Reductions in anxiety sensitivity cognitive concerns prospectively mitigate trauma symptom development

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A B S T R A C T

Identifying a malleable pre-trauma risk marker for posttraumatic stress is crucial to preventing symptom development among at-risk individuals. One such candidate is anxiety sensitivity cognitive concerns (ASCC), which represents the fear of psychological incapacitation due to anxious arousal. While the extant literature suggests that applying ASCC interventions prior to trauma exposure should mitigate development of posttraumatic stress symptoms (PTSS), this has not been formally tested. We examined whether individuals randomized to receive a Cognitive Anxiety Sensitivity Treatment (CAST; $n = 44$) prior to a trauma film paradigm would report lower film-specific PTSS after one week compared to individuals randomized to a physical health education training control condition ($n = 47$). Results revealed that post-intervention ASCC and week-one PTSS were both lower among the CAST condition, and reductions in ASCC mediated the relationship between intervention condition and follow-up PTSS. The current study demonstrated that reducing ASCC prior to an analog trauma can mitigate the development of PTSS. This is critical for establishing ASCC as a causal risk factor for PTSS and encourages the use of ASCC interventions in samples at-risk for trauma exposure.

1. Introduction

Posttraumatic stress disorder (PTSD) is a disabling form of psychopathology precipitated by exposure to a traumatic event and followed by at least one month of intrusive reminders of the trauma, negative alterations in cognitions and mood, avoidance of trauma reminders, and hyperarousal symptoms (American Psychiatric Association [APA], 2013). Although it is suggested that well over half of the population is exposed to a traumatic event during their lifetime (Frans, Rimmö, Åberg, & Fredrikson, 2005; Kilpatrick et al., 2013; Read, Ouimette, White, Colder, & Farrow, 2011), it is estimated that less than 10% of trauma exposed individuals will develop PTSD (Keane, Marx, & Sloan, 2009; Kessler et al., 2005). While research has identified factors including gender, intelligence, and trauma history (Brewin, Andrews, & Valentine, 2000) that influence for whom trauma exposure will lead to PTSD, the inalterable nature of these specific variables limits our ability to preemptively thwart the potential development of PTSD symptoms even before an individual is exposed to trauma.

Alternatively, several malleable, trait-like cognitive biases have been highlighted as vulnerabilities in PTSD (Bomyea, Risbrough, & Lang, 2012; Elwood, Hahn, Olautnji, & Williams, 2009). Investigating these endogenous factors is imperative to understanding not only the causal etiology of PTSD (Ingram & Price, 2010), but by extension how

to alter the course of symptom development. Utilizing the four criteria outlined by Kraemer et al. (1997) for determining causal risk, causal risk factors for PTSD should: (1) be identified prior to trauma exposure; (2) demonstrate a relationship with PTSD symptoms following traumatic exposure; (3) be amenable to intervention; and (4) produce disparate outcomes in PTSD symptoms if intervened upon prior to trauma exposure. One variable proposed to be a causal risk factor for PTSD is anxiety sensitivity (AS; Bomyea et al., 2012; Elwood, Hahn, Olatunji, & Williams, 2009), a transdiagnostic risk factor that manifests as a fear of negative social, physical, or cognitive consequences resulting from anxious arousal (Reiss, Peterson, Gursky, & McNally, 1986; Taylor et al., 2007; Zinbarg, Barlow, & Brown, 1997). Where elevated AS social concerns influence one to catastrophize the social consequences of publicly-observable signs of anxiety (e.g., blushing), elevated AS physical concerns conflate physical symptoms of anxiety (e.g., shortness of breath) with potential harm or death (e.g., a heart attack), and elevated cognitive concerns may lead one to misconstrue racing or intrusive thoughts as a sign they are "going crazy" or will "lose control."

To date, AS has demonstrated the first three criteria outlined by Kraemer et al. (1997) to be considered a causal risk factor for PTSD. First, emerging evidence has indicated that pre-trauma AS is related to future PTSD symptoms. For instance, Olatunji and Fan (2015) utilized a 10-min film of motor vehicle accidents (MVAs) to demonstrate that pre-

film AS cognitive concerns predicted intrusive reminders of the film and AS physical concerns interacted with physiological responses to the film (i.e., skin conductance) to predict the development of avoidance and hyperarousal symptoms specific to the trauma film after one week. Relatedly, Boffa et al. (2016) found that pre-trauma AS physical and cognitive concerns interacted with proximity to a campus shooting to predict post-shooting PTSD symptoms. Second, meta-analytic reviews confirm a positive, concurrent relationship between PTSD symptoms and post-trauma AS (Naragon-Gainey, 2010; Olatunji & Wolitzky-Taylor, 2009). These reviews draw from studies that demonstrate that post-trauma AS is related to PTSD symptoms in both cross-sectional (e.g., Asmundson & Stapleton, 2008; Fedoroff, Taylor, Asmundson, & Koch, 2000; Lang, Kennedy, & Stein, 2002; Stephenson, Valentiner, Kumpula, & Orcutt, 2009) and longitudinal studies (Feldner, Zvolesnky, Schmidt, & Smith, 2008; Hansen & Elklit, 2014; Marshall, Miles, & Stewart, 2010). Similar to what we know of the relationship between pre-trauma AS and later PTSD symptoms, these studies further support the notion that individuals with higher post-trauma AS (particularly AS physical and cognitive concerns) experience greater PTSD symptoms (Naragon-Gainey, 2010).

Additional work on the malleability of AS has also supported the third criterion of causal risk factors (Broman-Fulks & Storey, 2008; Feldner, Zvolensky, Babson, Leen-Feldner, & Schmidt, 2008; Gardenswartz & Craske, 2001; Keough & Schmidt, 2012). Specific to the current investigation, work by Schmidt and colleagues has focused on the efficacy of single-session computerized AS interventions. In an initial study, a brief intervention produced a 30% decrease in overall AS and was prospectively associated with lower incidence of mood and anxiety psychopathology, including PTSD, over a 24-month follow-up period (Schmidt et al., 2007). More recently, Schmidt and colleagues (Schmidt, Capron, Raines, & Allan, 2014) developed a computer-based, single-session cognitive anxiety sensitivity treatment (CAST), which produced significant reductions in all facets of AS; however, the most robust effect was for AS cognitive concerns, which also mediate later change in suicidal ideation. Together, these studies indicate that AS, in particular the cognitive concerns dimension, is liable to change, and doing so has the potential to prevent further development of psychiatric disorders.

Although we are unaware of any study to explicitly demonstrate that intervening upon pre-trauma AS thwarts PTSD symptom development (i.e., the fourth causal risk factor criterion) there is evidence that this is plausible. For instance, AS reductions during a 12-week cognitive behavioral therapy program for MVA survivors was significantly related to reductions in PTSD symptoms (Fedoroff et al., 2000). Vujanovic and colleagues (2012) also found that reductions in AS predict subsequent reductions in PTSD symptoms at three-month follow-up in a single-session treatment case series of trauma-exposed adults. Similarly, Mitchell, Capron, Raines, and Schmidt (2014) found reductions in AS after a single-session computerized AS intervention were associated with reductions in PTSD symptoms at month one follow-up among a mixed veteran-civilian sample. Extending this one step further, two investigations have utilized the single-session CAST to demonstrate that reductions in AS, specifically the cognitive concerns dimension, account for (i.e., mediate) reductions in PTSD symptoms among trauma-exposed individuals (Allan, Short, Albanese, Keough, & Schmidt, 2015; Short et al., 2017). Together, these studies provide robust support for the idea that intervening upon post-trauma AS, in particular the cognitive concerns dimension, reduces concomitant PTSD symptoms. Considering the corpus of literature that identifies AS as a correlate and predictor of future PTSD symptoms, as well as a malleable intervention target that produces subsequent change in pre-existing PTSD symptoms, it is plausible that applying an AS intervention *prior* to trauma exposure may alter the course of PTSD symptom development. However, no study has explicitly tested this hypothesis.

1.1. The current study

The present investigation was designed to examine whether mitigating AS cognitive concerns prior to viewing an analog trauma film would differentially influence the development posttraumatic stress symptoms (PTSS) specific to the analog trauma film. Participants were randomized to receive either CAST or a physical health education training (PHET) control, prior to viewing an analog trauma film. Changes in AS were measured immediately prior to and following the assigned intervention, and PTSS were measured one week after viewing the video. The primary hypotheses for this study were: (1) individuals randomized to CAST would experience greater reductions in AS (global and subfactors) compared to PHET; (2) individuals in the active condition would report lower PTSS one week after the trauma film; and (3) intervention related reductions in AS would account for (i.e., mediate) PTSS one week after the trauma film. Furthermore, we hypothesized that this mediating effect would be specific to AS cognitive concerns given that CAST explicitly targets this domain (Schmidt et al., 2014) and it is the most consistently reported mechanism of PTSD change in prior trials (Allan et al., 2015; Short et al., 2017).

2. Method

2.1. Participants

Participants were recruited from an undergraduate research pool ($N = 2422$). We initially offered, via email, 624 individuals the opportunity to participate based on pre-screening scores at or above previously reported clinical means (≥ 9) on the Anxiety Sensitivity Index-3 (ASI-3; Taylor et al., 2007) cognitive concerns subscale. Approximately 75% ($N = 77$) of the final sample consisted of individuals who responded to that recruitment email. The remaining 25% ($N = 25$) were unselected undergraduates who opted to enroll in appointments opened to the entire research pool (i.e., were not required to evince elevated AS cognitive concerns). A total of 102 participants were recruited for the study, all of which were randomized to an intervention condition (Fig. 1). Of those, 97 received the allocated intervention, after one participant withdrew from the study citing time constraints, and another four did not receive the intervention due to technical errors with study equipment. Ninety-four participants returned for the one-week follow-up appointment. Ninety-one participants were included in the final analyses, after removing the three participants who did not return for the follow-up appointment, and three participants who failed to respond correctly to a question intended to check for accurate reporting.

The analyzed sample was primarily female (81.7%) and ranged in age from 18 to 36 ($M = 19.00$, $SD = 2.10$). Most participants identified as Caucasian (82.4%), the remainder comprised of 8.8% African-American, 5.5% Asian/Pacific-Islander, and 3.3% 'Other' (e.g., bi-racial). Of the 91 participants analyzed, 70 (76.9%) reported a probable lifetime history of trauma exposure. Among the subset of trauma exposed individuals, sexual assault (22.9%) was the most common index trauma followed by the sudden death or loss of a loved one (e.g., suicide; 20.0%), witnessing the serious bodily harm or death of a close friend or family member (15.7%), 'other' (e.g., witnessing domestic abuse, learning of a friend's rape; 15.7%), motor vehicle or work-related accident (12.9%), physical assault (7.1%), and natural disasters (5.7%).

2.2. Self-report measures

2.2.1. Anxiety Sensitivity Index-3 (ASI-3)

The ASI-3 is an 18-item self-report questionnaire designed to index the fear of anxious arousal. The ASI-3 comprises three lower-order subscales that index the fear of physical, mental, and social incapacitation in response to anxiety. Items are rated on a 5-point Likert scale from 0 ("very little") to 4 ("very much"), with global AS total
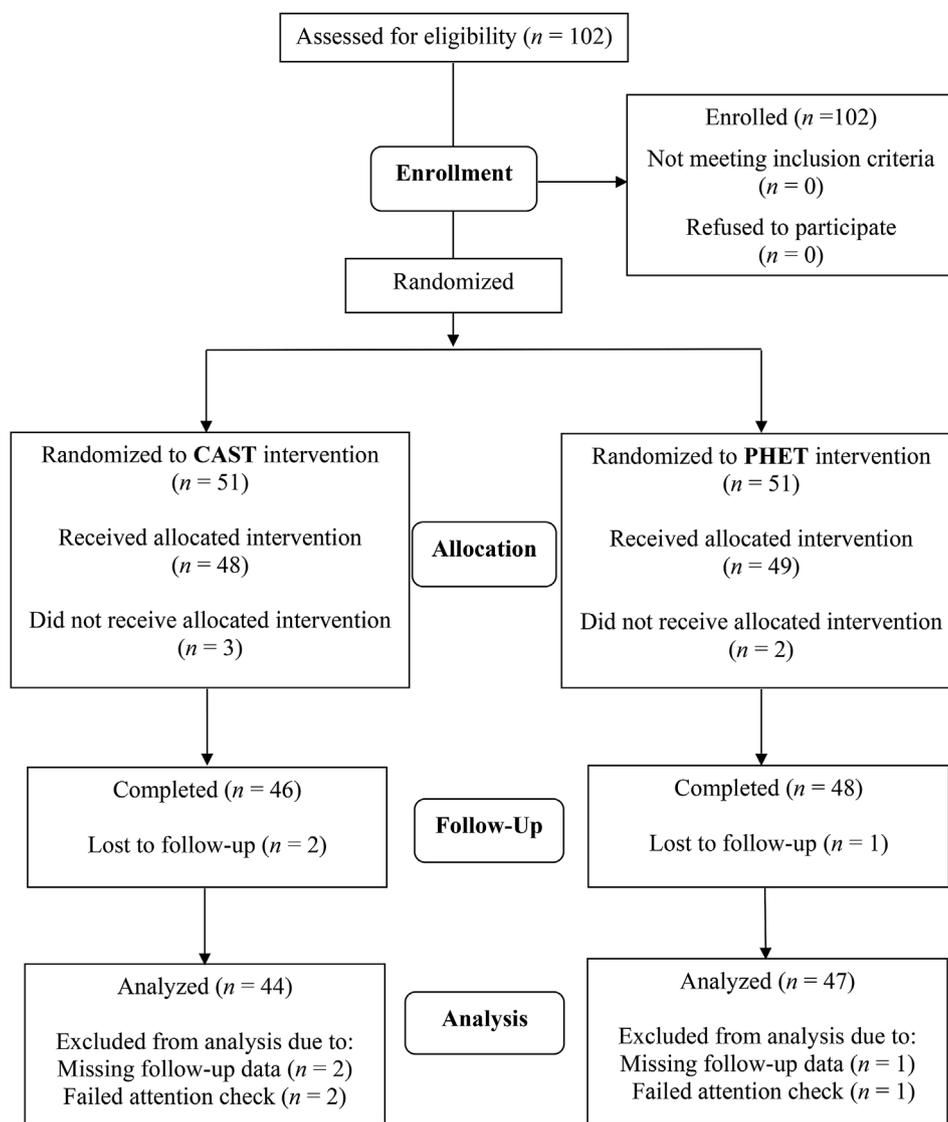
Fig. 1. CONSORT diagram of participant flow through study phases.
CONSORT = Consolidated Standards of Reporting Trials.

scores ranging from 0 to 72 and AS cognitive, physical, and social subscale scores ranging from 0 to 24; higher scores are indicative of greater self-reported fear of each respective domain of anxious arousal. The ASI-3 has demonstrated excellent reliability and validity (Taylor et al., 2007). The ASI-3 was administered to participants before and after they received their assigned intervention. Internal consistency was good at baseline and post-intervention for all ASI-3 total and subscale scores (α's $\geq$ 0.81).

2.2.2. Differential emotions scale-modified version (MDES)

The MDES (Gross & Levenson, 1995) is an 8-item scale consisting of state emotion items (e.g., "angry, irritated, mad") corresponding to a broader category (e.g., "unhappy"). Four items on the scale reflect positive affectations, while the other 4 reflect negative affectations. Participants were prompted (i.e., "I feel....") to respond to each emotion item on a 9-point Likert scale from 0 ("Do not feel the slightest bit of the emotion") to 8 ("The most I have ever felt in my life"), with higher subscale scores reflecting greater positive or negative affectation. Consistent with prior trauma film studies, the MDES was administered before and after the trauma film as a manipulation check of trauma film's ability to induce negative emotions (Olatunji & Fan, 2015). The four items from the negative affectation scale were used as a

manipulation check regarding the trauma film's intended purpose and demonstrated good internal reliability both pre- and post-film (α's = 0.75 and 0.87, respectively).

2.2.3. Impact of Event Scale- Revised (IES-R)

The IES-R (Weiss & Marmar, 1997) is a 22-item questionnaire assessing intrusions, avoidance, and hyperarousal symptoms associated with a specific traumatic event on a 5-point Likert scale from 0 ("Not at all") to 4 ("Extremely"). The IES-R was utilized as the primary outcome measure to index PTSS responses specific to the trauma film. As such, the IES-R instructions were modified such that participants were explicitly directed to respond to each item using the trauma film as the index event (i.e., "Please read each item, and then indicate how distressing each difficulty has been for you DURING THE PAST SEVEN DAYS with respect to the film of motor-vehicle accidents that you watched during your last appointment.") Consistent with previous methods used to examine the longitudinal effects of AS and this trauma film paradigm on symptom development, only the avoidance (e.g., "I tried not to think about it") and hyperarousal (e.g., "I was easily startled") subscales of the IES-R were employed in the present study (Olatunji & Fan, 2015). Therefore, possible scores at one-week follow-up range from 0 to 56, with higher scores indicating greater severity of

avoidance and hyperarousal PTSS. The IES-R has demonstrated good psychometric properties in prior research and has been suggested to be a more sensitive measure of traumatic stress in individuals experiencing lower-level symptoms (Creamer, Bell, & Failla, 2003). In the present study, the subset of avoidance and hyperarousal items of the IES-R demonstrated good internal reliability at week-one follow-up ($\alpha = 0.91$).

2.2.4. Life events checklist for DSM-5 (LEC-5)

The LEC-5 (Weathers, Blake, et al., 2013) is a screening questionnaire pertaining to 16 potentially traumatic events that an individual may have experienced in their lifetime. The LEC-5 was administered in the present study in order to obtain statistics related to lifetime history and type of trauma exposure and as a prompt for participants to respond to the PCL-5 in relation to a specific index trauma. If an individual reported multiple past events they were instructed to identify which they consider to be the worst or most upsetting, and to respond to all prompts on the PCL-5 in relation to that event.

2.2.5. Posttraumatic stress disorder checklist for DSM-5 (PCL-5)

The PCL-5 is a 20-item self-report measure assessing past month severity of the 20 *DSM-5* symptoms of PTSD (Weathers, Litz, et al., 2013). The PCL-5 was administered to participants to identify and control for any potential influence of prior trauma exposure and subsequent PTSS on responses to the trauma film paradigm. After using the LEC-5 to identify a specific index trauma, participants were directed to indicate the degree to which they have been bothered by each *DSM-5* PTSD symptom on a 5-point scale ranging from 0 ("Not at all") to 4 ("Extremely") during the past month in relation to that event. Possible PCL-5 total scores therefore range from 0 to 80, with higher scores indicative of greater PTSS severity. The PCL-5 demonstrated excellent internal consistency at the baseline time point in the current sample ($\alpha = 0.94$).

2.2.6. Attention check

As a means of determining whether participants were appropriately attending to the instructions of each questionnaire, we included a single multiple choice question to which participants were explicitly instructed to select the reply "I sometimes attend to them" from four answer choices (i.e., "I rarely attend to them," "I sometimes attend to them," "I often attend to them," and "I always attend to them."). Participants who did not select "I sometimes attend to them" were eliminated from data analysis as it was assumed that their pattern of responding on all measures may have been jeopardized.

2.3. Trauma film paradigm

The trauma film paradigm is frequently used in PTSD research as a means of studying peri- and post-traumatic responses to analog trauma exposure. Participants were shown a 10-min film that comprises 20 clips of motor vehicle accidents that depict serious physical injury. All film clips were individually sourced from YouTube and compiled into one continuous film. This film has been used in prior studies to examine the development of intrusions and analog trauma symptoms (Hawkins & Cougle, 2013; Olatunji & Fan, 2015). It is evinced to be moderately successful at producing intrusive reminders across the week following exposure to the film in an unselected sample ($M = 5.00$, $SD = 4.08$; Olatunji & Fan, 2015), to a degree commensurate with other traffic-related trauma film paradigms (Arnaudova & Hagenaars, 2017).

2.4. Randomized intervention conditions

2.4.1. Cognitive anxiety sensitivity treatment (CAST)

CAST (Schmidt et al., 2014) is a 50-min interactive, audiovisual program modeled after the educational and behavioral techniques commonly discussed in individualized treatments for anxiety disorders.

The first several slides provide rationale for the intervention, as well as psychoeducation regarding the nature of stress and its effect on the body and brain. The program is designed to describe how these effects can lead to "stress sensitivity" and overreactions to various symptoms, while then dispelling the notion that experiencing these stresses are immediately dangerous or harmful to the body. Specifically, CAST is designed to address the sensations and feared consequences of cognitive AS (e.g., "I will lose my mind") and the physiological arousal that may have developed as a conditioned fear to those sensations. The rationale for interoceptive exercises (IE) is provided, and the program guides individuals through a repeated hyperventilation exercise to demonstrate how IE can correct this conditioned fear to bodily sensations. Individuals then participate in a series of hyperventilation exposures and track their ratings of symptom distress and intensity to observe an extinction of the distress response. The program also reviews examples of four other IE exercises, and encourages them to practice them on their own to help with their stress sensitivity.

2.4.2. Physical health education training (PHET)

The PHET condition is designed to be similar in length and presentation to CAST, though it focuses on the importance and benefit of a healthy lifestyle. General guidelines for achieving this are discussed, including what constitutes proper diet, alcohol consumption, water consumption, hygiene, sleep, sexual health, stress management, life organization, social support, and the importance of a positive outlook.

2.5. Procedures

Upon providing informed consent, participants completed the ASI-3, LEC-5, and PCL-5. Participants were then randomized to an intervention condition based on a pre-determined set via a random numbers table. Participants completed CAST or PHET, after which changes in ASI-3 AS were assessed. Prior to viewing the trauma film, participants completed the MDES to assess baseline negative emotions. Participants then watched the trauma film, during which they were instructed to focus their attention on each scene and do their best to not to look away. The film was played on a 19-inch LCD computer monitor. Immediately after viewing the film, participants completed the MDES to assess changes in mood. Consistent with prior studies that used the trauma film paradigm (Holmes, James, Coode-Bate, & Deeprose, 2009; Olatunji & Fan, 2015), participants completed 20 min of filler tasks prior to debriefing. Prior to leaving, participants were scheduled for their week-one follow-up appointment and awarded course credits for participating. After 1 week, participants returned to complete the IES-R to assess development of symptoms specific to the trauma film. Participants were then debriefed of the study's overall purpose and awarded their remaining research credit for their participation in the study. Participants randomized to PHET (i.e., control) were offered the opportunity to complete the CAST intervention, either during that session or at a time convenient for them.

2.6. Data analytic plan

Primary study variables were first screened for univariate outliers, skewness, and kurtosis. Two outliers were detected on IES-R scores at one-week and were hand-corrected using Tukey's Hinges approach. All primary study variables were found to be within acceptable ranges for skewness and kurtosis (≤ 3; Gravetter, Wallnau, & Forzano, 2016) following correction. Random assignment was assessed by testing for condition differences on relevant variables. No significant differences were observed between CAST and PHET among gender ($\chi^2[1] = 0.17$, $p = .69$), lifetime trauma exposure ($\chi^2[1] = 0.001$, $p = .94$), motor vehicle accident history($\chi^2[1] = 0.04$, $p = .85$), baseline PCL-5 PTSS (t[89] $= 0.66$, $p = .51$), or baseline ASI-3 AS global, cognitive, physical, or social concerns cognitive concerns (all $p's > 0.40$). Trauma film paradigm reactivity was tested similar to the method reported by

Table 1
Bivariate correlations and descriptive statistics.

	1	2	3	4	5	6	7	8
1. Condition	–							
2. Gender	-.04	–						
3. BL PCL-5	-.07	.01	–					
4. Δ AS-T	.24*	-.02	.06	–				
5. Δ AS-C	.30*	.01	-.01	.74**	–			
6. Δ AS-P	.30*	-.05	.10	.75**	.61**	–		
7. Δ AS-S	.10	.04	.04	.83**	.43**	.49**	–	
8. W1 IES-R	.21*	.13	-.02	.27*	.30**	.24*	.20	–
Mean(SD) or %	48.4%	81.7%	27.09 (18.24)	0	0	0	0	4.77 (5.43)
Range	0–1	1–2	0–66	−2.9–1.4	−3.3–1.7	−3.0–2.0	−3.3–1.5	0–22
Skewness	-.07	−1.73	.34	-.98	-.98	-.51	−1.2	1.31
Kurtosis	−2.04	1.02	-.94	.87	.87	.50	1.20	1.20

Note. Condition (CAST = 0, PHET = 1); Gender (Male = 0, Female = 1); BL PCL-5 = PTSD Checklist for *DSM-5* scores at baseline; Δ AS-T = standardized residualized change scores for ASI-3 total scores; Δ AS-C = standardized residualized change scores for ASI-3 cognitive concerns subscale; Δ AS-P = standardized residualized change scores for ASI-3 physical concerns subscale; Δ AS-S = standardized residualized change scores for ASI-3 social concerns subscale; W1 IES-R = Impact of Events Scale – Revised scores at week-one follow-up.
**$p < .01$, *$p < .05$.

Olatunji and Fan (2015) by subjecting pre- and post-film MDES negative mood scale scores to a repeated measures ANOVA. Results revealed that the trauma film was successful in producing a main effect of increased negative emotionality ($F[1,89] = 65.56$, $p < .001$, partial $\eta^2 = 0.436$). We did not observe a time by condition interaction ($F[1,89] = 0.26$, $p = .61$, partial $\eta^2 = 0.003$), suggesting that pre-to post-film increases in state negative emotionality were statistically equivalent across the CAST and PHET conditions. Bivariate correlations between primary study variables were examined (Table 1).

Because risk for PTSD (Tolin & Foa, 2002) and AS severity (Deacon, Abramowitz, Woods, & Tolin, 2003; Schmidt & Koselka, 2000; Stewart, Taylor, & Baker, 1997) appear to be elevated among women, we controlled for participant gender in each analysis. Baseline PTSS due to previous traumatic exposure were likewise controlled for in all analyses for which film-specific traumatic stress response was the dependent variable. To examine the first study hypothesis, that individuals randomized to CAST would report greater decreases in AS, standardized residualized change scores were calculated for all ASI-3 total and subscale scores independently by regressing post-intervention values for each scale score onto their respect baseline value. Each residualized change scores was then regressed on condition and gender variables in separate linear multiple regressions. The second hypothesis regarding predictors of week-one IES-R PTSS was examined using hierarchical regression. The first step included the gender and baseline PCL-5 PTSS covariates. Intervention condition was added in the second step to examine the hypothesis that week-one IES-R PTSS would be lower among CAST than PHET. Finally, a parallel mediation model was conducted using the PROCESS macro (Hayes, 2012) for SPSS to test the third hypothesis, that residualized changes in ASI-3 global AS would account for (i.e., mediate) the relationship between intervention condition and week-one IES-R PTSS. To examine whether this effect was due specifically to reductions in AS cognitive concerns, we entered residualized changes scores for all ASI-3 AS subscales which were shown to be significantly reduced by CAST from the individual linear regressions in hypothesis one. Indirect effects of condition on one-week PTSD symptoms through any of the ASI-3 subscales were considered significant if the 95% confidence interval (CI) did not include zero. Estimates were calculated using 5000 bias-corrected bootstrap resamples.

3. Results

3.1. Condition effects on change in AS domains

The first hypothesis predicted that individuals randomized to CAST

would evince greater decreases in ASI-3 global AS, and that this would be largely driven by greater reductions of the cognitive concerns subfactor compared to the physical and social subfactors. Gender was included as a covariate in all analyses. In their respective models, condition was a significant predictor of residualized change in ASI-3 (AS global ($\beta = 0.24$, $p = .02$), cognitive ($\beta = 0.30$, $p < .01$), and physical concerns ($\beta = 0.30$, $p < .01$), but not social concerns ($\beta = 0.01$, $p = .36$). Gender was a non-significant predictor in each of the models (all p's > 0.65).

3.2. Condition effects on week-one PTSS

The second hypothesis predicted that individuals randomized to CAST would evince lower week-one IES-R PTSS than those in PHET, controlling for potential effects of gender and baseline PCL-5 PTSS. The first step of the hierarchical linear regression model (Table 2) included the non-significant effects of participant gender and baseline PCL-5 PTSS, which did not account for significant variance in week-one IES-R PTSS ($F[2,88] = 0.78$, $p = .46$, $r^2 = 0.02$). As hypothesized, the addition of intervention condition in the second step accounted for a significantly larger portion of variance in week-one IES-R PTSS ($\Delta F[1,87] = 4.32$, $p < .05$, $\Delta r^2 = 0.05$), as week-one IES-R scores were higher among the PHET condition by 2.34 points ($SE = 1.13$).

3.3. Residualized change in AS as a mediator of PTSS

The third hypothesis predicted that condition-specific reductions in ASI-3 global AS would mediate condition effects on week-one IES-R PTSS. The full model accounted for a significant portion of variance ($F[4,86] = 2.77$, $p = .03$, $r^2 = 0.114$) in week-one IES-R PTSS.

Table 2
Hierarchical linear regression model predicting week-one PTSS.

	est.	*SE*	*β*	*t*	*p*	*sr²*
Step 1						
Gender	1.85	1.50	.13	1.23	.22	.017
BL PCL-5	-.01	.03	-.02	-.23	.82	.001
Step 2						
Gender	1.98	1.45	.14	1.34	.18	.020
BL PCL-5	-.003	.03	-.01	-.09	.93	< .001
Condition	2.34	1.13	.22	2.08	.04	.041

Note. est. = unstandardized estimate; SE = standard error; β = standardized estimate; Gender (Male = 0, Female = 1); BL PCL-5 = PTSD Checklist for *DSM-5* scores at baseline; Condition (CAST = 0, PHET = 1).

Intervention condition significantly predicted lower ASI-3 global AS (i.e., greater pre-to post-intervention residualized change) among the CAST condition (path a; $B = 0.48$, $SE = 0.21$, $p = .02$), which in turn significantly predicted lower week-one IES-R PTSS (path b; $B = 1.27$, $SE = 0.58$, $p = .03$). Although there was a significant total effect of intervention condition on week-one IES-R PTSS (path c; $B = 2.34$, $SE = 1.13$, $p = .04$), such that unadjusted mean PTSS were lower among the CAST condition, the direct effect of condition on week-one IES-R PTSS (path c'; $B = 1.73$, $SE = 1.14$, $p = .13$) was no longer significant after accounting for the significant indirect effect through ASI-3 global AS ($B = 0.60$, $SE = 0.40$, 95% CI [0.075, 1.806]). Partial effects of gender ($B = 1.99$, $SE = 1.44$, $p = .17$) and baseline PCL-5 PTSS ($B = -0.003$, $SE = 0.03$, $p = .80$) on week-one IES-R PTSS were non-significant. As a measure of mediation effect size (Wen & Fan, 2015) we calculated the ratio of the indirect effect (path ab) to that of the total effect. The resultant ratio of 0.26 suggests that roughly one quarter of the influence of all predictors in the model on week-one IES-R PTSS was due to residualized change in ASI-3 global AS scores.

3.4. Specificity of AS subfactors as a mediator of PTSS

After we observed that changes in AS global concerns accounted for the effect of condition on week-one PTSS, we sought to test the specificity of this effect among the AS subfactors that showed significant change from pre-to post-intervention (i.e., AS cognitive and physical concerns). The first mediation model tested the indirect effect of condition on week-one PTSS through AS cognitive concerns (Fig. 2a). The full model accounted for a significant portion of variance (F [4,86] = 3.04, $p = .02$, $r^2 = 0.124$) in week-one IES-R PTSS. CAST produced greater residualized change in (i.e., lower) ASI-3 cognitive concerns scores (path a), which in turn were significantly related to less IES-R PTSS at week-one (path b). Although there was a significant total effect (path c) of intervention condition on week-one IES-R PTSS, such that unadjusted mean PTSS were lower among the CAST condition, the direct effect (path c') of condition on week-one IES-R PTSS was no longer significant after accounting for the significant indirect effect through ASI-3 cognitive concerns ($B = 0.83$, $SE = 0.42$, 95% CI [0.209, 1.977]). The ratio of the indirect to total effect of 0.35 suggests that

roughly 35% of the influence of all predictors in the model on week-one IES-R PTSS was due to residualized change in ASI-3 cognitive concerns.

The second mediation model, which tested the indirect effect of condition on week-one PTSS through AS physical concerns (Fig. 2b), accounted for a marginally significant portion of variance (F [4,86] = 2.42, $p = .05$, $r^2 = 0.101$) in week-one IES-R PTSS. CAST produced greater residualized change in (i.e., lower) ASI-3 physical concerns scores (path a), which in turn demonstrated a non-significant trend ($p = .06$) toward predicting less IES-R PTSS at week-one (path b). Although there was a significant total effect (c) of intervention condition on week-one IES-R PTSS, such that unadjusted mean PTSS were lower among the CAST condition, the direct effect (path c') of condition on week-one IES-R PTSS was no longer significant after accounting for the non-significant indirect effect through ASI-3 physical concerns ($B = 0.67$, $SE = 0.47$, 95% CI [-0.010, 1.961]). The ratio of the indirect to total effect of 0.29 suggests that roughly 29% of the influence of all predictors in the model on week-one IES-R PTSS was due to residualized change in ASI-3 physical concerns. However, because the 95% CI includes zero the we could not definitively conclude that the effect of intervention condition on week-one IES-R PTSS was due to changes in ASI-3 physical concerns. Thus, as expected, the effect of CAST on week-one PTSS appeared to have been primarily driven by intervention-specific changes in AS cognitive concerns.

4. Discussion

To our knowledge, this study is the first to demonstrate the potential of AS, specifically the cognitive concerns dimension, as a causal mechanism in the development of post-traumatic stress responses. Consistent with emerging evidence (Boffa et al., 2016; Olatunji & Fan, 2015), AS was prospectively related to PTSS development in response to the trauma film paradigm. This further suggests AS may be causal risk factor for PTSD, though additional research is needed with designs that employ the *DSM-5* diagnostic criteria (i.e., a valid index trauma and more than one-month of symptom development). As hypothesized, intervention condition directly affected week-one symptom reports, such that IES-R PTSS were lower among CAST than the PHET condition. However, this effect was no longer significant when accounting for
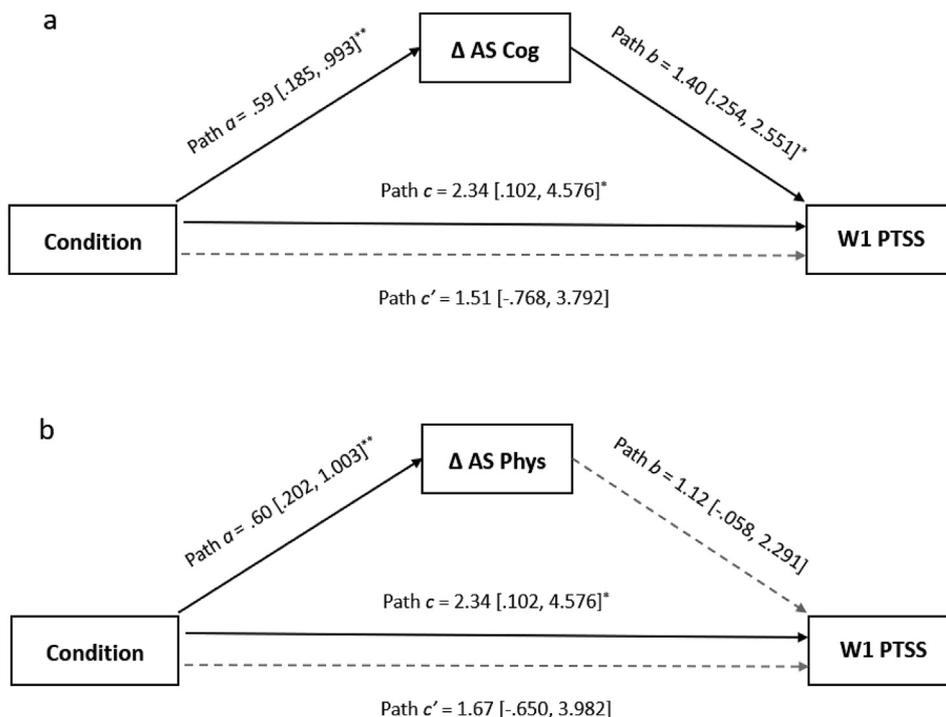
a

Path a = .59 [.185, .993]** · Δ AS Cog · Path b = 1.40 [.254, 2.551]*

Path c = 2.34 [.102, 4.576]*

Path c' = 1.51 [-.768, 3.792]

Condition · W1 PTSS

b

Path a = .60 [.202, 1.003]** · Δ AS Phys · Path b = 1.12 [-.058, 2.291]

Path c = 2.34 [.102, 4.576]*

Path c' = 1.67 [-.650, 3.982]

Condition · W1 PTSS

Fig. 2. Mediation models of total and direct effects of intervention condition on week-one PTSS through residualized change in (a) AS cognitive and (b) AS physical concerns.
Note. Unstandardized path coefficients displayed with 95% confidence interval bracketed; Condition (0 = CAST, 1 = PHET); Δ AS cog = standardized residualized change scores for ASI-3 cognitive concerns subscale; Δ AS phys = standardized residualized change scores for ASI-3 physical concerns subscale; W1 PTSS = Impact of Events Scale – Revised scores at week-one follow-up.
**$p < .01$, *$p < .05$.

change in ASI-3 AS cognitive concerns subfactor, thus suggesting that AS cognitive concerns may be the specific mechanism through which the development of film-specific PTSS were mitigated. This finding is consistent with prior reports of CAST in trauma-exposed samples (Allan et al., 2015; Short et al., 2017). Importantly, the design of the present study allowed us to evaluate this effect as a preventative approach to mitigating PTSS development as opposed to intervening upon ongoing PTSD symptoms. Support for our hypothesized effect of CAST on thwarting the trajectory of film-specific symptom responses holds several theoretical and clinical implications.

Theories of PTSD symptom development suggest that naturally occurring intrusive reminders of the traumatic event first emerge as a psychological consequence of trauma. Given that intrusive reminders are persistent and distressing, they give rise to avoidance of trauma-relevant thoughts (Ehlers & Clark, 2000; Ehlers, Mayou, & Bryant, 1998; Horowitz, Wilner, & Alvarez, 1979). which paradoxically increase the frequency of intrusive reminders (Abramowitz, Tolin, & Street, 2001; Davies & Clark, 1998; Harvey & Bryant, 1998a; Shipherd & Beck, 1999). As such, data suggest that negative interpretations of intrusive reminders (cf. AS cognitive concerns) and attempts to suppress intrusive reminders are related to greater intrusion-related distress and PTSD symptom severity (Steil & Ehlers, 2000), and the persistence of PTSD diagnoses (Mayou, Ehlers, & Bryant, 2002) among MVA survivors. These reports dovetail with the current findings, which illustrate that greater tendency to catastrophize cognitive dyscontrol is related, in part, to the development of greater avoidance PTSS. Limiting efforts to suppress such thoughts may therefore interrupt this negative feedback cycle and mitigate PTSS development.

In the interest of normalizing the occurrence of and responses to intrusive reminders, AS cognitive concerns therefore present an ideal target. Because individuals high in AS cognitive concerns catastrophize meaning of uncontrollable thoughts (Taylor et al., 2007), they would theoretically benefit from understanding that intrusive traumatic reminders are normative and not indicative of psychological or physical catastrophe. Indeed, CAST targets this vulnerability by introducing the "White Bear Effect" (Wegner, Schneider, Carter, & White, 1987) in order to illustrate that efforts to suppress specific thoughts will make them more likely to occur, but that this cognitive dyscontrol does not foreshadow mental incapacitation. In the present sample CAST may have reduced the tendency to catastrophize (i.e., ASI-3 AS cognitive concerns) and suppress intrusive reminders, and ultimately IES-R PTSS development. Importantly, due to the bi-directional nature of AS and PTSD symptom development (Marshall et al., 2010), even individuals low in pre-trauma AS may learn to catastrophize and suppress intrusive reminders. The implications of the present findings may therefore apply to any individuals at risk for trauma exposure.

Clinically, CAST and other brief, portable interventions may be of use for those whom we can identify to be at risk for trauma exposure (e.g., first responders) or likely to develop symptoms shortly following trauma exposure (e.g., in hospital emergency departments). Although the efficacy of past approaches like critical incidence stress debriefing appear to be negligible, at best, in the prevention of PTSD (Rose, Bisson, Churchill, & Wessely, 2002), mounting evidence suggests brief Prolonged Exposure (PE) protocols initiated in emergency service settings shortly after trauma mitigate PTSD symptom development (Price, Kearns, Houry, & Rothbaum, 2014; Rothbaum, Houry, et al., 2008; Rothbaum, Kearns, et al., 2012). Though promising, these endeavors require well-trained and dedicated staff to deliver the therapy, which limits the availability and scalability of such an approach. Alternatively, because CAST is web-based, portable, and can be completed/revisited in under an hour, it may be an attractive alternative to reaching larger swaths of individuals who are at risk for or have recently been exposed to trauma.

Though this study advances preventative approaches to mitigating the effects of trauma, results should be interpreted in light of its limitations. Foremost, use of an analog trauma exposure (i.e., trauma film)

may strictly limit the degree to which our results apply to individuals at risk of exposure to actual Criterion A events (e.g., combat, assault). Moreover, although prolonged exposure to aversive film media has been associated with PTSS (Silver et al., 2013), DSM-5 criteria necessitate that exposure to electronic media must be work-related in order to be considered for a PTSD diagnosis. This exposure must also be repetitive and therefore presumably for a much greater duration than participants in the present study were exposed to during the trauma film paradigm. Although PTSS levels in the present sample are comparable to prior studies utilizing the trauma film paradigm (Olatunji & Fan, 2015), the mean of the IES-R avoidance ($M = 0.34$; $SD = 0.40$) and hyperarousal subscales ($M = 0.26$; $SD = 0.38$) were significantly lower (p's < 0.001) than those reported in a sample of motor vehicle accident survivors with PTSD ($M_{avoidance} = 1.7$; $SD = 0.85$; $M_{hyperarousal} = 2.2$; $SD = 0.94$; Beck et al., 2008), a discrepancy which further underscores that the pattern of results observed in the present sample may be specific to analog (cp. Crtierion A) trauma exposure. Still, studies such as this highlight the importance of the trauma film paradigm for translating our understanding of PTSD from the laboratory to clinical settings and beyond (James et al., 2016).

It will be important that future studies endeavor to test the long-term effects of CAST or similar AS interventions as a preventative tool in samples at risk for exposure to actual Criterion A traumatic events. This may be particularly relevant among military service members or first responders, who are likely to experience traumatic events and evince elevated levels of PTSD symptoms (Berger et al., 2012; Hoge, Terhakopian, Castro, Messer, & Engel, 2007; Kulka et al., 1990). Future efforts should also replicate these findings among other, more diverse samples, as the current study was conducted using a convenience sample of undergraduates that were largely female and Caucasian.

In sum, the current study utilized a lab-controlled stressor to determine whether AS cognitive concerns may be a causal risk factor for PTSD. Consistent with the framework for establishing a causal risk factor, we were able to demonstrate that mitigating AS cognitive concerns prior to the trauma film paradigm limited the development of PTSS among those individuals who received the CAST intervention. This is a critical step toward establishing AS cognitive concerns as a preventative target among individuals at risk for trauma exposure. Moreover, because CAST is a web-based intervention it has the potential to reach underserved populations who may have limited access to mental health resources but just as likely to experience trauma. Future longitudinal studies investigating the effects of pre-trauma AS interventions on PTSS development will be important for solidifying the effects described herein.

Declarations of interest

None.

Conflicts of interest

The authors declare no conflict of interest.

Acknowledgement

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