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Positive emotion in posttraumatic stress disorder: A global or context-specific problem?

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Abstract

Problems with positive emotion are an important component of posttraumatic stress disorder (PTSD), with competing perspectives as to why. The global model suggests that people with PTSD experience a relatively permanent shift in their capacity for positive emotion regardless of context, whereas the context-specific model posits access to the full repertoire of positive emotion that only becomes reduced during exposure to trauma reminders. We tested the global versus context-specific models using ecological momentary assessment (EMA). Trauma-exposed adult community members (N = 80) with (n = 39) and without diagnosed PTSD completed 3 days of EMA (n = 2,158 observations). Participants with PTSD reported lower average momentary levels of positive emotion, B = −0.947, 95% CI [−1.35, −0.54], p < .001, and positive situations, B = −0.607, 95% CI [−1.16, −0.05], p = .032, and more thinking about trauma reminders, B = 0.360, 95% CI [0.21, 0.51], p < .001. There was no between-group difference in positive emotion reactivity (degree of positive emotion derived from positive situations), B = 0.03, 95% CI [−0.09, 0.14], p = .635. Increased thinking about trauma reminders predicted lower momentary levels of positive emotion, B = −0.55, 95% CI [−0.83, −0.26], p < .001, but not reactivity, B = 0.02, 95% CI [−0.35, 0.40], p = .906, irrespective of PTSD status. Findings supported the global model and were inconsistent with the context-specific model. This study helps clarify positive emotional functioning in trauma-exposed adults and highlights future directions to better understand problems with positive emotion in PTSD.

Problems with positive emotions and other positive psychological processes are an important but often overlooked component of posttraumatic stress disorder (PTSD). The *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; American Psychiatric Association [APA], 2013) includes a persistent inability to experience positive emotion, feeling distant or cut-off from others, and diminished interest or pleasure as part of the PTSD diagnostic criteria. Beyond this constellation of symptoms—collectively referred to as emotional numbing (Litz & Gray, 2002) or anhedonia (Armour et al., 2015)—PTSD is associated with difficulty accessing and recalling positive memories (Contractor et al., 2019); fewer positive cognitions (Foa et al., 1986); and problems experiencing,

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expressing, and regulating positive emotions (Litz et al., 2000; Weiss et al., 2018). Despite the importance of positive psychological processes in PTSD, most research has focused on negative emotions (e.g., fear and anxiety; Foa et al., 1986), memories (e.g., disturbances in autobiographical trauma memory; Brewin, 2011), and cognitions (e.g., negative appraisals; Ehlers & Clark, 2000). This is problematic because positive emotions (e.g., happiness), cognitions (e.g., positive self-statements and self-talk), and memories (e.g., positive autobiographical memories) are often neglected relative to negative processes in empirically validated PTSD treatments (Contractor et al., 2022) and because anhedonia symptoms are associated with more functional impairment than other PTSD symptom factors (May et al., 2022). In this study, we sought to reduce this research gap by examining positive emotion in the daily lives of trauma-exposed community members with and without PTSD.

Positive emotional functioning in PTSD: From the laboratory to daily life

Our investigation of positive emotion dysfunction in PTSD included three aspects of positive emotional functioning: overall levels of positive emotion, how "positive" one rates their positive situations, and the degree of positive emotion one derives from positive situations (i.e., "positive emotion reactivity"). These facets were selected because they each provide unique information about positive emotional functioning. Overall levels of positive emotion provide information about one's average emotional experience, how positively one rates their situation offers a measure of the participant's appraisal of the situation, and positive emotion reactivity captures how positive emotions fluctuate in response to daily events. In this study, positive emotion reactivity was operationalized as the effect of positive situations on positive emotions (i.e., situation as a time-varying predictor of momentary positive emotions, controlling for prior positive emotions). Of these three facets, positive emotion reactivity offers the most direct comparison to laboratory-based studies of positive emotion in PTSD, which typically measure affective responses to positive stimuli rather than general levels of positive affect or cognitive appraisals. Including a measure of positive emotion reactivity is important because most knowledge about positive emotion in PTSD comes from laboratory studies of reward processing (May & Wisco, 2020; Nawijn et al., 2015; Weaver et al., 2020). For example, Nawijn et al. (2015) conducted a systematic review on reward processing in PTSD and found that compared with controls, individuals with PTSD show decreased reward anticipation, approach, and hedonic responses for a range of positive emotional stimuli (e.g., films, faces, autobiographical memories, money), with decreased reward processing most frequently evident among female participants and in relation to positive social stimuli. As the ability to seek out and enjoy positively valenced stimuli are broadly reflected in these reward processing deficits, these findings provide reason to believe that people with PTSD may be less likely to pursue positive situations in daily life and may experience less positive emotion when these situations are encountered.

Laboratory-based studies of reward processing in PTSD use standardized emotional stimuli, however, raising questions about whether these findings generalize to the lives of people with PTSD. The use of ecological momentary assessment (EMA) is ideally positioned to address this question. First, the repeated sampling of experiences in daily life provides greater reliability than a single point assessment and offers more ecologically valid estimates

of emotional experience. Second, asking people to subjectively rate the quality of their daily experiences allows for the indirect assessment of how they appraise those experiences. Given that an individual's perception of their experiences may be as or more important than the objective characteristics of those experiences (Hammen & Glass, 1975), examining the link between positive situations encountered in one's environment and positive emotions may provide a unique opportunity to examine positive emotion reactivity. Finally, the repeated sampling of experiences in daily life allows for the capability to examine dynamic patterns of emotional functioning in response to the environment (i.e., emotional reactivity).

Unfortunately, only a few studies have examined positive emotion in the daily lives of individuals with PTSD. In a sample of 117 male combat veterans, Beckham et al. (2000) found that over a single day of EMA, participants with PTSD reported blunted positive emotion relative to those without PTSD. Similarly, Kashdan et al. (2006) found that veterans with war zone–related PTSD reported lower levels of daily positive emotion in a 2-week daily diary study of 55 veterans with and without PTSD. Simons et al. (2020) used an EMA burst design over 1.5 years in a sample of 256 veterans to assess positive emotional functioning and found that PTSD symptoms were associated with lower levels of daily positive emotion. Finally, and contrasting prior literature, Dornbach-Bender et al. (2020) conducted a 7-day EMA study of 202 responders to the September 11, 2001, terrorist attacks on the World Trade Center and found that individuals with current PTSD did not differ in their daily experiences of positive emotion compared to those without PTSD. Together, this research shows that people with PTSD experience lower levels of overall positive emotion in daily life, at least among veterans. Yet, these studies are limited by their focus on overall levels of positive emotion and not positive emotion reactivity, which would provide the most direct comparison to laboratory-based studies on reward processing in PTSD. Thus, the first goal of this study was to examine whether PTSD-related deficits in positive emotion reactivity would generalize from the laboratory to daily life by providing the first EMA study of reactivity to positive situations among trauma-exposed individuals with and without PTSD. We also sought to address whether the positive emotion dysfunction observed in veteran populations would generalize to a diverse sample of adult community members.

Positive emotional functioning in PTSD: A global or context-specific problem?

A key but understudied question is why individuals with PTSD develop problems with positive emotion. The PTSD diagnostic criteria would suggest that symptoms associated with positive emotion dysfunction in PTSD are a global deficit (e.g., *DSM-5* Criterion D7, "persistent inability to experience positive emotions"; APA, 2013). The global models suggests that individuals with PTSD experience a limited or constrained capacity for positive emotions, perhaps as a consequence of chronic avoidance behavior, positive emotion dysregulation, or neural alterations in reward processing circuitry that are observed in PTSD (see Vinograd et al., 2022, for a review). In contrast, PTSD researchers have argued that emotional numbing, and presumably positive emotion dysfunction more broadly, is context-specific (Litz, 1992; Litz & Gray, 2002). In this latter model, positive emotions (e.g., experiencing, expression) are believed to be intact but more difficult to access during trauma

reexperiencing characterized by highly arousing negative emotions. In other words, trauma reminders and reactions, along with a preparedness for defensive emotional responding, may raise the threshold needed to activate positive emotional responses. Building on the context-specific model, Weaver et al. (2020) proposed that when a rewarding stimulus is associated with a trauma cue, the avoidance of trauma cues undermines the rewarding value of a positive stimulus and results in what the authors term a "sacrificing of reward." The context-specific model, therefore, yields two implications for positive emotional processing in PTSD. First, in general (e.g., when an individual is not reminded of their traumatic experience), people with PTSD should exhibit the same pattern of positive emotion reactivity to positive stimuli as those without PTSD. Second, when a trauma reminder is experienced, those with PTSD should exhibit a blunted pattern of positive emotion reactivity to positive stimuli.

Direct empirical tests of the context-specific hypothesis are scarce, and to our knowledge, no study to date has examined the context-specific hypothesis in daily life. An experimental study by Litz and colleagues (2000) presented combat veterans with either a neutral- or trauma-related priming video and subsequently examined self-reported, behavioral, and physiological reactivity to a series of positive, neutral, and negative emotional photographs. Veterans with PTSD demonstrated no reduced capacity in responding to positive emotional stimuli following the neutral prime, which is inconsistent with the idea that positive emotion dysfunction is a global problem in PTSD. Instead, they exhibited reduced behavioral expressivity in response to positive stimuli following the trauma prime, providing some evidence for the context-specific hypothesis (Litz et al., 2000). Weaver et al. (2020) recently found added support for the context-specific model in an experimental study of trauma-related approach-avoidance conflict in PTSD. Here, PTSD diagnostic status and symptom levels were associated with decreased pursuit of reward in service of the avoidance of trauma reminders. In contrast, May and Wisco (2020) examined reward processing in trauma-exposed community members who completed a wheel-of-fortune reward processing task. The authors found that participants with PTSD experienced reduced reward anticipation, but not satisfaction, relative to those without PTSD. Reward processing was unaffected by exposure to a trauma-related versus neutral prime, however, contradicting the context-specific hypothesis.

The present study

The goal of this study was to clarify the nature of positive emotion in the daily lives of trauma-exposed individuals with and without PTSD. We posed the following questions: In comparison to trauma-exposed individuals without PTSD, (a) are overall levels of positive emotion and ratings of positive situations blunted among those with PTSD; (b) is positive emotion reactivity to positive events blunted; and (c) does this blunting solely occur during greater thinking about trauma reminders? To achieve this goal, we examined positive emotion in a community sample of trauma-exposed adults, approximately half of whom were diagnosed with PTSD. We used EMA to repeatedly sample for ratings positive emotion, positive situations, and trauma reminders in daily life, allowing for real-time data collection in naturalistic settings and providing the advantages of minimizing retrospective

recall and enhancing the ecological validity of emotional experiences as they unfold in personal contexts.

To test hypotheses about emotion reactivity and following previous research (Bylsma et al., 2011; Thompson et al., 2012), we examined concurrent associations between participants' reporting of positive situations and positive emotion, controlling for positive emotion at the previous time point. To test the global versus context-specific models of positive emotion dysfunction in PTSD, we examined whether PTSD status would moderate the link between positive situations and corresponding changes in positive emotion and evaluated whether this association was further moderated by trauma reminders (i.e., a significant three-way interaction between positive situations, PTSD status, and trauma reminders). Based on the foregoing review, we expected that average ratings of positive situations and emotions would be blunted in people with PTSD compared to trauma-exposed participants without PTSD. Because our primary study goal was to pit the global versus context-specific models against one another, and given mixed evidence for both models, we did not have a hypothesis about which model would emerge from the data.

METHOD

Participants

The data presented here are from the Ambulatory Physiological Assessment of PTSD Study. Participants were 85 trauma-exposed community members recruited from a mid-sized city in the southeastern United States. Five participants started the study but were excluded from the final sample because they either reported an exclusion criterion after being consented ($n = 1$) or were not able to complete all study procedures ($n = 4$), yielding a final sample of 80 participants. Based on the Clinician Administered PTSD Scale for *DSM-5* (CAPS-5; Weathers et al., 2013b), 39 participants met the criteria for current (i.e., past-month) PTSD, and 41 participants were categorized as trauma-exposed controls (TECs) who did not meet the criteria for current PTSD. Respondents were eligible for this study if they were fluent in English, between 18 and 40 years old, endorsed lifetime exposure to at least one *DSM-5* Criterion A traumatic event, and had a body mass index (BMI) between 18.5 and 34.9. Exclusion criteria were psychosis; past-month trauma exposure precluding a current PTSD diagnosis; and factors known to influence psychophysiological data collected as part of the parent study, such as pregnancy, a history of cardiovascular disease, medications that affect cardiovascular functioning (e.g., antidepressants, antihistamines), or dissociative symptoms.

Procedure

Participants were recruited from local online advertisements, community flyer postings, and a repository of trauma-exposed people who had previously participated in research and consented to future contact. Participants were recruited into the study after completing an online prescreen questionnaire administered via Qualtrics, which included demographic information, lifetime trauma exposure (i.e., the Life Events Checklist for *DSM-5* [LEC-5]; Weathers et al., 2013a), past-month PTSD symptoms and trauma-related dissociative symptoms (i.e., PTSD Checklist for *DSM-5* [PCL-5]; Weathers, Litz, et al., 2013), psychosis (i.e., PRIME Screen; Miller et al., 2004), and health-related information (e.g., conditions

and medications known to affect physiological data acquisition, including BMI). Eligible respondents were carefully vetted in a follow-up phone screening administered by trained graduate students to confirm that the index traumatic event (i.e., "worst" event) reported on the LEC-5 prescreen occurred beyond 1 month ago and met the *DSM-5* definition of Criterion A trauma exposure.

Recruited participants provided informed consent for all study procedures, which were approved by the Institutional Review Board at the University of North Carolina at Greensboro. Participants with probable PTSD were identified based on a cutoff score of 33 on the PCL-5 (Bovin et al., 2016) and oversampled to obtain an approximately 1:1 ratio of individuals with and without PTSD. Recruitment was stratified by trauma type (e.g., sexual assault, physical assault, transportation accident), age, race and ethnicity, and BMI to ensure that participants with and without PTSD were matched on these variables as much as possible. The parent study was composed of two laboratory sessions and 3 days of ambulatory assessment, which included the EMA procedures described later as well as ambulatory physiological assessment (not presented here). In the first laboratory session, participants completed structured clinical interviews to assess for PTSD and co-occurring *DSM-5* mood and anxiety conditions. Participants then completed two standardized study scripts used for a script-driven imagery procedure conducted in a second laboratory session. Days after the first laboratory session, participants began of the 3-day ambulatory assessment protocol, then returned for the second laboratory session.

Participants began the 3 days of ambulatory assessment within 1 week of completing their first laboratory session (M = 5.48 days, SD = 4.50). On the morning of each session, participants were connected to Mindware mobile physiological acquisition hardware, oriented to a Lenovo tablet used to collect EMA data via the offline Qualtrics survey system, and completed a practice EMA questionnaire. Tablets were pseudorandomly configured to administer prompts within 90-min blocks starting at 9:00 a.m. and ending at 11:30 p.m. or when participants went to bed, for a total of up to 17 prompts per day. Participants had 20 min after each prompt to complete the corresponding questionnaire. The mean time between prompts was 53.67 min (SD = 13.34, range: 31–73 min). Following the 3 days of ambulatory assessment, participants completed the second laboratory session, which consisted of an experimental script-driven imagery procedure and questionnaires not analyzed here, and were compensated $150 (USD).

Measures

PTSD diagnosis—The CAPS-5 (Weathers et al., 2013b) is a structured clinical interview used to assess PTSD diagnosis and symptom severity. The measure includes 20 items corresponding to *DSM-5* symptom criteria for PTSD plus two items that are used to assess dissociation. Symptom severity for each item is rated on a 5-point Likert scale ranging from 0 (*absent*) to 4 (*extreme/incapacitating*) based on symptom frequency and intensity. All participants completed the CAPS-5 based symptoms experienced in the past month to determine current PTSD. All interviews were administered by trained graduate students and were audio-recorded and independently scored by a second trained graduate to determine interrater reliability, intraclass correlation coefficient (ICC) =.99. Discrepancies were

resolved in concert with a doctoral-level psychologist with expertise in PTSD diagnostic assessment.

EMA Items

Positive emotion.: At each observation, participants rated three discrete positive emotions on a 7-point Likert scale ranging from 1 (*not at all*) to 7 (*very much*). The item stem "In the past 10 minutes I felt…" was used to assess positive emotions (i.e., happy, relaxed, safe), which were averaged to create an index of positive emotion. Items were selected based on their relevance to PTSD and all adjectives tapping positive emotion in the dataset were used for analysis. Multilevel reliability values for the positive emotion composite were $\omega_B = .83$ and $\omega_W = .67$.

Positive situations.: At each prompt, positive event appraisal was measured using a single item (i.e., "In the past 10 minutes, my situation was positive") rated on the same 0–7-point Likert scale used to rate emotion items. This item was selected based on validated EMA examining positive experiences in daily life (e.g., Eddington et al., 2016) and to reduce participant burden given protocol density. Though internal reliability cannot be estimated with a single item, recent psychometric work suggests that single-item measures of emotional experience show strong concurrent and predictive validity that is comparable to their multiple-item counterparts in EMA designs (Song et al., 2022).

Trauma reminders.: Four items (i.e., "I had unwanted memories of the trauma," "I was thinking about the trauma," "I relived the trauma as though it were actually happening again," and "Something reminded me of the trauma") were designed to capture trauma reminders. Items used the stem, "In the past ten minutes…" and were rated on a 7-point Likert scale ranging from (*not at all*) to 7 (*very much*). Items were averaged to create an index of trauma reminders. Reliability values for this scale were $\omega_B = .95$ and $\omega_W = .85$.

Data analysis

Multilevel modeling (MLM) was used for all primary analyses due to the nested data structure. MLM partitions data at the level of observations (Level 1) and participants (Level 2), which allows for estimation of within- and between-subject effects without assuming independence. MLM can also accommodate time-varying intervals between observations and missing data. All MLMs were conducted in Mplus (Version 8.7) using full-information maximum likelihood with robust standard errors. Data preprocessing was conducted and descriptive statistics calculated using SPSS (Version 28).

First, unconditional models were estimated with positive emotion as the outcome to determine variability at the within- and between-person levels, as reflected by the ICC. Second, to examine the proportion of variance explained by PTSD status, we estimated three means-as-outcomes models with positive situation, positive emotion, and trauma reminder ratings as the outcome variables. Finally, to test the global versus context-specific models of positive emotion dysfunction in PTSD, we constructed a single multilevel model. Following past work (e.g., Bylsma et al., 2011; Thompson et al., 2012), emotion reactivity was operationalized as the unique within-person link between the degree to which the strength

of a participant's positive situations predicted concurrent changes in positive emotion across the sampling period. We estimated a slopes-as-outcome model to examine the influences of PTSD status and trauma reminders on positive emotion reactivity, adjusted for positive emotion at the previous observation. Here, the model is depicted using notations by Bolger and Laurenceau (2013) where $_i$ represents observations, $_j$ participants, r_{ij} the within-person (Level 1) random effect, and u_{0j} the between-person (Level 2) random effect.

Level 1 (observations):

$$PE_{ij} = \beta_{0j} + \beta_{1j}(PE_{t-1}) + \beta_{2j}(\text{Positive Situation}) + \beta_{3j}(\text{Reminder}) + \beta_{4j}(\text{Int}) + r_{ij}$$

Level 2 (participants):

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{PTSD Status}) + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21}(\text{PTSD Status}) + u_{2j}$$

$$\beta_{3j} = \gamma_{30} + \gamma_{31}(\text{PTSD Status}) + u_{3j}$$

$$\beta_{4j} = \gamma_{40} + \gamma_{41}(\text{PTSD Status}) + u_{4j}$$

As shown, the within-person (Level 1) predictors were the autoregressive effect of positive emotion at the preceding prompt *t*-1 (β_{1j}), the current positive situation rating (β_{2j}), the current rating of trauma reminders (β_{3j}), and the Positive Situation × Trauma Reminders interaction term (β_{4j}). Level 1 predictors were person-mean-centered and modeled as random effects. The between-person (Level 2) predictor was PTSD status, dummy-coded as 0 = TEC, 1 = PTSD, and the outcome was positive emotion at time *t*. At Level 2, γ_{00}, γ_{20}, $\gamma_{30,}$ and γ_{40} reflect the TEC group averages for positive emotion, positive emotion reactivity, trauma reminders, and the Positive Situation × Trauma Reminders interaction, respectively, and γ_{01}, γ_{21}, $\gamma_{31,}$ and γ_{41} reflect the influence of PTSD status on these variables (i.e., cross-level interactions). We did not specify a cross-level interaction of PTSD status on the autoregressive effect (β_{1j}) because we had no hypothesis about this effect. For overall levels of positive emotion, the global model would predict a significant effect of PTSD status on positive emotion (γ_{01}) in the absence of a significant two-way PTSD Status × Trauma Reminders interaction (γ_{31}). The context-specific model would predict a significant two-way interaction between PTSD status and trauma reminders such that individuals with PTSD would experience blunted positive emotion that was only present or was worsened during moments dominated by more thinking about trauma reminders. For positive emotion reactivity, the global model would predict a significant two-way PTSD

Status × Positive Situation interaction (γ_{21}) in the absence of a significant three-way PTSD Status × Positive Situation × Trauma Reminders interaction (γ_{41}). The context-specific model would predict a significant three-way interaction term, with follow-up tests indicating that individuals with PTSD would experience blunted positive emotion reactivity relative to TECs but that this blunting was only present or was worsened during trauma reminders. Due to potential concerns about our positive emotion composite (i.e., happy, relaxed, safe), we performed tests of robustness by reestimating the primary multilevel model at the item level. The results remained unchanged (see Supplementary Table S2); therefore, we report the model using the full positive emotion index in the results.

To estimate lagged effects for the global and context-specific models, we binned observations into 60-min intervals based on the 24-hr clock. This approach treats intervals between observations as equivalent, which we permitted based on minor variability between pseudorandom beeps. Bins that contained more than one survey (n = 315; 7.58% of all bins) were averaged together, and bins that did not contain a survey were treated as missing data. Prior to estimating the models, we examined whether linear time elapsed from the first completed survey and time of day predicted momentary positive emotion to assess for effects related to temporal change and natural diurnal mood fluctuation.

RESULTS

Demographic and clinical characteristics

Demographic and trauma exposure characteristics of diagnostic groups are presented in Table 1. Consistent with our recruitment approach, the TEC and PTSD groups did not differ in age, gender, distribution of race/ethnicity, religious identity, or relationship status. The groups also did not differ on Criterion A index traumatic events, which were heterogeneous and spanned multiple types of interpersonal (e.g., sexual assault, physical assault) and noninterpersonal trauma (e.g., transportation accident, life threatening illness or injury). Consistent with clinical diagnostic criteria, participants with PTSD self-reported higher levels of PTSD symptoms on the PCL-5 prescreen (M = 41.62, SD = 14.53) compared with the TEC group (M = 32.51, SD, 14.68), p = .007, and had higher clinician-rated PTSD symptom severity on the CAPS-5 interview (PTSD: M = 30.08, SD = 7.07, TEC: M = 10.05, SD = 6.25), p < .001. Across the 3-day EMA period, participants completed 2,158 surveys (TEC: n = 1,132, PTSD: n = 1,026), or an average of 26.98 surveys per participant, and completed of 52.9% (SD = 18.4) of total possible surveys. Participants with (M = 51.6%, SE = 17.9%) and without PTSD (M = 54.1%, SE = 19.1%) did not differ in their completion rates, $t(78)$ = .605, p = .547. Of note, the overall compliance estimate is conservative because some participants missed the first morning surveys due to later start times, and participants were instructed to turn off their devices when they went to bed. After removing nonadministered surveys due to late start times in the morning and bedtimes in the evening, the average overall survey compliance was 63.1% (SD = 19.7%) with no differences between groups, $t(78)$ = .575, p = .567.

Group differences in positive emotions, positive situations, and trauma reminders

Descriptive statistics for the daily life variables are presented in Supplementary Table S1. We first estimated an unconditional model with positive emotion as the outcome to examine variance explained within- and between-persons. The corresponding ICC was .485, indicating that approximately 51% of the variability in positive emotion was within-person. Fit indices were as follows: Akaike information criterion (AIC) = 6,549.00, Bayesian information criterion (BIC) = 6,566.031, sample size–adjusted BIC (ssaBIC) = 6,556.499. We also estimated the effects of temporal change and diurnal mood fluctuation on positive emotion, which were not significant *p*s = .325–.472, and, thus, dropped from subsequent analyses. Next, we examined the effect of PTSD status on overall levels of positive emotion, positive situations, and trauma reminders in three separate means-as-outcomes models. Compared to TECs ($M = 5.09$, $SD = 1.33$), participants with PTSD reported lower levels of momentary positive emotion ($M = 4.23$, $SD = 1.38$), $B = -0.947$, $SE = 0.206$, $p < .001$. Relative to TECs ($M = 4.45$, $SD = 1.93$), participants with PTSD rated their positive situations as less positive ($M = 3.87$, $SD = 1.93$), $B = -0.607$, $SE = 0.283$, $p = .032$. Finally, compared to TECs ($M = 1.17$, $SD = 0.47$), people with PTSD reported thinking more about trauma reminders ($M = 1.48$, $SD = 0.84$), $B = 0.360$, $SE = 0.076$, $p < .001$.

Global versus context-specific models of positive emotion dysfunction

Results from the model are presented in Table 2. Fit indices showed improvement to the model, AIC = 2,960.885, BIC = 3,057.147, ssaBIC = 2,996.797. Overall, we found a significant autoregressive effect of positive emotion, indicating that positive emotion was self-perpetuating across time. Regarding overall levels of positive emotion and consistent with the global model of positive emotion dysfunction and means-as-outcome models described previously, PTSD status was a significant predictor of overall positive emotion. The interaction between PTSD status and trauma reminders as predicted by the context-specific model was not significant; rather, higher-than-average thinking about trauma reminders predicted lower levels of positive emotion even when controlling for prior positive emotion, indicating that trauma reminders influenced participants' mood irrespective of PTSD status. For positive emotion reactivity, the slope was significant such that participants reported more positive emotion when their situations were more positive even after controlling for positive emotion at the previous observation. Positive emotion reactivity did not vary by PTSD status, however, as predicted by the global model of positive emotion dysfunction. Further, thinking about trauma reminders did not influence positive emotion *reactivity* (i.e., no significant interactions between trauma reminders and positive situations). The three-way interaction between PTSD, trauma reminders, and positive situations, predicted by the context-specific model, was also not significant.

DISCUSSION

The goal of this study was to examine positive emotional functioning in the daily lives of trauma-exposed adults with and without PTSD. We sought to clarify whether individuals with PTSD experience problems with positive emotion regardless of context compared to those without PTSD, consistent with the global model of positive emotion dysfunction, or whether problems with positive emotion only emerge when those with PTSD think about

trauma reminders, consistent with the context-specific model. Our findings were generally consistent with the global model and did not support the context-specific model. Despite finding that ratings of positive situations predicted concurrent increases in positive emotion, neither PTSD status nor thinking about trauma reminders influenced the strength of this association. Rather, we found that a diagnosis of PTSD and increased thinking about trauma reminders independently predicted blunting in overall levels of positive emotion and fewer positive situations in daily life.

Emotional numbing and anhedonia in PTSD refer to a cluster of symptoms characterized by a persistent inability to experience positive emotion, feeling distant or cut-off from others, and diminished interest or pleasure in activities (APA, 2013; Armour et al., 2015; Litz & Gray, 2002). These aspects of positive emotional functioning are positioned as and often assumed to be global problems. In this study, we found that participants with PTSD reported reduced overall levels of momentary positive emotion and rated their overall positive situations as less positive compared to those without PTSD. These findings are consistent with the global model of positive emotion dysfunction and prior EMA research in PTSD (Beckham et al., 2000; Kashdan et al., 2006; Simons et al., 2020).

At the same time, PTSD status did not influence within-person positive emotion reactivity in daily life such that adults with and without PTSD reported deriving proportionate levels of positive emotion from positive situations. These findings run counter to laboratory work on reward processing in PTSD that has shown decreased “liking” in response to a range of positive stimuli (e.g., faces, money, positive autobiographical events; May & Wisco, 2020; Nawijn et al., 2015) but are consistent with work on positive emotion reactivity in the daily lives of people with major depression (e.g., Bylsma et al., 2011; Thompson et al., 2012). Identifying reasons for the divergence between laboratory and naturalistic contexts will presumably be important in clarifying the nature of positive emotion dysfunction in PTSD. There are several explanations that could explain this discrepancy, including differences in the event samples (i.e., standardized vs. participant-rated events), differences in reactivity timescale (i.e., seconds to hours), and the frequency of positive events encountered in daily life that may have implications for naturalistic patterns of reactivity. Future work might consider combining laboratory and EMA designs to resolve these inconsistent findings. Nevertheless, our findings are consistent with the global model and show that positive emotions are generally blunted among individuals with PTSD. The results also suggest that trauma-focused treatments might benefit from targeting improvements in positive emotion by amplifying the quality and quantity of positive activities in the lives of people with PTSD (Contractor et al., 2022).

An alternative explanation for positive emotional blunting in PTSD—the context-specific model—states that individuals with PTSD retain access to the full repertoire of pretrauma positive emotional functioning, including emotional experiencing and expression, following trauma exposure (Litz et al., 1992). Instead, an acquired preparedness for defensive emotional responding in the service of avoidance behavior raises the threshold needed to experience positive emotions. In other words, positive emotion should be hampered during moments when people with PTSD are primed to respond to trauma reminders (Litz & Gray, 2002; Weaver et al., 2020). Here, we found that increases in trauma reminders were

associated with decreased momentary levels of positive emotion and that this blunting was similar in participants with and without PTSD. These findings are inconsistent with the context-specific model (Litz & Gray, 2002); although trauma reminders do seem to make positive emotion more difficult to access, this effect appears universal to trauma-exposed individuals with and without PTSD. Importantly, the interaction between trauma reminders and PTSD status was not significant ($p = .058$), and this effect was in the opposite direction than we hypothesized (i.e., the effect of PTSD on positive emotion was attenuated by the presence of trauma reminders). There was no effect of trauma reminders on positive emotional reactivity (i.e., no interaction between trauma reminders and positive situations) nor was there an effect of trauma reminders on reactivity moderated by PTSD status (i.e., no three-way interaction).

The lack of support for the context-specific model was unexpected, and we believe there are a few potential explanations. First, given the small but significant within-subjects correlation between positive situations and trauma reminders ($r = -.18$, $p < .001$), the concurrent experiencing of positive situations and trauma reminders in daily life may be relatively uncommon, precluding detection of an effect. Second, our short-term EMA protocol, which reflected participants' experiences over the past 10 minutes repeatedly for 3 days, may have been insufficient to capture the number or intensity of reminders needed to detect the effect of interest. Conversely, it is possible that the frequency of our assessment intervals may have influenced the extent to which participants thought about their traumatic experiences. Assessing trauma reminders over a longer sampling period with less frequency may have yielded different results, and these possibilities underscore the need for research examining the most appropriate timescale to assess trauma reminders in daily life. There is a trade-off between sampling frequency and density, though, and the density of our protocol allowed us to examine emotional reactivity with high temporal precision and limited retrospection. Finally, it is possible that the previously proposed mechanism for the context-specific model (i.e., trauma reminders) was misspecified. We found that the influence of trauma reminders on positive emotion may operate similarly in individuals with and without PTSD, and the findings offered no support for this proposed mechanism. However, recent work has found that the avoidance of trauma reminders rather than just exposure to reminders results in a sacrificing of reward that makes positive emotions more difficult to experience in PTSD (e.g., a sexual assault survivor avoiding sexual intimacy; Weaver et al., 2020). We encourage future researchers to consider other variables that might influence positive emotion dysfunction in PTSD beyond just trauma reminders. In addition to avoidance, the roles of negative emotion and emotion regulation are noteworthy factors to consider when examining positive emotion in PTSD. For example, research on negative affect interference suggests that individuals with PTSD are more likely to report negative emotion in response to positive events (Frewen et al., 2012) and more likely to use emotion regulation strategies that purposefully decrease positive emotions (e.g., dampening; Wolkenstein et al., 2022).

To our knowledge, this is the first study of positive emotion reactivity in the daily lives of individuals with and without PTSD. The study has several strengths, including the use of EMA to enhance ecological validity and temporal sensitivity. This method complements and extends previous laboratory studies of emotion reactivity that have typically employed standardized emotional stimuli and seldom assessed the influence of trauma reminders

on emotional processing. Assessing positive experiences and trauma reminders as they naturalistically occur in the daily lives of trauma-exposed people represents an important addition to this literature. Our clinically diagnosed sample was also relatively diverse, exposed to a wide spectrum of interpersonal and noninterpersonal traumatic events, and sampled at pseudorandomized intervals, increasing the generalizability of the findings. Finally, groups were matched on several demographic and trauma exposure variables to help interpretability by ruling out potential confounds.

There are also several limitations to discuss. First, our measure of positive emotion was limited and included three discrete states selected based on their relevance to PTSD. Though these states vary in valence and arousal (Russell, 1980), they do not fully capture the multifaceted nature of positive emotion (e.g., high vs. low arousal) nor can they directly speak to reward processing (e.g., distinguishing anticipatory from consummatory pleasure). Future research should aim to unpack the aspects of positive emotion most affected in PTSD using more comprehensive assessments of positive emotion states (e.g., satisfaction, hope, enthusiasm) and related processes (e.g., reward). Second, we used a single item to assess positive situational experiences over the 10 min prior to each prompt. Given that different types of positive emotional stimuli are more often associated with reward processing deficits in PTSD (Nawijn et al., 2015), a more granular assessment of daily positive experiences that includes event context (e.g., social, monetary, romantic), appraisals (e.g., pleasantness, importance, control), and separation of event frequency from intensity would have allowed us to better understand positive emotion dysfunction. Third, reliance on self-report when assessing positive events conflates objective and subjective experiences. For example, people with PTSD may encounter fewer positive situations in daily life (e.g., fewer social contacts due a tendency to feeling distant or cut off from others) or appraise objectively positive events as less positive, making it difficult to draw strong comparisons to laboratory research using standardized positive stimuli. Fourth, the density of the sampling protocol and nature of the clinical sample may have contributed to a lower EMA response rate. Though EMA sampling frequency does not appear to increase participant burden or influence data quantity or quality (Eisele et al., 2022), and though we took statistical steps to account for missed surveys, it is possible that factors such as selective reporting biased the results. Fifth, this was a secondary data analysis of an existing dataset. Monte Carlo simulations were conducted for primary study aims and confirmed that this sample size was powered to detect significant effects at .80 or higher for cross-level interactions at an alpha level of .05. The effect sizes of interest here likely differed, however, and we may have been underpowered to detect these effects.

Next, laboratory-based assessments of reward processing in PTSD often employ measures of reactivity across multiple output systems (i.e., subjective, behavioral, and physiological responding; Mauss et al., 2005), and changes in one system cannot be assumed to generalize to other systems (Nawijn et al., 2015). In the context-specific model, for example, Litz and Gray (2002) hypothesized that emotional expression (i.e., a behavior) is an area of emotional processing that is especially suppressed following exposure to trauma cues. This idea is based on laboratory research showing that following a trauma prime, veterans with PTSD exhibited blunted behavioral responding to positive emotional stimuli, a finding that did not emerge for subjective or physiological responding (Litz et al., 2002). It is, therefore, possible

that our tests of the global and context-specific models of positive emotion reactivity would have demonstrated a different pattern of findings had we included behavioral indices of reactivity.

Finally, the cross-sectional methods used here preclude us from unpacking the question of whether positive emotion dysfunction is a characteristic of PTSD or a risk factor for its onset and maintenance. They also cannot allow us to rule out the role of conditions highly comorbid with PTSD on positive emotional functioning (e.g., depression) or address whether the findings from this predominantly female and non–treatment-seeking sample might generalize to men, individuals seeking treatment for PTSD, or other groups that were not included due to exclusion criteria (e.g., individuals with the dissociative subtype of PTSD, people on antidepressants, or older individuals). Nevertheless, our findings have implications for trauma-focused treatments for PTSD. They suggest that positive emotion dysfunction is a global problem in PTSD and may require explicit targeting in trauma-focused interventions. Unfortunately, most existing interventions for PTSD either do not include a focus on positive emotion and related internal processes (e.g., cognition, memory) or treat these features as adjunctive to the primary targeting of negative processes (Contractor et al., 2022). Despite previous work suggesting several pathways through which improvements in positive internal processes may relate to better PTSD treatment outcomes (e.g., replacing trauma memories as the primary reference point for one's identity and filter through which they understand the world, using positive emotion to trigger positive cognitions and behaviors; see Contractor et al., 2022), understanding of these pathways remains limited and could be improved through the implementation of skills to address positive experiences in PTSD treatments.

Taken together, the results of this study lend support for the global model of positive emotion dysfunction in PTSD and offer little support for the context-specific model. They suggest that although people with PTSD report similar levels of reactivity to positive emotional stimuli in daily life compared to trauma-exposed individuals without PTSD, those with PTSD experience blunted overall levels of positive emotion and fewer positive situations. Irrespective of diagnostic status, problems with positive emotion appear exacerbated during increased thinking about trauma reminders. The results add to a growing body of research on positive emotion in PTSD and reveal important directions for future research to clarify the basis of these problems.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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OPEN PRACTICE STATEMENT

The study reported in this article was not formally preregistered. The data that support the findings will be available to the general research community from the National Institute of Health National Data Archive at www.nda.nih.gov after an embargo period of exclusive access following the end date of the research award.

TABLE 1

Demographic and trauma exposure characteristics, by posttraumatic stress disorder (PTSD) diagnostic group

Characteristic	Trauma-exposed Control (*n* = 41)		PTSD (*n* = 39)		Difference test	*p*
	M	***SD***	***M***	***SD***		
Age	22.22	5.06	21.33	3.07	$t(78) = 0.941$	.349
	n	**%**	***n***	**%**		
Women	31	75.6	29	74.4	$\chi^2(1, N = 80) = 0.017$	.897
Race/ethnicity					$\chi^2(5, N = 80) = 5.385$	.371
Non-Hispanic White	18	43.9	10	25.9		
Black/African American	9	21.9	14	35.9		
Hispanic/Latino	9	21.9	8	20.5		
Asian/Pacific Islander	0		2	5.1		
Biracial	2	4.9	2	5.1		
Other/multiracial	3	7.3	3	7.7		
Educational attainment[a]					$\chi^2(4, N = 79) = 0.360$	.986
High school diploma	7	17.1	7	17.9		
Associate's degree	5	12.2	4	10.3		
Some college	22	53.7	19	48.7		
Bachelor's degree	4	9.8	4	10.3		
Graduate degree	3	7.3	4	10.3		
Religion[a]					$\chi^2(4, N = 79) = 2.242$	.691
Christian	22	53.7	19	48.7		
Jewish	0	0.0	1	2.6		
Hindu	0	0.0	1	2.6		
Other	3	7.3	3	7.7		
None	16	39.0	14	35.9		
Currently in a romantic relationship[a]	23	56.1	19	48.7	$\chi^2(1, N = 79) = 0.294$	.587
Index traumatic event					$\chi^2(4, N = 80) = 2.194$	.700
Sexual assault	17	41.5	17	41.5		
Physical assault	8	19.5	11	28.2		

Characteristic	Trauma-exposed Control (*n* = 41)		PTSD (*n* = 39)		Difference test	*p*
	M	***SD***	***M***	***SD***		
Natural disaster/accident/fire	8	19.5	5	12.8		
Serious illness/injury/death	7	17.1	6	15.4		
Combat exposure	1	2.4	0	0.0		

[a] Missing information for one participant for this variable.

[b] Index traumatic events were determined per Criterion A in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). PTSD symptom ratings were anchored to this event.

TABLE 2

Multilevel model testing the global versus context-specific models of positive emotion dysfunction in posttraumatic stress disorder (PTSD)

Variable	*B*	*SE*	95% CI	*p*
Intercept	5.05	0.15	[4.75, 5.34]	< .001
PE_{T-1} [a]	0.18	0.05	[0.08, 0.28]	< .001
Positive situation	0.31	0.04	[0.23, 0.39]	< .001
Trauma reminder	−0.55	0.14	[−0.83, −0.26]	< .001
PTSD status	−0.86	0.22	[−1.28, −0.43]	< .001
Positive Situation × PTSD Status	0.03	0.06	[−0.09, 0.14]	.635
Trauma Reminder × PTSD Status	0.23	0.12	[−0.01, 0.47]	.058
Positive Situation × Trauma Reminder	−0.05	0.21	[−0.47, 0.36]	.805
Positive Situation × Trauma Reminder × PTSD Status	0.02	0.19	[−0.35, 0.40]	.906

Note: PTSD status: 0 = trauma-exposed control; 1 = PTSD. PE = positive emotion.

[a]PE at the previous observation.