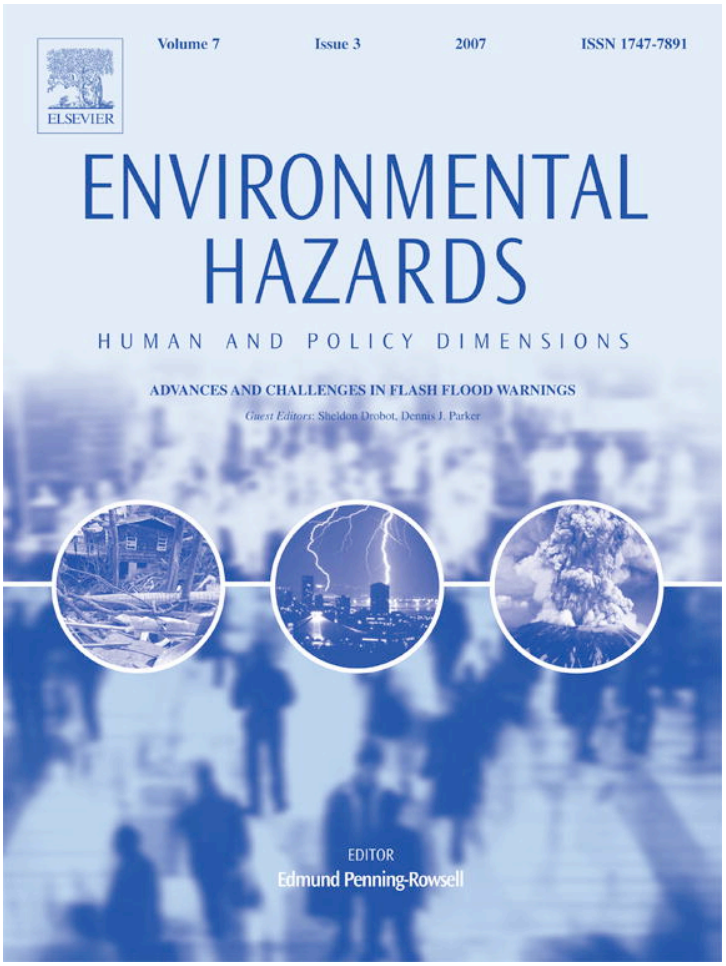

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Trauma and short-fuse weather warning perceptions

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Abstract

The purpose of this research was to assess the importance of psychological trauma in understanding reactions to short lead time weather warnings. The research consisted of two case studies, one in Denver, Colorado and the other in Austin, Texas. A total of 61 individuals with 9 or greater traumas were compared to 281 non-trauma exposed individuals. Results demonstrated significant differences on questions related to general beliefs about flash floods and warning perceptions as well as reported anticipated actions during a flash flood at home. Results suggest high trauma exposure may lead to more threat sensitivity and a higher probability of initiated action in a home-based flash flood.

Keywords: Trauma; Flash flood; Short-fuse weather disaster

1. Introduction

Improvements in warning communication and response depend on agencies' acceptance of the notion that there are many possible constituents of warning information (i.e., publics), each with its own particular set of preferences and possible responses to warning information. Willingness and even ability to respond to warnings go beyond typical demographic characteristics (e.g., age, ethnicity, and gender differences). This study investigated the importance of previous psychological trauma exposure on warning perceptions and reported warning response.

2. Literature review

Disaster warnings aim to promote public safety behaviors to reduce human casualties and property losses (Lindell and Perry, 2004). Effective warnings must motivate people to take protective actions. There has been a lack of research investigating individual difference factors that differentiate those who take these protective actions from those who do not. The purpose of this paper was to investigate the role of psychological trauma as an individual factor that could influence perceptions of and responses to warnings for flash floods.

Epidemiological estimates for trauma exposure vary, yet rates are significant ranging from 40% to an astounding 90% (Breslau et al., 1998). Multiple trauma exposure is also much more common than one might think. Kessler et al. (1995) reported that 26% of a representative sample reported 3 or greater lifetime traumas, and Resnick et al. (1993) found that more than 50% of a national sample of women reported more than one major traumatic event in their lifetime. Given the significant trauma exposure of the general population it is important to investigate the role this exposure might have in shaping perceptions to short-fuse weather warnings.

The effect of trauma exposure has been tangentially examined by previous research targeting personal experience and self-protective behaviors (Weinstein, 1989).

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Although not directly addressing traumatic exposure, Weinstein summarized the effects of personal experience on self-protective behaviors and concluded that the effects were modest and transient. However, more recent work specifically related to exposure to natural hazards (Norris et al., 1999) demonstrated a relatively robust and generalized effect following involvement with Hurricane Hugo. These authors demonstrated that exposure to the hurricane influenced preparedness behaviors, vigilance toward threats, and more self-disciplined behaviors two years following the storm. Interestingly, these effects were seen for aspects directly related to hurricane preparedness and risk assessment as well as other important domains such as crime prevention, vehicle safety, and general health protective behaviors. What is missing in the literature on previous experience with hazards is research that looks at extreme trauma exposure and the effects of this on hazard preparedness, risk awareness, and perceptions of warnings. This study focused on the importance of extreme trauma exposure in understanding perceptions of flash flood warnings.

The research on risk and decision making is critical to understand the potential impact of extreme trauma exposure on warning perceptions. This literature has relied on expected utility theory[1] to understand human responses to threat (Loewenstein et al., 2001). Loewenstein et al., however, have argued that emotional reactions during threat are potentially critically important in human decision making. Empirical evidence supports the role of emotions in decision making and suggests that they may provide information on decisional options separate from cognitive interpretation (Loewenstein et al., 2001). Indeed, there is substantial research that suggests that certain internal aspects of the person (e.g., self-esteem, emotional states, etc.) can and do influence decision processes rather than relying only on environmental cues (e.g., Lauriola et al., 2005; Mcelroy et al., in press; Wang, 2006). Thus, the previous argument would suggest that emotional information should influence risk perception and responses to short-fuse weather warnings. The literature on traumatized populations demonstrates direct cognitive interpretation and cognitive processing effects that have implications for warning perceptions.

Research on trauma and cognitive processing has primarily focused on individuals suffering from post-traumatic stress disorder (PTSD), a clinical syndrome associated with severe emotional and psychosocial dysfunction[2]. Traumatized individuals with PTSD have shown differences on a number of important cognitive processing variables when compared with trauma-exposed individuals without PTSD. They have shown deficits in attention, impairments in memory, and greater threat cue sensitivity (Buckley et al., 2000; Vasterling et al., 1998). Similar to individuals with diagnosable PTSD, research on more generally anxious individuals has also shown these individuals to be more sensitive to threat information (Barr-Haim et al., 2007).

Based on the reviewed literature we hypothesized that individuals with extreme levels of reported trauma exposure will show significantly different perceptions to risk and vulnerability questions (threat cue sensitivity) and responses to flash flood threat scenarios compared to people who report no trauma exposure.

3. Method

3.1. Survey development

Two survey instruments were developed to assess perceptions of short-fuse weather hazards in Denver and in Austin. The questionnaires were developed in 2003. The questionnaire drafts were reviewed by a select advisory committee made up of officials involved in floodplain management and weather warning from Denver and Austin. The questionnaires were tailored for the risks and local hazards and geography for each city, and the advisors reviewed the project materials. They served as a "local knowledge" base to enhance the likelihood that the most critical "local" aspects were incorporated in the study and to increase the chances that the study conclusions and recommendations would be applicable. In collaboration with the advisory committee, questions were designed to assess the use of new warning sources, new sources of technology, experience with false alarms, attitudes toward government, previous experience with the hazard, physical understanding of the potential hazards, physical limitations, demographic characteristics, trauma history, and perceptions of coping. The present study focused specifically on the influence of the trauma questions on warning perceptions.

In addition to the general survey questions, two brief flash flood scenarios were also included based on actual severe weather events in both Denver and Austin followed by warning behavior questions. Two tornado scenarios were also included in the Austin survey. The scenarios were developed to provide a realistic warning context for respondents facing imminent severe weather conditions: one was based on being at home and the other while driving. Particular localized scenarios were written to elicit respondents' perceptions of environmental cues such as six inches of water on the road, the issuance of official warnings, and how their perceptions differed if they were at

[1]Expected utility theory proposes that individuals make decisions based on maximizing the probability of positive outcome using all available information relative to environmental conditions.

[2]Posttraumatic Stress Disorder symptoms include: (a) intense replaying of the trauma through intrusive thoughts, reliving the trauma, and nightmares, (b) strong on-going physical reactivity resulting in being easily startled and having difficulty sleeping, and (c) avoiding things that relate to the trauma. Posttraumatic Stress Disorder is considered an Anxiety

(*footnote continued*)
Disorder by the Diagnostic Manual for the American Psychiatric Association.

home or driving. The survey and pre-survey letter were translated into Spanish by two different people fluent in the Spanish language.

3.2. Sampling methodology

The survey procedure was conducted based on the Dillman (2000) method for mail and Internet questionnaires. The 90-question survey of 16 pages had seven parts: (1) Your thoughts about flash floods; (2) Imagine yourself in a flash flood situation; (3) Your experiences with flash floods; (4) Imagine yourself in a tornado situation (only in Austin, because Denver has a lower tornado risk); (5) Your weather information sources; (6) Your experiences with trauma; and (7) About you and your family. The survey is available in electronic format from the first author for follow-up research on other hazards or in other cities.

The Denver study was conducted first. The sample was drawn from floodplain addresses developed by the Urban Drainage and Flood Control District in Denver. A total of 3000 households were selected. In September 2004, a total of 1500 pre-survey letters were sent to 1500 randomly selected residences in the Denver sample to inform them that a survey would follow shortly. Within two days of mailing the letter, 1500 surveys were sent out. A reminder/thank you postcard was sent approximately two weeks after the initial mailing. Two weeks later 195 completed surveys were returned. A second mailing of 1375 reminder postcards was mailed in November 2004. A second full questionnaire packet was sent to those who did not respond. Then another round of 610 surveys was mailed. Rather than sending out a third mailing, a new randomly selected subset of the original set of addresses not utilized in the first random sample was selected for a final mailing. In December of 2004, a total of 1300 pre-survey letters were mailed, followed by 1300 surveys two days later. The final number of returned surveys for Denver was 415 for a response rate of 14.8%.

A flood plain list was also obtained through the Watershed Protection and Development Review Agency in Austin. In Austin the same system was utilized with pre-post cards followed by a mass mailing. An initial 1500 randomly selected addresses were sent surveys. A second mailing was sent to those who did not return the first survey. A total of 519 surveys were sent back to us from Austin residents for a return rate of 34.6%.

For the present study a sub-sample of the total 934 participants was chosen focusing on extreme trauma. A total of 61 individuals with 9 or more lifetime traumas was identified and then compared with 281 non-exposed individuals. Thus, for this sample the percentage of participants with extreme trauma (i.e., 9 or more lifetime trauma) was 6.5%. The two groups did not differ in percentages of males and females ($\chi^2 = 0.28$, ns), Hispanic versus Caucasian distribution ($\chi^2 = 2.97$, ns), or on completed education ($F(1, 332) = 0.39$, ns). Actual numbers for each analysis differed slightly due to number of participants in each group answering each item.

As part of the overall survey we asked participants the following question: ''We are interested in knowing how traumatic experiences influence people's lives and how they cope with weather warnings. Please put an X in the box below that represents how many traumatic experiences you've had in your life. A *traumatic event is defined as an event that threatened your life or someone close to you where you felt intensive fear, horrified, or helpless,* such as being in a natural disaster, terrorist attack, major accident such as a car accident, physical attack, sexually assaulted, mugged.'' Respondents answered the question on the following scale: [0 times, 1–4 times, 5–8 times, 9–12 times, more than 12 times]. Because the focus of the study was on comparing extreme trauma exposure versus no trauma, we created a dichotomous variable with 0 reported traumas versus 9 or greater traumas. There is no accepted number of traumas that has been utilized for defining extreme trauma exposure. Thus for this study we chose a threshold of 9 or more traumas to maximize the potential differential effects seen between the extremely exposed group versus the non-trauma exposed group, while still retaining a reasonable sample size per group.

3.3. Dependent variables

The dependent variables were divided into conceptual groupings for ease of interpretation. All items, except those listed as true false below, were answered on a four point Likert-type scale with 1 = strongly disagree and 4 = strongly agree (the complete survey is available from the first author).

Risk and vulnerability: The first group included 3 items that were designed to assess perceived risk or vulnerability. These include: ''A flash flood in Denver (Austin) poses a life threatening risk to me'' (true, false); ''I take flash flood warnings seriously''; and ''Flash flood waters may cause dams and other water control structures to fail''.

Hazard knowledge: The second group of 3 items related to perceived hazard knowledge and included the following: ''I live in an area where flash floods occur'' (true, false); ''A vehicle can be carried away by moving water 18″ deep''; and ''I consider myself a good judge of whether flood waters are dangerous''.

Risk behavior: One item was used to measure risky behavior more generally. It said: ''I would drive through an intersection with 6″ of moving water''. In addition to this item, we provided respondents with two different flash flood scenarios. The first scenario focused on behavior if one were at home during a flash flood. The response items included: ''I feel I am completely capable to keep myself safe in this situation''; ''I would first try to confirm that the hazard was serious''; ''I would either immediately seek higher ground or go to an upper floor''; ''I would call 911 for help''; ''I would get in my vehicle and attempt to drive away''; and ''I would take no action''. The second scenario

was designed to be more threatening than the first and focused on being caught in a flash flood while driving. The response options were: "I feel I am completely capable to keep myself safe in this situation"; "If traffic started moving, I would attempt to cross the water"; "Regardless of the car I'm driving, if the water were covering most of the tires of the truck in front of me, I would attempt to drive through the water"; "If I were driving an SUV, truck, or 4-wheel drive instead of a car, I would attempt to drive through the water"; and "I would attempt to drive through the water to get home to loved ones and/or pets" (see Drobot et al., 2007, for more details on the driving scenario).

3.4. Analytic strategy

To test the effects of trauma exposure and distress on the different warning perception questions we compared high level of exposure to trauma (9 or more reported trauma) versus no reported trauma. We also utilized a dichotomous grouping variable for the sample city to be able to test for regional differences. Due to the dependent variables not conforming to the normality assumption of analysis of variance (ANOVA), we also conducted Mann–Whitney *U* non-parametric tests for each of the response questions in addition to ANOVA. Results were virtually identical. We decided to provide the results to the ANOVA analyses for ease of interpretations using the mean values. In addition, due to the unequal *N*'s between our two groups we also ran the ANOVA analyses with a random sample of 65 individuals with no reported trauma. The results were consistent, but the effects were stronger.

4. Results

Initial ANOVAs were computed to test for differences between Denver and Austin on the total number of reported traumas and total weather-related trauma. Austin residents reported on average significantly more weather-related trauma ($M_{austin} = 25$) than Denver residents ($M_{denver} = 2$) [$F(1, 429) = 50.24$, $p < 0.01$]. Table 1 depicts the means and standard deviations for all the response questions utilized separated by content domain. We did ask participants to tell us which trauma had the most impact on them at the present time. For those who chose to answer this question, we had a variety of responses ranging from rape, domestic violence, sexual abuse, sudden death of a loved one, weather-related trauma, non-weather disasters, and combat/war trauma.

Table 2 depicts the significant differences found between highly trauma-exposed individuals compared with those who reported no trauma. Looking at the entire sample together, we did find some interesting findings for individuals reporting nine or greater lifetime traumas versus those reporting no trauma. ANOVA demonstrated a marginally significant effect for taking flash flood warnings seriously. Mean values indicated that those with high level of trauma exposure took warnings slightly more seriously ($M_{trauma} = 3.57$) compared to those with no trauma exposure ($M_{non\text{-}trauma} = 3.37$). A significant difference was identified with traumatized individuals reporting that they more strongly agree ($M_t = 2.93$) that flood waters may cause dams and other flood control structures to fail than non-trauma exposed individuals ($M_n = 2.67$). A marginally significant finding was also found for the item related to whether 18″ of moving water can wash away a car with highly trauma-exposed individuals agreeing more ($M_t = 3.52$) compared to those with no trauma exposure ($M_n = 3.39$).

When faced with the at home flash flood scenario some interesting differences also emerged. Highly trauma-exposed participants were significantly more likely to agree that they would seek higher ground or go to an upper floor ($M_t = 3.35$) or get into their car and drive away ($M_t = 2.10$) compared to their non-trauma exposed counterparts ($M_n = 3.15$; $M_n = 1.93$, respectively). They also disagreed more strongly than the non-exposed group that they would take no action ($M_t = 1.44$; $M_n = 1.68$).

No significant differences were found for the driving scenario. This is interesting given the more threatening nature of the second scenario. For a broader analysis of the risk factors for driving through flooded streets see Drobot et al. (2007).

5. Discussion

This preliminary study on the effect of extreme trauma exposure on flash flood warning perceptions and anticipated behavioral actions suggests that this type of elevated trauma exposure may be an important differentiating factor for flash flood situations. Collectively, the results suggest that highly trauma-exposed individuals are more threat sensitive and more likely to take some action within the context of a flash flood. These data are consistent with the previous literature that has found traumatized individuals to be more sensitive to threat cues (Barr-Haim et al., 2007; Buckley et al., 2000; Vasterling et al., 1998).

The finding that highly trauma-exposed participants were more likely to take some action in the home flash flood scenario is potentially important in the context of the threat cue sensitivity and the responses they indicated they would do. They agreed significantly more that they would go to a higher floor or seek higher ground (safe response), but also agreed more (albeit less than seeking a higher place) that they would get into a vehicle and drive away (unsafe response). We were unable to find any empirical literature on actual behavioral responses within a hazard setting for highly trauma-exposed people. One could argue that the cognitive processing differences in anxious and traumatized people that include attention and concentration difficulties combined with threat cue sensitivity could predispose this group to making more risky decisions during a true crisis situation. However, it is also possible that these individuals would be more aware of

Table 1
Means and standard deviations for main response variables

Response item	Denver		Austin	
	M (% Yes, No)	*SD*	*M* (% Yes, No)	*SD*
Risk and vulnerability				
A flash flood in Denver (Austin) poses a life threatening risk to me	Yes = 49 No = 51		Yes = 48 No = 39 Do not know = 14	
I take flash flood warnings seriously	3.29	0.65	3.55	0.59
Flash flood waters may cause dams and other water control structures to fail	2.73	0.80	2.72	0.84
Hazard knowledge				
I live in an area where flash floods occur	Yes No			
A vehicle can be carried away by moving water 18″ deep	3.21	0.59	3.60	0.55
I consider myself a good judge of whether flood waters are dangerous	2.71	0.69	2.96	0.76
Risk behavior				
I would drive through an intersection with 6″ of moving water	2.22	0.83	2.07	0.82
Home scenario responses				
I feel I am completely capable to keep myself safe in this situation	2.67	0.80	2.68	0.79
I would first try to confirm that the hazard was serious	2.43	0.77	2.78	0.80
I would either immediately seek higher ground or go to an upper floor	3.25	0.64	3.21	0.71
I would call 911 for help	2.21	0.77	2.54	0.88
I would get in my vehicle and attempt to drive away	2.00	0.73	1.87	0.75
I would take no action	1.59	0.62	1.57	0.64
Driving scenario responses				
I feel I am completely capable to keep myself safe in this situation	2.21	0.79	2.38	0.87
If traffic started moving, I would attempt to cross the water	2.13	0.71	1.56	0.61
Regardless of the car I'm driving, if the water were covering most of the tires of the truck in front of me, I would attempt to drive through the water	1.61	0.61	1.31	0.51
If I were driving an SUV, truck, or 4 instead of a car, I would attempt to drive through the water	2.11	0.76	1.58	0.64
I would attempt to drive through the water to get home to loved ones and/or pets	2.05	0.73	1.59	0.73

environmental cues and therefore react in a more positive protective manner (Norris et al., 1999). These suggestions are purely speculative and require future research that can verify actual behavioral actions taken by traumatized individuals within the context of warning behaviors during threatening situations.

It is important to consider some alternative explanations for the present findings. It is possible that the sub-sample of individuals reporting greater than 9 lifetime traumas might be unique in some psychological respects effecting their responding to these questions. It is possible that individuals who report this many traumas are, in fact, more anxious or neurotic in some way that causes them to report greater numbers of traumas as well as differential answers to the flash flood warning questions. Because we were unable to include standardized measures of anxiety or some other potentially important personality construct (e.g., neuroticism) we are unable to address this issue. However, future research in this area should include such measures to be able to rule out this possible confound.

It is also possible that the constellation of the traumas is important in warning perceptions. For example, an individual with extreme exposure to natural hazards due to physical location (tornado alley or flood plain) might perceive and respond quite differently to a flash flood warning when compared to an individual with both natural hazard exposure and interpersonal traumas (e.g., rape or mass violence exposure). The present data set does not provide an opportunity to address this issue. Future research on this topic should gather the type and response to the trauma (e.g., felt horrified, coped well, etc.) for each exposure identified. This information might provide very useful categorizations of trauma-exposed populations where different warning messages could be targeted.

Future experimental studies designed in an ethical manner that manipulate different levels of threat with various levels of trauma-exposed individuals (e.g., driving simulator or virtual reality studies) would also help extend this research. Naturalistic observational studies that sample within real flood environments where retrospective information on lifetime trauma exposure is obtained would also be useful.

Another potentially important factor might be how recently the individual was exposed to a life-threatening situation. Research with traumatized populations has shown that most people will experience significant distress early after a trauma (within the first month) followed by a steady decline of symptoms over the next several months

Table 2
ANOVA results comparing high trauma versus no trauma groups

Response item	High trauma	No trauma	*F*-value	*p*-value	Partial eta^2
Risk and vulnerability					
I take flash flood warnings seriously	3.57	3.37	3.17	0.07	0.009
Flash flood waters may cause dams and other water control structures to fail	2.93	2.67	5.12	0.02	0.016
Hazard knowledge					
A vehicle can be carried away by moving water 18″ deep	3.52	3.39	2.58	0.11	0.008
I consider myself a good judge of whether flood waters are dangerous	2.82	2.88	0.03	0.87	0.000
Risk behavior					
I would drive through an intersection with 6″ of moving water	2.20	2.07	1.29	0.26	0.004
Home scenario responses					
I feel I am completely capable to keep myself safe in this situation	2.62	2.62	0.01	0.95	0.000
I would first try to confirm that the hazard was serious	2.70	2.53	2.17	0.13	0.007
I would either immediately seek higher ground or go to an upper floor	3.35	3.15	4.67	0.03	0.014
I would call 911 for help	2.50	2.42	0.42	0.52	0.001
I would get in my vehicle and attempt to drive away	2.10	1.93	2.70	0.09	0.008
I would take no action	1.44	1.68	6.53	0.01	0.019
Driving scenario responses					
I feel I am completely capable to keep myself safe in this situation	2.32	2.29	0.05	0.82	0.000
If traffic started moving, I would attempt to cross the water	1.71	1.85	2.03	0.16	0.006
Regardless of the car I'm driving, if the water were covering most of the tires of the truck in front of me, I would attempt to drive through the water	1.39	1.49	1.27	0.26	0.004
If I were driving an SUV, truck, or 4 instead of a car, I would attempt to drive through the water	1.78	1.80	0.04	0.84	0.000
I would attempt to drive through the water to get home to loved ones and/or pets	1.83	1.79	0.11	0.74	0.000

(Shalev, 2002). Unfortunately, we did not ask participants when their trauma(s) had occurred and were therefore unable to test the importance of time since the event. Future research is necessary that addresses this issue.

It is unclear why the two groups did not differ in their reported responses to the more intense driving scenario. It is possible that the shifting from a home-based situation to driving is important. The behavioral options within the driving scenario were much riskier in that we focused specifically on driving forward through moving water. When environmental conditions are this salient it may override the emergence of individual differences. Thus, differences in behavioral action for highly trauma-exposed individuals may be seen when conditions are more ambiguous with less environmental and social cues for determining actions. Future research needs to determine if this is the case in that it may have implications for early warnings when environmental cues are more limited.

The limitations of this exploratory study are important to consider. First, the focused sampling strategy of this study on flood plain residents reduces the generalizability of the findings considerably. Thus, it is unclear if a random sample of an entire metropolitan population would yield the same findings. Second, due to the exploratory nature of the study no experimenter-wise error rate was utilized to correct for multiple statistical tests. The decision to accept a higher possibility of a Type I error was made due to the exploratory nature of this study and to not obscure group differences that could lead the way for future studies in this area. However, the possibility of a Type I error does exist and over interpretation of findings is not recommended. Third, due to the survey approach to this study we were unable to conduct a more reliable and possibly valid approach to measuring trauma exposure. Future work in this area should utilize well-validated and reliably structured clinical interviews such as the Structured Clinical Interview for the DSM-IV (First et al., 1997). Finally, it should be noted that the effect sizes for the significant findings were small ranging from below 1% to just below 2% of the variance. Future studies are needed to replicate these findings and to determine the practical value of these differences.

In summary, this is the first study to evaluate differences in warning perceptions and anticipated responses comparing highly trauma-exposed versus non-exposed individuals. The results provide a starting point for future research which may provide further evidence for the importance of warnings for different publics; in this case those who have faced life's most difficult challenges.

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