The impact of startle reactivity to unpredictable threat on the relation between bullying victimization and internalizing psychopathology

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ABSTRACT

Background: Being bullied has detrimental effects on mental health functioning. Individuals who are highly reactive to unpredictable threats (U-threat) may be particularly vulnerable to the negative consequences of being bullied. For them, persistent, unpredictable bullying likely elicits chronic anticipatory anxiety and depression. The aim of the present study was to examine the main and interactive effects of aversive reactivity to U-threat and past-year bullying victimization on current anxiety and depressive symptoms.

Methods: Seventy-one young adults (ages 17–19) completed a well-validated threat-of-shock task used to probe reactivity to both U-threat and predictable threat (P-threat). Startle eyeblink potentiation was recorded to index aversive responding.

Results: We found a main effect of bullying, such that individuals with more bullying experience exhibited greater anxiety and depressive symptoms than individuals with less bullying experience. There was also a bullying by U-threat reactivity interaction such that among individuals with high reactivity to U-threat, more bullying experience was associated with more anxiety and depressive symptoms. Among individuals with low U-threat reactivity, there was no association between bullying and internalizing symptoms. There were no main or interactive effects involving reactivity to P-threat.

Conclusions: Together, these results suggest that among individuals who are bullied, those who are sensitive to U-threat are particularly vulnerable to depression and anxiety in young adulthood. These individuals may represent a high-risk group for the development of internalizing psychopathology.

1. Introduction

Bullying is a universal public health problem that impacts almost one-third of young adults worldwide (Craig et al., 2009; UNESCO, 2018). Bullying is typically described as the act of intentional and repeated aggressive behavior (e.g., verbal, physical, cyberbullying) carried out by a group or an individual against one or more victims (Wolke and Lereya, 2015). In response to bullying, victims often develop a range of depressive and anxiety symptoms that may persist for years, including chronic worrying, nightmares, social withdrawal, hypervigilance and panic (Arseneault et al., 2010; Egan and Perry, 1998; Kochenderfer-Ladd and Wardrop, 2001; Veenstra et al., 2005). However, not all individuals who are bullied develop internalizing problems (Schoeler et al., 2018; Singham et al., 2017), thus suggesting that there may be certain phenotypes, or subgroups, who are at particularly high risk for the development of depression and anxiety in the context of

being bullied.

Individual vulnerability factor that may increase the propensity for anxiety and/or depression in individuals who are bullied is heightened reactivity to unpredictable threat (U-threat). U-threat is specific type of stressor that is ambiguous in its timing, intensity, frequency and/or duration (e.g., not knowing if there is a bear lurking in the woods), while predictable threat (P-threat) is a type of imminent and immediately present stressor signaled by a brief, discrete cue (e.g., a hungry bear approaching you; see Grupe and Nitschke, 2013 for review). P-threat evokes a phasic 'fight or flight' response that diminishes quickly once the threat is terminated (Barlow, 1986; Davis et al., 2010). In contrast, U-threat is more sustained and aversive as it diminishes one's ability to predict and effectively prepare for future events, and thus elicits a generalized feeling of hypervigilance and apprehension (Barlow, 1986; Davis, 1998). Some individuals are particularly sensitive to U-threat and hold the belief that all (or most) forms of ambiguity are

unacceptable and intolerable (Carleton et al., 2007). This negative be-lief can manifest in a variety of ways, including excessive worry, avoidance of uncertain situations, and chronic distress (Carleton, 2016). Bullying is conceptualized as a real-world, potent U-threat as it is notoriously unpredictable in its timing, intensity, frequency and duration. Therefore, bullying victims sensitive to U-threat may experi-ence high levels of sustained anticipatory anxiety and depression. It is therefore posited that sensitivity to U-threat may increase the risk for internalizing problems in young adults who are bullied; however, this hypothesis remains to be tested.

Behavioral response to U- and P-threat has been frequently assessed using a well-validated No-Predictable-Unpredictable threat (NPU) paradigm (Schmitz and Grillon, 2012), in which temporal predictability of threat (e.g. mild electric shock) is manipulated and startle eye blink potentiation is recorded as an index of aversive responding. Startle potentiation is a rather useful research tool given that it is sensitive to changes in both valence and arousal, and is therefore suitable for the study of threat processing (Lang et al., 1990; Lang, 1995). Using the NPU task, prior studies have shown that individuals with anxiety and depressive disorders exhibit heightened reactivity to U-threat, but not P-threat, relative to healthy controls (Gorka et al., 2017; Grillon et al., 2008; Nelson and Hajcak, 2017; Shankman et al., 2013). Prior research has also demonstrated elevated startle reactivity to negative stimuli, including U-threat, among individuals with a history of trauma ex-posure (Jovanovic et al., 2009; McTeague et al., 2010; Morgan et al., 1997; Niles et al., 2018) and posttraumatic stress disorder (PTSD; Butler et al., 1990; Grillon et al., 2009; Metzger et al., 1999; Pole et al., 2009). Although sensitivity to U-threat has been proposed as a potential core dimensional construct underlying internalizing psychopathology, cri-tical questions remain as to whether such underlying dysfunction ex-tends to bullying victims and subsequently contributes to the high rates of co-occurrence between bullying and internalizing psychopathology.

The present study was designed to examine the main and interactive effects of startle reactivity to U- and P-threat and past year bullying victimization on anxiety and depressive symptomology in a sample of young adults. Specifically, the study examined: (1) the main effect of past year bullying victimization, (2) the main effect of reactivity to U- and P-threat, and (3) the interactive effect of past year bullying victi-mization and threat reactivity, on anxiety and depressive symptoms. Consistent with extant literature, we hypothesized that more bullying experience and greater startle reactivity to U-threat, but not P-threat, would be associated with higher endorsement of internalizing symp-toms. We further expected that these two individual difference factors would interact such that among individuals with high reactivity to U-threat, more bullying victimization would be associated with higher anxiety and depressive symptoms.

2. Methods

2.1. Participants

Seventy-one participants were recruited from the community and enrolled as part of a larger longitudinal study examining the link be-tween reactivity to U-threat and psychopathology. Individuals were recruited via social media advertisements and flyers posted in the Chicago community including nearby high school and college cam-puses. Participants were required to be between the ages of 17 and 19. Although not required, all participants indicated that they were current students. Exclusionary criteria for the overall study included any major active medical or neurological illness, lifetime history of manic/psy-chotic symptoms or active suicidal ideation, deafness, traumatic brain injury, psychotropic medication use (past 4 months), lifetime history of alcohol or substance use disorder, positive urine drug screen or breathalyzer test, and pregnancy. For the purposes of the current study, only data collected at baseline were examined. Individuals were in-structed to abstain from drugs and alcohol at least 24-h prior to the lab

assessments, which was verified via breath alcohol and urine screens. All study procedures were approved by University of Illinois at Chicago Institutional Review Board. Participants provided written informed consent and were compensated ($55) for their time.

2.2. Self-report measures

Past year bullying victimization at school and work was measured with a 21-item Generalized Harassment Questionnaire (GHQ), which was originally developed for adults, but has recently been modified for adolescents and young adults (Rospenda and Richman, 2004). Our re-search group has previously shown that the modified GHQ predicts a variety of psychiatric symptoms and outcomes in young adults (Rospenda et al., 2013), underscoring its potential research utility. Relative to other bullying measures used in student samples (Chapell et al., 2004; Espelage et al., 2000), the GHQ provides a broader cov-erage of specific forms of bullying, such as 'passive' (e.g. failing to re-spond to requests for help), 'verbal' (e.g. talking down to someone), 'physical' (e.g. hitting) and 'cyberbullying' (e.g. posting offensive and hurtful things on social media). The GHQ follows a behavioral defini-tion of bullying that does not require respondents to define themselves as having been bullied, but rather asks about frequency of a variety of experiences that represent the construct of bullying. This is because research shows that even when people do not label themselves as being harassed or bullied, they still experience negative effects (Harned, 2004; Rospenda et al., 2009; Vie et al., 2011). The instructions for the GHQ are therefore straightforward but do not provide a definition of bullying. Instead, the measure is presented as a checklist and partici-pants are instructed to indicate the frequency that any "student, tea-cher, or coach" did the following events using a 3-point scale (0 = *Never*, 1 = *Once*, 2 = *More than once*). A total score, computed by summing the 21 items, is used to index the frequency of past year bullying victimization. Reliability of the scale within the current sample was good ($\alpha = .85$).

Symptoms of anxiety and depression within the past two weeks were assessed using the Inventory of Depression and Anxiety Symptoms (IDAS-II; Watson et al., 2012) – a 99-item self-report measure. Partici-pants responded to each item using a 5-point Likert-type scale ranging from 1-*not at all* to 5-*extremely*. The IDAS-II yields 17 empirically de-rived and symptom-specific scales. For the purposes of our study, we used the "general depression" scale to evaluate depressive symptoms, and created a composite "general anxiety" scale by averaging five an-xiety-related scales (panic, social anxiety, claustrophobia, traumatic intrusions and avoidance) similar to our prior studies (e.g., Gorka et al., 2018). Reliability of all scales within the current sample was good ($\alpha = .81$ to $\alpha = .89$).

2.3. Study procedure and startle NPU threat task

After providing written informed consent, participants completed a clinical interview, battery of self-report questionnaires, and startle task. The NPU startle task and laboratory procedures have been extensively described by our group (Gorka et al., 2017, 2013). Briefly, each parti-cipant had two shock electrodes placed on their left wrist and a shock work-up procedure was completed to determine the level of shock in-tensity that they described as "highly annoying but not painful" (be-tween 1 and 5 mA). Ideographic shock levels were used to ensure equality in perceived shock aversiveness (Rollman and Harris, 1987). Participants then completed a 2-min startle habituation task in which six probes were delivered to reduce early, exaggerated startle po-tentiation.

The threat task was modeled after the NPU startle task designed by Grillon and colleagues, and thus included no shock (N), predictable shock (P), and unpredictable shock (U) conditions. Text at the bottom of the computer monitor informed participants of the current condition (e.g. "No shock", "Shock at 1", or "Shock at any time"). Each condition

lasted 145s, during which a 4s visual countdown (CD) was presented six times. The inter-stimulus intervals (ISIs; i.e., time between CDs) ranged from 15 to 21s during which only the text describing the condition was on the screen. During N trials, participants never received a shock. During P trials, participants were shocked every time the CD on the screen reached "1" and thus the timing of the threat was fully predictable. During U trials, participants were shocked at any time (both during the CD and ISI) and the timing of the threat was therefore unpredictable. Startle probes were administered during both the CD and ISI, and there was always at least 10s between two probes or a shock and a probe. Each condition was presented two times in a randomized order (counterbalanced). Participants received 24 total electric shocks (12 in P; 12 in U) and 60 total startle probes (20 in N; 20 in P; 20 in U).

2.4. Startle data collection and processing

Startle data were acquired using BioSemi Active Two system and stimuli were administered using Presentation. Electric shocks lasted 400-ms. Acoustic startle probes were 40-ms long, 103-dB bursts of white noise with near-instantaneous rise time presented binaurally through headphones to elicit a startle reflex.

Startle responses were recorded from two 4-mm Ag/AgCl electrodes placed over the orbicularis oculi muscle below the left eye. The ground electrode was located at the frontal pole (Fpz) of an electroencephalography (EEG) cap that participants were wearing as part of the larger study. One startle electrode was placed 1-cm below the pupil and the other was placed 1-cm lateral of that electrode. Data were collected using a bandpass filter of DC-500-Hz at a sampling rate of 2000-Hz.

Blinks were processed (and scored) according to published guidelines (Blumenthal et al., 2005): we applied a 28 Hz high-pass filter, rectified, and then smoothed using a 40 Hz low-pass filter. Peak amplitude was defined within 20–150-ms following the probe onset relative to baseline (i.e., average activity for the 50-ms preceding probe onset). Each peak was identified by software but examined by hand to ensure acceptability. Blinks were scored as non-responses if activity during the post-stimulus time frame did not produce a peak that was visually differentiated from baseline. Blinks were scored as missing if the baseline period was contaminated with noise, movement artifact, or if a spontaneous or voluntary blink began before minimal onset latency. To quantify the difference between threat and no-threat trials, we followed guidelines by Meyer et al. (2017) and calculated a standardized residual score for U-threat (U-threat$_{resid}$) and P-threat (P-threat$_{resid}$) by saving the variance leftover (i.e., the amount of variability in a dependent variable [DV] that is not explained by an independent variable [IV]) in two simple linear regressions where the N$_{CD}$ (IV) was entered to separately predict the U$_{CD}$ and P$_{CD}$ (DVs). The residual scores were then used as the primary variables in all subsequent analyses.

2.5. Data analysis plan

As a manipulation check, we first conducted a 3 (Condition: N, P, U) x 2 (Cue: CD, ISI) repeated measures ANOVA to confirm that the task elicited startle reactivity to P- and U-threat as designed by comparing the magnitudes of the startle response. Tukey's Honestly Significant Difference (HSD) test was used to make *post hoc* comparisons between conditions.

Next, we assessed the main and interactive effects of threat condition (i.e., U or P) and past year bullying victimization on current IDAS-II anxiety and depressive symptoms. To do so, we conducted *two* hierarchical linear regressions with IDAS-II anxiety or depressive symptoms as the dependent variable (separate models). All continuous predictors were first mean-centered. Main effects of bullying victimization and U-threat$_{resid}$ (or P-threat$_{resid}$), and sex as a covariate were entered in Step 1, and the bullying victimization x U-threat$_{resid}$ (or P-threat$_{resid}$) interaction term was entered in Step 2. Significant interactions were

Table 1
Demographics and clinical characteristics (N = 70).

	Mean (SD) or %
<u>Demographics</u>	
Age (years)	18.4 (0.7)
Sex (% female)	70.0%
Ethnicity (% Hispanic)	40.0%
Race	
White	48.6%
Black	10.0%
Asian	15.7%
American Indian or Alaskan Native	2.9%
Other or Unknown	22.9%
<u>Clinical Variables</u>	
Bullying Victimization Frequency	6.0 (6.5)
IDAS-II Anxiety	8.6 (2.4)
IDAS-II Depression	40.3 (11.4)
<u>SCID Variables</u>	
Current Major Depressive Disorder diagnosis	5.7%
Current Generalized Anxiety Disorder diagnosis	5.7%
Current Social Anxiety Disorder diagnosis	12.9%
Current Panic Disorder diagnosis	2.9%
Current Post-Traumatic Stress Disorder diagnosis	2.9%
Lifetime Major Depressive Disorder diagnosis	34.3%
Lifetime Generalized Anxiety Disorder diagnosis	10.0%
Lifetime Social Anxiety Disorder diagnosis	18.6%
Lifetime Panic Disorder diagnosis	11.4%
Lifetime Post-Traumatic Stress Disorder diagnosis	7.1%
<u>Psychophysiological Variables (Startle Magnitudes)</u>	
No-Threat Countdown	59.7 (59.6)
P-Threat Countdown	79.5 (61.7)
U-Threat Countdown	105.6 (72.9)

Note. U = Unpredictable; P = Predictable; IDAS-II = Inventory for Depression and Anxiety Symptoms-II.

followed-up using a standard simple slopes approach (Aiken, L. S., & West, 1991), in order to investigate the effects of the IV (bullying victimization) at different levels of the moderator (U- and P-threat reactivity).Specifically, the moderator was re-centered at 1 SD above the mean for "high symptoms" and 1 SD below the mean for "low symptoms". Two new interaction terms were created and *post-hoc* additional follow-up linear regression models were run at high and low symptoms.

Influential outliers were detected and removed using Cook's distance (Cook and Weisberg, 1982). All tests were two-tailed and were deemed significant at $\alpha < 0.05$. Statistical analyses were performed, and results were graphed using R (Version 3.5.2; R Development Core Team, Vienna, 2004) and the following R-packages: *effects* (Version 4.1–0; Fox, 2003; Fox and Hong, 2009), *afex* (Version 0.23–0; Singmann et al., 2019), *sjPlot* (Version 2.6.2; Lüdecke, 2018), and *ggplot2* (Version 3.1.0; Wickham, 2016).

3. Results

Participants' descriptives are presented in Table 1. We identified one influential outlier in our data using the Cook's Distance ($D = .75 > D_{cutoff\ score} = .06$) and removed this observation from our sample ($N_{final} = 70$).

3.1. Main task effects

Across subjects, there was a significant main effect of condition (F [2, 138] = 89.32, $p < .0001$, $\eta^2 = .10$), and cue (F[1, 69] = 67.45, $p < .0001$, $\eta^2 = .04$), and a condition × cue interaction (F[2, 138] = 10.95, $p < .0001$, $\eta^2 = .003$). Startle magnitude was greater during P$_{CD}$ (t[196] = 5.05, $p < .0001$) and U$_{CD}$ (t[196] = 11.73, $p < .0001$) compared with N$_{CD}$. Startle magnitude during U$_{CD}$ was also greater than startle magnitude during P$_{CD}$ (t[196] = 6.68, $p < .0001$; i.e., U > P > N). Similarly, startle magnitude was greater during U$_{ISI}$ compared to N$_{ISI}$ (t[196] = 11.76, $p < .0001$) and P$_{ISI}$ (t

[196] = 10.14, p < .0001), but P_{ISI} did not differ from N_{ISI} (t [196] = 1.63, p = .24; i.e., U > P, U > N, P ≈ N).

3.2. Hierarchical regression results

Hierarchical linear regression analyses indicated a main effect of bullying, such that individuals with more bullying experience within the past year exhibited greater depression and anxiety symptoms than individuals with less past year bullying experience. There was no main effect of threat condition (U or P) on current anxiety and depressive symptoms; however, there was a significant bullying x U-threat$_{resid}$ interaction.[1] Follow-up simple slopes analyses indicated that among individuals with high U-threat$_{resid}$, more bullying experience was associated with more anxiety (β = .73, t = 4.61, p < .001; see Fig. 1A) and depressive symptoms (β = .68, t = 4.23, p < .001; see Fig. 1B). Among individuals with low U-threat$_{resid}$, there was no association between past year bullying victimization frequency and depression and anxiety (p_s > .21). No main effect of sex was found in any of the analyses. All results from the hierarchical linear regression analyses are presented in Tables 2 and 3.

4. Discussion

The present study sought to determine the main and interactive effects of bullying victimization and U- and P-threat reactivity on current anxiety and depressive symptoms in a community sample of young adults. Consistent with our hypothesis, we found a main effect of bullying, such that individuals with more past-year bullying experience reported greater current anxiety and depressive symptoms than individuals with less past year bullying experience. Contrary to our hypothesis, we did not find a main effect of U- and P-threat reactivity on internalizing symptoms; however, there was a significant bullying by U-threat reactivity interaction. Specifically, within individuals with high but not low U-threat reactivity, more bullying was associated with more anxiety and depressive symptoms.

The association between bullying victimization and internalizing symptoms has been well established in the previous literature. Specifically, studies have shown that bullying victims score higher than uninvolved individuals on measures of anxiety and depressive symptoms (Fekkes et al., 2004; Undheim and Sund, 2010; Wang et al., 2011; Yen et al., 2013). In addition, a large amount of cross-sectional and longitudinal research has demonstrated that different types of bullying (e.g., physical, verbal, cyberbullying), are associated with higher rates of developing anxiety (Bond et al., 2001; Fredstrom et al., 2011) and depressive disorders (Cole et al., 2016; Kaltiala-Heino and Fröjd, 2011; Landoll et al., 2015; Wright, 2015). Similarly, studies have shown that being bullied in childhood may predict internalizing problems in adolescence and young adulthood (Copeland et al., 2013). These internalizing problems could persist over a two-year period (Zwierzynska et al., 2013), or they could dissipate over time (Schoeler et al., 2018; Singham et al., 2017). Nevertheless, research indicates that bullying victimization early in life can lead to lifetime higher risk of internalizing disorders (Takizawa et al., 2014).

Consistent with our hypothesis, we found that this association between bullying victimization and internalizing symptoms was particularly robust among individuals with high but not low reactivity to U-threat. Thus, heightened sensitivity to U-threat may be an important psychophysiological marker that may help identify bullying victims at high-risk for anxiety and depression in young adulthood. These high-

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[1] Bootstrap results (10,000 samples) revealed that the effect of bullying × U-threatresid interaction on anxiety symptoms remained significant (CI 95%: 0.19 to 0.36). However, the effect of bullying × U-threatresid interaction on depressive symptoms was no longer significant (CI 95%: −0.16 to 0.62), and thus this finding should be interpreted with caution.
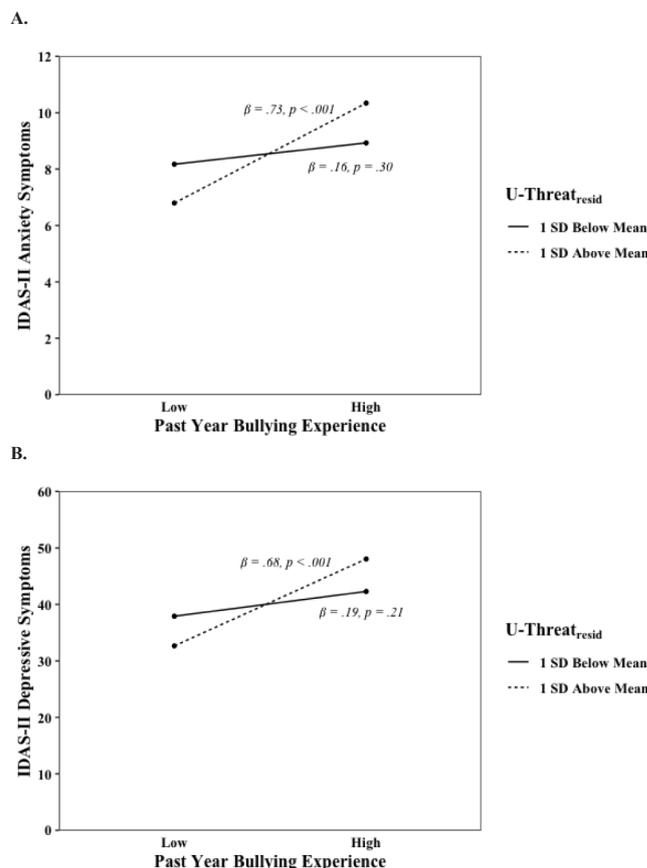

Fig. 1. The moderating effect of startle reactivity to unpredictable threat on current (A) anxiety and (B) depressive symptoms in individuals with past year bullying experience. U = Unpredictable. IDAS-II = Inventory for Depression and Anxiety Symptoms-II.

risk individuals may not only exhibit increased levels of anticipatory anxiety and distress in response to irregular, unpredictable bullying, but they may also become sensitized to other forms of ambiguous or uncertain threat, regardless of its true potential to confer harm (Grillon et al., 2008). Thus, experimental therapeutic approaches targeting unpredictable stressors hold high promise for early detection, prevention and treatment of internalizing problems among bullying victims. The NPU paradigm may be a particularly useful tool in studying changes in behavioral response to different types of unpredictable stressors to detect and therapeutically target bullying victims at risk for internalizing disorders (Kaye et al., 2017). This paradigm has excellent psychometric properties and is well suited to track illness severity over time. In addition, it is cost-efficient and easy to administer (Gorka et al., 2017; Kaye et al., 2016), which is critical for its potential application to the clinic. However, more research is needed to examine whether startle magnitude values are clinically meaningful at an individual level. In addition, it is still presently unclear whether sensitivity to U-threat among bullying victims is a premorbid risk factor for internalizing psychopathology, or if it is an acquired propensity in response to repeated and unpredictable bullying attacks. Thus, longitudinal research is needed to (1) clarify the causal interactions between bullying victimization experiences, U-threat sensitivity and internalizing psychopathology, and (2) examine the potential utility of targeting and treating U-threat sensitivity within internalizing disorder prevention and treatment efforts among bullying victims.

Of note, we did not observe a main effect of reactivity to U-threat on current anxiety and depressive symptoms. This finding is inconsistent with prior startle literature, which shows an elevated startle response to U-threat across internalizing disorders (Gorka et al., 2017; Grillon et al.,

Table 2

Hierarchical regression analyses examining whether U-Threat$_{resid}$ and past year bullying victimization predict current IDAS-II anxiety and depressive symptoms (*N* = 70).

Predictors	IDAS-II Anxiety					IDAS-II Depression				
	β	t	adjusted R²	ΔR²	F for ΔR²	β	t	adjusted R²	ΔR²	F for ΔR²
Step 1			.153					.170		
Sex	.02	.19				.11	.95			
Bullying Victimization	.43**	3.84				.42**	3.80			
U-Threat$_{resid}$	.00	.00				.01	.07			
Step 2			.220	.067*	6.67			.213	.043*	4.63
Bullying Victimization × U-Threat$_{resid}$	.28*	2.58				.23*	2.15			

Note. * indicates *p* < .05, ** indicates *p* < .001. U = Unpredictable, IDAS-II = Inventory for Depression and Anxiety Symptoms-II.

Table 3

Hierarchical regression analyses examining whether P-Threat$_{resid}$ and past year bullying victimization predict current IDAS-II anxiety and depressive symptoms (*N* = 70).

Predictors	IDAS-II Anxiety					IDAS-II Depression				
	β	t	adjusted R²	ΔR²	F for ΔR²	β	t	adjusted R²	ΔR²	F for ΔR²
Step 1			.153					.187		
Sex	.02	.18				.09	.85			
Bullying Victimization	.43*	3.84				.43*	3.88			
P-Threat$_{resid}$	.01	.07				.13	1.17			
Step 2			.164	.011	1.87			.185	-.001	.88
Bullying Victimization × P-Threat$_{resid}$	.16	1.37				.11	.94			

Note. *indicates *p* < .001. P = Predictable; IDAS-II = Inventory for Depression and Anxiety Symptoms-II.

2009, 2008; Nelson and Hajcak, 2017; Shankman et al., 2013). There are a couple of differences among these investigations worth noting. First, prior studies involved individuals with clinical diagnoses of current and lifetime internalizing psychopathologies, including several studies within treatment seeking individuals. This was not the case in the present study, as individuals were not required to have a DSM diagnosis of internalizing disorders. Instead, internalizing symptoms were examined dimensionally. Second, the current sample had a very restricted age range (17–19 years) and was therefore younger than previous samples. These differences may therefore account for the discrepant findings. Given the potential clinical significance of these relationships, however, continued research is needed to elucidate the associations between U-threat reactivity and internalizing symptoms among young bullying victims.

The current study had numerous strengths including the use of a well-validated threat-of-shock task and the study of the main and interactive effects of bullying victimization and U-threat reactivity on internalizing symptoms within the same sample. However, there are also several limitations worth noting. First, the current sample included individuals from the general community and although this increases external validity, rates of DSM-defined internalizing psychopathologies were low (though comparable to the rates of internalizing psychopathologies in general adolescent/young adult population). Furthermore, the frequency of bullying victimization was generally low. It is therefore unclear whether the current pattern of results would generalize to severe clinical samples. Second, the majority of our participants were female, and while controlling for sex in our analyses did not have a significant impact on our results, the potential for sex differences is still unclear. Third, the current study was cross-sectional, and we are therefore unable to make inferences about the directionality of the associations between U-threat reactivity, bullying victimization and internalizing symptoms. Fourth, the study did not account for the confounding effects of potentially ongoing or historical bullying experiences (i.e., early childhood and adolescence) on startle reactivity to U-threat. Finally, the present study did not include a symptom severity measure of exposure to trauma and other adversities. Testing a more complex model that incorporates this information (i.e., retrospective

report of bullying and other adverse life events; record of whether the adversity is ongoing) may be an important next step towards examining the potential of using startle reactivity to identify bullying victims at a higher risk for development of internalizing psychopathology. Future studies are critically needed to address these gaps and continue to investigate if and how bullying experience and reactivity to U-threat interact to influence anxiety and depressive symptoms.

In conclusion, our findings indicate that past year bullying victimization and startle reactivity to U-threat interact to impact internalizing symptomology. Specifically, among individuals who are bullied, those with high but not low sensitivity to U-threat display more depressive and anxiety symptoms. Thus, these individuals may represent a high-risk group for the development of anxiety and depression in young adulthood. Given that individuals exposed to bullying victimization frequently experience symptoms of anxiety and depression, and individuals with comorbid disorders represent a particularly vulnerable clinical population (Garber and Weersing, 2010), future studies should continue to probe the potential utility of treating or targeting sensitivity to U-threat within depression and anxiety prevention and treatment efforts.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of interest declaration

Authors have no potential conflicts of interest to disclose.

Author contributions

SMG was the principal investigator of the study; SMG and KMR contributed to the conceptual design, made important contributions to the editing of the manuscript and assisted in data interpretation. MR conducted the statistical analyses, interpreted the data, and wrote the initial draft of the manuscript. FDA assisted in data preprocessing and

manuscript preparation.

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