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EMOTION REGULATION AND POSTTRAUMATIC STRESS DISORDER: A PROSPECTIVE INVESTIGATION

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Current conceptualizations suggest that individuals with Posttraumatic Stress Disorder (PTSD) over-utilize relatively ineffective emotion regulation strategies such as expressive suppression, and under-utilize relatively effective emotion regulation strategies such as cognitive reappraisal. In the first prospective investigation of the association between emotion regulation use and PTSD symptom severity among military veterans in residential treatment for PTSD, we found that: (1) at both treatment intake and discharge, use of expressive suppression was associated with more severe PTSD symptoms and use of cognitive reappraisal was associated with less severe PTSD symptoms; (2) from treatment intake to discharge, use of expressive suppression decreased and use of cognitive reappraisal increased; and (3) change in expressive suppression, but not cognitive reappraisal, from treatment intake to discharge was significantly and incrementally predictive of PTSD symptom severity at treatment discharge after accounting for intake PTSD symptom severity, length of treatment stay, and participant age. These results highlight the clinical importance of targeting and reducing the use of relatively ineffective regulation strategies within the context of PTSD treatment, in addition to providing alternative emotion regulation strategies.

Many influential theories of emotion agree that emotions are coordinated, biologically-based responses to internal or external cues that are perceived as relevant to an organism's needs, goals, or concerns (Scherer, Schorr, & Johnstone, 2001). These responses are often adaptive. However, it is sometimes necessary to regulate emotions that are either too intense or are poorly matched to the demands of the present situation (Gross, 1998a).

Two types of emotion regulation, expressive suppression and cognitive reappraisal, have attracted particular attention in the social and personality psychology literatures, and to a lesser extent in the clinical psychology literature. According to the process model of emotion regulation (Gross, 1998a), emotion regulation strategies can be used to modulate different components of emotion at different points on the trajectory of an emotional response. Expressive suppression (which involves inhibiting ongoing emotion-expressive behavior) is considered a response-focused strategy, as it is used to modulate an emotional response after it has developed in full. Alternatively, cognitive reappraisal (which involves changing one's thinking so as to change one's emotional responses) is considered an antecedent-focused strategy, as it is typically used to modulate an emotional response prior to its complete unfolding. A large basic social and personality psychology literature has found that expressive suppression is typically maladaptive as it does not reli-

ably reduce negative experiences, and paradoxically increases psychophysiological and neurobiological indices of negative emotional responding (Feldner, Zvolensky, Stickle, Bonn-Miller, Leen-Feldner, 2006; Gross & Levenson, 1997). In contrast, cognitive reappraisal is typically adaptive, as it is effective at down-regulating (reducing) unpleasant emotion in a broad range of contexts, without deleterious physiological or cognitive consequences (Gross, 1998b). Mirroring these results, clinically oriented investigations have found that lesser use of expressive suppression and greater use of cognitive reappraisal tend to be associated with lower levels of psychopathology (Werner & Gross, 2010).

Consistent with these findings, current conceptualizations of posttraumatic stress disorder (PTSD) hold that it is in part a disorder of experiential and emotional avoidance, as individuals with PTSD attempt to limit or avoid exposure to trauma-related cues and associated emotional reactivity (Feeny & Foa, 2005; Marx & Sloan, 2005; Orsillo & Batten, 2005; Polusny & Follette, 1995). Furthermore, cognitive models of PTSD posit that inaccurate, negative appraisals of a traumatic event, and lack of revision based on newly acquired information, produce a sense of current threat and contribute to the maintenance of PTSD symptoms (Ehlers & Clark, 2000). This conceptualization suggests that individuals with PTSD may over-utilize avoidant emotion regulation strategies such as expressive suppression, and under-utilize cognitive reappraisal. Specifically, the use of expressive suppression to limit expression of these intense and frequent unpleasant emotional experiences that are characteristic of PTSD may paradoxically increase unpleasant emotional experience among individuals with PTSD (Gross & Levenson, 1997). Increased unpleasant emotional arousal may: (a) be experienced as PTSD hyperarousal symptoms and accompany PTSD re-experiencing symptoms, (b) contribute to further attempts to avoid emotions and stimuli that elicit emotions, thus increasing PTSD avoidance symptoms, and (c) deplete cognitive-affective resources and emotional responsiveness over time, thus increasing PTSD numbing symptoms (Litz, 1992; Litz et al., 1997). Furthermore, more adaptive emotion regulation strategies, such as cognitive reappraisal are infrequently used, and thus do not contribute to improvements in emotional disturbances that underlie PTSD.

Several studies have found that greater difficulty in regulating emotions is associated with greater PTSD symptom severity (Bonn-Miller, Vujanovic, Boden, & Gross, 2011; Tull, Barrett, McMillan, &

Roemer, 2007). However, only three cross-sectional studies have investigated the use of expressive suppression and cognitive reappraisal in the context of PTSD (Eftekhari, Zoellner, & Vigil, 2009; Ehring & Quack, 2010; Moore, Zoellner, & Mollenhelt, 2008). Using cluster analysis, Eftekhari and colleagues (2009) found that, among women exposed to a traumatic event, frequent use of expressive suppression and infrequent use of cognitive reappraisal were associated with higher levels of PTSD symptoms. Ehring and Quack (2010) also found that frequent use of expressive suppression and infrequent use of cognitive reappraisal were associated with higher levels of PTSD symptoms in a large sample of trauma exposed participants. Finally, among trauma-exposed undergraduate and community samples of women, Moore and colleagues (2008) found that frequent use of expressive suppression, but not cognitive reappraisal, was associated with higher levels of PTSD symptoms. As demographic factors, trauma-exposure, and measures used to assess expressive suppression and PTSD symptom severity were similar across studies, it is unclear why Moore and colleagues (2008) did not find an association between cognitive reappraisal and PTSD symptoms, whereas Eftekhari and colleagues (2009) and Ehring and Quack (2010) did.

The goal of the present investigation was to examine prospectively the associations between the use of expressive suppression and cognitive reappraisal and PTSD symptom severity among male military veterans in a residential rehabilitation program for PTSD at a Department of Veterans Affairs (VA) medical center. This is the first investigation of the use of expressive suppression among veterans with PTSD (see Boden, Bonn-Miller, Kashdan, Alvarez, & Gross, 2012 for a cross-sectional investigation of cognitive reappraisal among veterans) and the first prospective investigation of expressive suppression and cognitive reappraisal in any population receiving treatment for PTSD. The primary treatment modality was cognitive-behavioral group therapy, and included group Cognitive Processing Therapy (Resick, Monson, & Chard, 2007). We posited that this treatment program would be a useful context in which to investigate change in the use of emotion regulation strategies because, like many evidence-based treatments for PTSD, cognitive behavioral therapies for PTSD focus on reducing the use of avoidant emotion regulation strategies and increasing the use of alternative strategies (Hamblen, Schnurr, Rosenberg, & Eftekhari, 2009). Specifically, cognitive-behavioral therapies include cognitive restructur-

ing as a central technique, which is similar to cognitive reappraisal. Furthermore, cognitive reappraisal has been theoretically identified as a key mechanism by which individuals with PTSD can expect improved outcomes (Ehlers & Clark, 2000). Cognitive-behavioral therapies also invite patients to direct their attention to memories and cognition, emotion, and physical sensations, in real-time, to process and habituate to them. In doing so, cognitive-behavioral therapies promote the reduction of avoidance of trauma-related stimuli, and resulting maladaptive consequences (e.g., increased unpleasant emotional arousal) (Zayfert & Becker, 2008). Thus, increasing the use of cognitive reappraisal and decreasing the use of expressive suppression may be important mechanisms of therapeutic change for cognitive-behavioral therapies, such as the one included in this study.

We hypothesized that at both treatment intake and discharge, use of expressive suppression would be associated with higher PTSD symptom severity, and use of cognitive reappraisal would be associated with lower PTSD symptom severity. As a subsidiary analysis, we investigated differences in degree of associations between emotion regulation and PTSD symptom severity variables at treatment intake and discharge. We further hypothesized that use of expressive suppression would decrease and use of cognitive reappraisal would increase during treatment. Lastly, we hypothesized that decreases in expressive suppression and increases in cognitive reappraisal from treatment intake to discharge would incrementally predict lower PTSD symptom severity at treatment discharge after accounting for shared variance with PTSD symptom severity at treatment intake, length of treatment stay, and age. As a subsidiary test of the directionality of this effect, we investigated whether decreases in PTSD symptom severity from treatment intake to discharge would incrementally predict lower expressive suppression and higher cognitive reappraisal at treatment discharge after accounting for shared variance with expressive suppression and cognitive reappraisal at treatment intake, respectively, as well as length of treatment stay and age. In all analyses including PTSD symptom severity, we separately investigated total PTSD symptom severity, and each symptom cluster. Furthermore, because of the conceptual overlap between expressive suppression and PTSD avoidance symptoms, we separately investigated PTSD avoidance and numbing symptoms (King, Leskin, King, & Weathers, 1998).

METHOD

PARTICIPANTS

A total of 93 male military veteran patients (M_{age} = 44.5 years, *SD* = 14.4) admitted to a VA residential rehabilitation program for PTSD between 2008 and 2010 participated in this study. All participants had a primary diagnosis of PTSD. The majority of the sample identified their racial/ethnic composition as Caucasian (49.5%), followed by Hispanic/Latino/a (23.1%), African American (12.1%), Asian (4.4%), Pacific Islander (4.4%), Native American/Alaskan Native (3.3%), and Other (3.3%). Almost all participants (93.0%) were exposed to some form of combat. The majority reported combat experiences in Iraq/Afghanistan (45.1%), followed by Vietnam (33.3%) and the Persian Gulf (16.2%). In terms of employment immediately preceding entry to the residential rehabilitation program, the majority of participants reported being unemployed (51.1%), followed by employed full-time for pay (21.7%), certified disabled by the VA (12.0%), officially retired (10.9%), employed part-time for pay (3.3%), and full-time student (1.1%). The mean income of participants fell between $20,000 and $40,000.

Participants were included in this study if they completed measures of emotion regulation and PTSD symptom severity at both treatment intake and discharge. Participants who were not included in this study because of incomplete data (*n* = 19) did not significantly differ from participating patients who completed the residential program in terms of length of stay, *t* (101) = 0.04, *p* = .97, Cohen's *d* = .01, baseline PTSD symptom severity, *t* (107) = 1.1, *p* = .27, Cohen's *d* = .21, use of expressive suppression, *t* (95) = -0.7, *p* = .50, Cohen's *d* = .14, or cognitive reappraisal, *t* (95) = -1.0, *p* = .33, Cohen's *d* = .21.

MEASURES

Emotion Regulation Questionnaire (ERQ; Gross & John, 2003). We used the ERQ to assess individual differences in the use of expressive suppression and cognitive reappraisal at treatment intake and discharge. The ERQ consists of 10 items, each rated on a 7-point Likert-type scale (1 = strongly disagree to 7 = strongly agree). The expressive suppression subscale contains four items (e.g., I keep my

emotions to myself) and the cognitive reappraisal subscale contains six items (e.g., When I want to feel less negative emotion, I change the way I'm thinking about the situation). Each subscale has good psychometric properties (Gross & John, 2003). When assessed at both treatment intake and discharge, internal reliability was adequate to excellent for both expressive suppression and cognitive reappraisal subscales (Cronbach's $\alpha > .75$). See Table 1 for descriptive statistics for all measures.

PTSD Checklist—Military Version (PCL-M; Weathers, Litz, Herman, Huska, & Keane, 1993). The PCL-M is a 17-item measure that was used to assess the severity of PTSD symptoms as they occur in response to stressful military experiences, including the four symptom clusters corresponding to the DSM-IV diagnostic criteria for PTSD (re-experiencing, avoidance, numbing, and hyperarousal; American Psychiatric Association, 2000; King et al., 1998), at treatment intake and discharge. Participants indicate their symptom severity using a 5-point Likert-type scale (1 = not at all bothered to 5 = extremely bothered). The psychometric properties of the PCL-M are excellent, with adequate reliability and strong convergent and divergent validity (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996; Ruggiero, Del Ben, Scotti, & Rabalais, 2003). When assessed at both treatment intake and discharge, internal reliability was good to excellent for the total symptom severity scale and all subscales of the PCL-M (Cronbach's $\alpha > .81$).

PROCEDURE

Participants were consecutively admitted for PTSD treatment at the residential rehabilitation programs of the VA Palo Alto Health Care System for a mean length of stay of 83.7 days ($SD = 31.1$). This program admits veterans and active-duty military personnel with military-related PTSD and related problems on a rolling basis. The program has a national catchment area, receiving referrals from VHA hospitals/clinics, Vet Centers, and private practitioners around the country. Veterans are referred to the residential program when a more intensive, residential treatment environment is indicated. Often, this means that PTSD symptoms had been treatment-refractory in outpatient treatment, but referrals are also made directly from acute psychiatric inpatient and residential substance abuse set-

TABLE 1. Descriptive and Change Statistics and Zero-order Correlations among Variables at Treatment Intake (Below Diagonal) and Discharge (Above Diagonal)

	1.	2.	3.	4.	5.	6.	7.
Emotion Regulation							
1. Expressive Suppression		–.32***	.49***	.39***	.49***	.45***	.46***
2. Cognitive Reappraisal	–.07		–.44***	–.38***	–.35***	–.42***	–.40***
PTSD Symptom Severity							
3. Total	.32***	–.44***		.91***	.87***	.89***	.92***
4. Re-experiencing	.23*	–.31***	.87***		.81***	.69***	.80***
5. Avoidance	.24*	–.38***	.78***	.66***		.70***	.74***
6. Numbing	.36***	–.41***	.84***	.56***	.59***		.75***
7. Hyperarousal	.23*	–.41***	.88***	.70***	.61***	.62***	
Mean (*SD*)—Intake	4.5 (1.4)	3.4 (1.3)	63.0 (12.4)	17.6 (4.3)	7.8 (1.8)	18.3 (4.5)	19.3 (3.9)
Mean (*SD*) —Discharge	4.1 (1.2)	4.2 (1.1)	49.1 (16.2)	14.3 (5.1)	5.8 (2.4)	14.2 (5.8)	14.8 (4.8)
F^	9.4***	30.5***	89.6***	48.8***	63.8***	53.9***	97.0***
η_p^2	.09	.25	.49	.35	.41	.37	.51

Note. ^ Test of difference between value at treatment intake and discharge.
***$p < 0.01$; **$p < .0125$ (critical p-value of Bonferroni correction for F-tests involving four symptom clusters); *$p < 0.05$

tings. Exclusion criteria included: (a) imminent risk of harm to self or others, (b) active withdrawal or inability to remain alcohol and illegal substance-free during treatment, (c) medical or psychiatric conditions rendering the individual unsuitable for residential level of care or unable to participate in treatment, and (d) legal issues requiring absence from treatment or court-ordered specifically to the program.

The primary treatment modality was cognitive behavioral group therapy delivered by an interdisciplinary team within the context of a therapeutic community/milieu. Group Cognitive Processing Therapy, a 14-session, manualized, trauma-focused form of cognitive behavioral therapy for PTSD that is based on a cognitive theory of PTSD (Resick & Schnicke, 1992) was the primary form of trauma-focused treatment that patients received (Alvarez et al., 2011). Two of the 14-sessions were devoted to gaining information about veterans' pre-military autobiography, and the remaining 12 sessions followed the standard CPT protocol, which included an exposure component (i.e., writing and reading about the traumatic event). Additional treatment groups included cognitive therapy, communication skills, psychoeducation, process groups, parenting skills, and recreation therapy. Furthermore, individuals who reported sub-

stance use problems prior to intake engaged in regular mutual self-help groups (e.g., Alcoholics Anonymous). Intake measures were collected during the week following treatment intake and discharge measures during the week prior to treatment discharge. This study conformed to ethical guidelines set forth by the American Psychological Association.

DATA ANALYSIS PLAN

We began by investigating associations between the use of expressive suppression and cognitive reappraisal and PTSD symptom severity at intake and discharge using zero-order correlations, and whether associations between these variables significantly differed between treatment intake and discharge using Fisher's z' transformations. We next investigated whether use of expressive suppression and cognitive reappraisal, as well as PTSD symptom severity, changed from pre- to posttreatment using a series of repeated measures ANOVAs. Because expressive suppression and cognitive reappraisal were significantly associated at treatment discharge, we conducted a repeated measures MANOVA with Time (intake vs. discharge) as a within-subjects independent variable and expressive suppression and cognitive reappraisal as dependent variables, followed by univariate post-hoc tests. We conducted a similar repeated measures MANOVA with individual PTSD symptom clusters as dependent variables, followed by univariate post-hoc tests with Bonferroni corrections to control for Type 1 error. Finally, we tested whether change in emotion regulation from pre- to posttreatment would predict PTSD symptom severity at discharge using five hierarchical linear regression (HLR) analyses. Separate analyses were conducted to predict symptom severity for PTSD total and for each symptom cluster. For individual symptom clusters we used a Bonferroni correction, with alpha set at .0125 for an overall rejection level of .05. In Step 1 of each HLR analysis, intake values of the corresponding PTSD symptom variable were entered. In Step 2 of each HLR analysis, change in expressive suppression and cognitive reappraisal from intake to discharge (i.e., Δ = discharge - intake) were simultaneously entered as independent variables. As noted by previous researchers (e.g., Fitzmaurice, Laird, & Ware, 2004), when analyzing longitudinal data, the use of methods to adjust for baseline scores is generally recommended over the use of change scores

only when data are obtained from a randomized trial. Therefore, we conducted analyses that included emotion regulation change scores rather than predicting PTSD symptom severity at discharge from emotion regulation scores at discharge. As a subsidiary test of the directionality of our findings, we conducted two parallel HLR analyses, in which we predicted expressive suppression and cognitive reappraisal at treatment discharge. Intake values of expressive suppression and cognitive reappraisal were entered in Step 1 of respective HLR analyses, and change in total PTSD symptom severity from intake to discharge (i.e., Δ = discharge - intake) were entered in Step 2 of each HLR.

RESULTS

We began by investigating associations between expressive suppression, cognitive reappraisal, and PTSD at treatment intake and discharge. As shown in Table 1, at both time-points, greater use of expressive suppression was associated with higher symptom severity for PTSD total and all symptom clusters. Also at both time-points, greater use of cognitive reappraisal was associated with lower symptom severity for PTSD total and all symptom clusters. We found no significant differences between correlation coefficients at treatment intake and discharge for the association between expressive suppression and total PTSD symptom severity, PTSD re-experiencing, or PTSD numbing (ps > .17) or between cognitive reappraisal and total PTSD symptom severity and all symptom clusters (p's > .60). However, we found that the association between expressive suppression and PTSD avoidance (z' = -2.0, p = .05) and PTSD hyperarousal (z' = -1.8, p = .07) symptom clusters differed at the level of a trend, with associations stronger at treatment discharge relative to intake in both cases.

Next, we investigated whether use of expressive suppression and cognitive reappraisal changed from pre- to posttreatment using a series of repeated measures ANOVAs. The multivariate main effect of time was significant and large, Pillai's trace = .31, F (2, 91) = 20.6, p < .01, ηp^2 = .31. Univariate post-hoc tests showed that expressive suppression significantly decreased during treatment and cognitive reappraisal significantly increased during treatment (see Table 1). In terms of total PTSD symptom severity, a repeated measures ANOVA revealed that total PTSD severity decreased significantly

during treatment. In terms of specific PTSD symptom clusters, the multivariate main effect of time was significant and large, Pillai's trace = .53, F (4, 89) = 25.5, $p < .01$, $\eta p^2 = .53$, and subsequent univariate post-hoc tests showed significant (Bonferroni corrected to control for Type 1 error) and large reductions in all PTSD symptom clusters. Although PTSD symptoms decreased significantly during treatment, participants continued to experience sub-threshold levels of PTSD at treatment discharge (see Table 1).

Having found significant change in use of both emotion regulation strategies and PTSD symptom severity from treatment intake to discharge, we next tested whether change in emotion regulation from pre- to posttreatment predicted PTSD symptom severity at discharge. As shown in Table 2, the addition of expressive suppression and cognitive reappraisal change scores on Step 2 significantly improved the prediction of PTSD total ($\Delta R^2 = .10$, $p < .01$). Furthermore, the addition of expressive suppression and cognitive reappraisal change scores at Step 2 significantly improved the prediction of PTSD avoidance ($\Delta R^2 = .13$, $p < .01$), and PTSD numbing ($\Delta R^2 = .12$, $p < .01$) symptom severity, but not PTSD re-experiencing ($\Delta R^2 = .04$, $p = .08$) or hyperarousal symptom severity after the Bonferroni correction ($\Delta R^2 = .07$, $p = .02$).

Examination of beta scores revealed that lower total PTSD symptom severity was significantly predicted by reductions in the use of expressive suppression and increases in the use of cognitive reappraisal.[1] After applying a Bonferroni correction, an examination of beta scores for individual PTSD symptom clusters revealed that lower PTSD avoidance and numbing symptom cluster severity was significantly predicted by reductions in the use of expressive suppression.[2] PTSD re-experiencing and hyperarousal symptom cluster severity was not significantly predicted by change in expressive suppression, and change in cognitive reappraisal did not predict total PTSD symptom severity or any symptom cluster.

To improve understanding of the directionality of the observed findings, subsidiary analyses were conducted to test whether

1. By entering length of treatment stay and participant age on Step 3 of the HLR analyses, we found that change in expressive suppression ($\beta = .26$) and cognitive reappraisal ($\beta = -.21$) continued to significantly predict total PTSD symptom severity when adjusting for these covariates (p's < .01).

2. Change in expressive suppression continued to significantly predict avoidance ($\beta = .29$) and numbing ($\beta = .30$) symptom cluster severity when adjusting for length of treatment stay and participant age (p's < .01).

TABLE 2. Prediction of PTSD Symptom Severity at Discharge by PTSD Severity (Step 1), Change in Emotion Regulation (Step 2), and Covariates (Step 3)

		Dependent Variables: PTSD Total and Individual Symptom Clusters at Discharge				
		Total	Re-experiencing	Avoidance	Numbing	Hyperarousal
Step	Independent Variables	Betas (sr^2)	Betas (sr^2)	Betas (sr^2)	Betas (sr^2)	Betas (sr^2)
1	PTSD severity variable at Intake	.53*** (.28)	.50*** (.25)	.40**** (.16)	.48*** (.23)	.51*** (.26)
	Multiple R^2	.28***	.25***	.16***	.23***	.26***
2	PTSD severity variable at Intake	.52*** (.27)	.47* (.22)	.40*** (.15)	.51*** (.25)	.52* (.25)
	Expressive suppression Δ	.26*** (.06)	.17 (.03)	.31*** (.09)	.30*** (.09)	.21* (.04)
	Cognitive reappraisal Δ	–.21* (.04)	–.14 (.02)	–.22* (.05)	–.22* (.05)	–.18 (.03)
	Multiple R^2	.38***	.30***	.29***	.36***	.32***
	ΔR^2	.10***	.04	.13***	.12***	.07*

Note. ***p < 0.01; **p < .0125 (critical p-value of Bonferroni correction for tests involving four symptom clusters); *p < 0.05

change in total PTSD symptom severity from pre- to posttreatment would predict expressive suppression and cognitive reappraisal at discharge. Indeed, we found that the addition of total PTSD symptom severity change scores at Step 2 significantly improved the prediction of expressive suppression (ΔR^2 = .05, p < .05), and of cognitive reappraisal (ΔR^2 = .07, p < .01).[3]

DISCUSSION

The present study is the first to investigate expressive suppression in a veteran population, and the first to prospectively investigate change in the use of expressive suppression and cognitive reappraisal in relation to PTSD symptoms among individuals receiving treatment for PTSD. Consistent with previous research (Eftekhari et al., 2009; Ehring & Quack, 2010; Moore et al., 2008), our findings show that use of expressive suppression was associated with more severe PTSD symptoms. Also consistent with previous research (Eftekhari et al., 2009; Ehring & Quack, 2010), but inconsistent with the findings of Moore and colleagues (2008), the use of cognitive

3. Change in total PTSD symptom severity continued to significantly predict expressive suppression (β = .50) and cognitive reappraisal (β = .33) when adjusting for length of treatment stay and participant age (p's < .01).

reappraisal was associated with less severe PTSD symptoms at both treatment intake and discharge. Thus, the weight of the empirical evidence demonstrates that PTSD symptom severity is positively associated with use of expressive suppression, and inversely associated with use of cognitive reappraisal.

Furthermore, the associations between emotion regulation and PTSD symptom severity variables did not reliably differ between intake and discharge. However, the association between expressive suppression and PTSD symptoms, especially hyperarousal and avoidance symptoms at treatment discharge tended to be larger than at treatment intake. This finding suggests that processes occurring during treatment may lead to a tighter coupling between the frequency of use of expressive suppression and PTSD symptom severity. The use of expressive suppression may be more generalized when patients enter treatment. As patients reduce their use of expressive suppression during treatment, expressive suppression may become more closely linked to explicit encounters with trauma-related stimuli, which will tend to increase unpleasant emotional arousal and associated PTSD symptoms.

The use of expressive suppression decreased and the use of cognitive reappraisal increased from treatment intake to discharge among Veterans receiving residential treatment for PTSD. These findings are congruent with the fact that this treatment was offered primarily in a cognitive-behavioral framework that was designed to reduce the use of maladaptive emotion regulation strategies, such as expressive suppression, and to increase the use of adaptive emotion regulation strategies, such as cognitive reappraisal. Additionally, total PTSD symptom severity and severity of all symptom clusters significantly decreased during treatment, although participants continued to experience sub-threshold levels of PTSD at treatment discharge (see Table 1). The fact that patients continued to experience PTSD symptoms following treatment further demonstrates the well-documented chronicity of PTSD (e.g., Kessler, Berglund, Demler, Jin, & Walters, 2005). Although, on average, PTSD symptoms were at sub-threshold levels at treatment discharge, significant decreases in expressive suppression and significant increases in cognitive reappraisal were associated with even lower total PTSD symptom severity. Given the nature of our population (i.e., severe PTSD in need of residential treatment), we posit that these results are clinically meaningful (Kraemer & Kupfer, 2005).

We extended the literature by demonstrating that change in expressive suppression and cognitive reappraisal together significantly predicted total PTSD symptom severity, as well as PTSD avoidance and numbing symptom cluster severity, at treatment discharge, when accounting for PTSD symptom severity at treatment intake, length of treatment stay, and participant age. These changes accounted for 10–13% of additional variance in overall PTSD symptom severity at discharge, which is considered substantial (Cohen, 1988). However, change in PTSD symptom severity occurring during treatment also significantly predicted expressive suppression and cognitive reappraisal at treatment discharge, when accounting for PTSD symptom severity at treatment intake, as well as length of treatment stay and participant age. These findings suggest that change in these emotion regulation strategies co-occur with change in PTSD symptom severity, with no evidence of causality in either direction (e.g., change in expressive suppression result in decreases in PTSD symptom severity). In other words, although change in PTSD symptom severity and emotion regulation strategy use appear to be bidirectionally related, it remains to be determined whether increases in adaptive emotion regulation are an active treatment ingredient that directly facilitates treatment success (i.e., served as a mechanism of change; Kazdin, 2007) or merely a result of decreases in PTSD symptom severity.

Lastly, although change in both expressive suppression and cognitive reappraisal were significant independent predictors of total PTSD symptom severity, change in expressive suppression, but not cognitive reappraisal significantly, independently predicted PTSD avoidance and numbing symptom cluster severity at discharge. We note that the difference in variance accounted for by change in expressive suppression (6–9%) and change in cognitive reappraisal (4–5%) in these analyses were not much different, and change in cognitive reappraisal came close to reaching the level of significance. Thus, these results are consistent with a meta-analysis demonstrating that although both suppression and cognitive reappraisal are significantly associated with anxiety psychopathology, suppression is a stronger predictor of anxiety psychopathology than is cognitive reappraisal (Aldao, Nolen-Hoeksema, & Schweizer, 2010).

By demonstrating that expressive suppression was a robust predictor of total PTSD symptom severity, as well as PTSD avoidance and numbing symptom cluster severity, our findings support the theoretical model that guided this research. Specifically, consistent

with basic research (Gross & Levenson, 1997), we posit that the use of expressive suppression may paradoxically increase unpleasant emotional experience among individuals with PTSD (Gross & Levenson, 1997). This increase in negative emotions may result in further attempts to avoid emotions and stimuli that elicit emotions, thus increasing PTSD avoidance symptoms and depleting cognitive-affective resources and emotional responsiveness over time, thus increasing PTSD numbing symptoms (Litz, 1992; Litz et al., 1997). Although not quite statistically significant, we propose that change in cognitive reappraisal was associated with total PTSD symptom severity, as well as PTSD avoidance and numbing symptom cluster severity, because, as an active strategy, it is associated with decreased levels of these symptoms. Our results do not, however, provide evidence to support the directionality implied in our theoretical model (i.e., from emotion regulation strategy use to PTSD symptom severity). Future research might do so by using experimental paradigms in which emotion regulation strategy use is actively manipulated (e.g., inhibit expressive suppression during presentation of trauma-cues) to investigate the effects on PTSD symptoms as they occur in real-time.

The incremental prediction of PTSD re-experiencing and hyperarousal symptoms by expressive suppression and cognitive reappraisal was smaller in size (accounting for 4–7% of additional variance) than for total PTSD symptom severity, as well as PTSD avoidance and numbing symptom cluster severity. These changes were not significant for re-experiencing symptoms, and after a Bonferroni correction, were not significant for hyperarousal symptoms. We note that change in expressive suppression had trend-level relations with hyperarousal symptoms. This finding is consistent with our theoretical conceptualization that increased unpleasant emotional arousal resulting from the use of expressive suppression may be experienced as PTSD hyperarousal symptoms, and thus, reductions in expressive suppression may be associated with corresponding decreases in PTSD hyperarousal symptoms. Cognitive reappraisal may not be as effective at reducing emotions of high intensity (Sheppes, Scheibe, Suri, & Gross, 2011), such as those experienced as PTSD hyperaraousal symptoms and accompanying PTSD re-experiencing symptoms. Though it is important for future work to determine the stability of these results among larger and more diverse PTSD samples, the present findings are congruent with prior work showing that therapies that involve cognitive restructuring have

a greater impact on PTSD numbing symptoms than hyperarousal symptoms (Monson et al., 2006).

Although the present study has notable strengths, it also has several limitations. First, in the absence of a control group, it is impossible to determine whether change in PTSD symptoms, expressive suppression, and cognitive reappraisal were due to treatment itself, or merely the passage of time. However, the substantial chronicity of PTSD and the fact that it often does not remit without treatment (Kessler et al., 2005) makes it unlikely that the passage of time accounted for bi-directional associations between change in emotion regulation and PTSD symptoms. Future research can address this issue by comparing change in emotion regulation and associated PTSD symptom change in (a) groups receiving active and no treatment, or (b) treatments that directly target for change emotion regulation strategies to those that do not (e.g., psychotropic drugs). Such research would also address a second limitation of the study: the study design did not allow us to directly test whether increases in adaptive emotion regulation were an active treatment ingredient that served as a mechanism of change (Kazdin, 2007).

Third, the sample consisted of veterans who were exposed primarily to combat-related trauma. A related limitation is that our assessment of PTSD symptoms using the PCL-M was completed in reference to stressful military experiences, rather than to an identified trauma. Therefore, we cannot be certain that the relations we found are specific to combat-related trauma, or stressful military experience, more generally. An examination of emotion regulation strategies among those who have experienced other forms of trauma would provide a more comprehensive picture of relations between emotion regulation and trauma exposure, more generally. Furthermore, we were limited to including an all male sample. Previous research has demonstrated that men report significantly more frequent use of expressive suppression than do women (Gross & John, 2003). Therefore, our results, at least those related to expressive suppression, may not generalize to trauma-exposed women.

A final limitation of our study was the use of self-report measures of emotion regulation, which limited our ability to test how efficaciously/skillfully expressive suppression and cognitive reappraisal were used in response to trauma-related cues and PTSD symptoms. Future research using laboratory methods to assess the use of emotion regulation strategies in 'real-time' may be useful in this regard. Laboratory paradigms have been particularly useful in assessing the

use of emotion regulation strategies among individuals with (e.g., social anxiety disorder; Goldin, Manber-Ball, Werner, Heimberg, & Gross, 2009) and without psychopathology (Gross, 1998b). By using laboratory assessments at intake and discharge from treatment, future research can directly measure whether treatment improved emotion regulation rather than inferring these effects through retrospective self-report.

Our results underscore the clinical importance of targeting and reducing the use of typically maladaptive regulation strategies (e.g., expressive suppression) within the context of PTSD treatment, in addition to providing alternative emotion regulation strategies, such as cognitive reappraisal. It may be difficult to reduce the use of expressive suppression and other avoidant coping/regulation strategies, as these strategies may be familiar and require less physical and mental resources to use. This hypothesis is consistent with previous theories suggesting that the use of avoidant coping may seem preferable to the use of active coping when resources are low, or the problem at hand (e.g., trauma-related distress) is perceived to be extremely threatening or substantial (Roth & Cohen, 1986; Sheppes et al., 2011). However, as demonstrated by our findings, there are clear benefits to using more adaptive forms of emotion regulation versus more avoidant strategies. Indeed, incorporating emotion regulation skill training into existing PTSD treatments may help to achieve these benefits (Berking et al., 2008).

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