and our demographic predictors of attrition are known risk factors for PTSD. However, our attrition analysis suggests that dropout was not associated with key study variables. We used self-report measures of symptoms rather than face-to-face clinical interviews. However, the use of Web-based data-collection methods provided anonymity that has been shown to lower rates of socially desirable responses (see Schlenger & Silver, 2006, for a review). Time limitations and the potential for questionnaire redundancy prevented assessments of posttraumatic-stress response to the Iraq War over time. A single item measured 9/11-related television exposure, although our assessment of war-related media exposure incorporated the content of images. We used reconstructed media exposure, although ongoing media diaries or experience-sampling methods might provide additional useful information. Finally, we used self-reports of physician-diagnosed physical ailments that were not independently corroborated with medical records and may have been subject to recall biases and respondents' interpretations of their medical encounters. That said, our health measure had been benchmarked against the NHIS, which itself has been validated against medical records (U.S. Department of Health and Human Services, 1994). Finally, although causal statements are never appropriate when working with correlational data, the strengths of our design and analysis provided evidence against reverse causation and enabled us to test and control for many potential confounds.

Many mental-health professionals have wondered whether exposure to graphic media images can trigger psychopathology such as PTSD and other anxiety disorders (Pfefferbaum, Pfefferbaum, North, & Neas, 2002). Our goal is not to answer whether media exposure is sufficient for clinical diagnosis; instead, we consider the widespread potential clinical or, more likely, subclinical public-health consequences of repeated exposure to vivid media images of terrorism and war. Our data suggest that media exposure has measurable negative psychological and physical effects, and that exposure to graphic media images specifically may be an important mechanism through which the negative impact of a collective trauma is dispersed widely. Of course, it is

important not to lose sight of other factors that were also associated with ongoing symptomatology after 9/11. Greater lifetime and ongoing adversity, low education, low income, and preexisting mental-health conditions (which strongly predict early acute stress response) are all risk factors for deleterious mental- and physical-health effects following trauma.

Vivid images now reach a larger audience than ever before because of widespread availability of graphic streaming video on Internet sites such as YouTube or Vimeo, social media, and smart phones. Television is no longer the only way to spread this vivid content. Media outlets, policymakers, parents, psychologists, and other health-care professionals must be sensitive to the potential negative consequences of a steady diet or sudden influx of this material. To use Putnam's (2002) terminology, our data, at a minimum, lead us to encourage "informed viewer discretion" (p. 311) regarding repeated exposure to media images of collective traumas.

Author Contributions

R. C. Silver, E. A. Holman, J. P. Andersen, M. Poulin, D. N. McIntosh, and V. Gil-Rivas all contributed to the design of the project and the development of the survey instruments. Data analysis was conducted by E. A. Holman with the assistance of J. P. Andersen. R. C. Silver and E. A. Holman drafted the manuscript with the assistance of J. P. Andersen; M. Poulin, V. Gil-Rivas, and D. N. McIntosh provided substantive comments on the final draft. All authors approved the final version of the manuscript for submission.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Funding

Funding for this project was provided by U.S. National Science Foundation Grants BCS-9910223, BCS-0211039, and BCS-0215937 to R. C. Silver.

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