HOW MUCH IS ENOUGH? TRAUMA RECALL AND THE EXPOSURE THERAPY PROCESS

by

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ABSTRACT

Prevailing theoretical models of posttraumatic stress disorder (PTSD) as well as exposure therapy (EXP) methodology suggest that recall of a trauma is crucial to altering the conditioned fear response associated with PTSD (Benito & Walther, 2015; Craske et al., 2008; Foa & Kozak, 1986). However, it is unclear whether limited recall of the event impacts the EXP process and treatment outcomes. This study examined whether incomplete trauma recall affected pre-treatment PTSD severity, Initial Fear Activation (IFA), Overall Fear Activation (OFA), Within-Session Habituation (WSH), Between-Session Habituation (BSH; overall extinction), average length of EXP sessions, number of EXP sessions, and post-treatment PTSD severity, in 166 veterans of Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn, who completed EXP treatment. Contrary to predicted outcomes, the extent of recall did not attenuate veterans' participation in EXP as measured by IFA, OFA, WSH and BSH. Furthermore, less recall did not result in more severe pre-treatment PTSD, longer EXP sessions, more EXP sessions, or attenuated treatment response, as measured by the Clinician-Administered PTSD Scale for DSM-IV (CAPS; Weathers, Ruscio, & Keane, 1999) and PTSD Checklist Military Version (PCL-M; Weathers, Huska, & Keane, 1991) at pre- and post-treatment. This suggests that veterans who are unable to recall aspects of their traumatic experience can engage successfully and benefit equally from EXP akin to veterans who experience less difficulty recalling trauma details. This research is the first to examine trauma recall in the context of the EXP process and contributes to the current body of literature that aims to address the question: For whom do treatments work?

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LIST OF ACROYNMS

BSH	Between-Session Habituation
CAPS	Clinician-Administered PTSD Scale for DSM-IV
EXP	Exposure Therapy
IFA	Initial Fear Activation
OFA	Overall Fear Activation
OLS	Ordinary Least Squares
PTSD	Posttraumatic Stress Disorder
SUDs	Subjective Units of Distress
TG	Treatment Group
TM	Trauma Memory
VR	Virtual Reality
WSH	Within-Session Habituation

CHAPTER 1: INTRODUCTION

Trauma memory (TM) is conceptualized to have an integral role in the etiology, maintenance, and treatment of posttraumatic stress disorder (PTSD). PTSD is hypothesized to be acquired through fear conditioning (Pavlov, 2009), a process through which neutral stimuli (people, places, sounds, smells, and things) that are associated with a fear response become conditioned stimuli and acquire the capacity to trigger and maintain anxiety long after the trauma has ended. Fear conditioning is evidenced by the manifestation of intrusive symptoms associated with the disorder (intrusive memories, distressing dreams, flashbacks, unpleasant physiological reactions).

Many factors influence the extent to which a TM becomes encoded, including level of arousal, emotion, head injury, dissociation, and intoxicating substances (Ahmed, Bierley, Sheikh, & Date, 2000; Bradley, Greenwald, Petry, & Lang, 1992; Halligan, Michael, Clark, & Ehlers, 2003; Pillemer, 1984; Kang & Wang, 2013; Van der Kolk, 1998; White, 2003; Yuille & Cutshall, 1986; Zinzow et al., 2010). Much like mundane memories, TMs are malleable and susceptible to distortion and forgetting (Morgan III, Southwick, Steffian, Hazlett, & Loftus, 2013; Nourkova, Bernstein, & Loftus, 2004; Strange & Takarangi, 2014; Van der Kolk, 1998).

Regarding event recall, limited research suggests that the severity of traumatic stress is associated with disorganized memory, dissociation, and reduced autobiographical memory recall (Harvey, Bryant, & Dang, 1998; Harvey & Bryant, 1999; Halligan et al., 2003). One study examining autobiographical memory in Vietnam combat veterans found that combat veterans with PTSD demonstrate less specific memory recall compared to veterans without PTSD (McNally, Litz, Prassas, Shin, & Weathers, 1994). Engelhard and colleagues (2008) also tested

the volatility of traumatic memories in veterans with PTSD: veterans demonstrated an increase in the number of discrete traumatic stressor events recalled as negative events across time points. In sum, research suggests that memory of traumatic events may be disorganized, overgeneral, and recall of traumatic events may change over time.

Effective treatments for PTSD tend to rely heavily on the recollection of the traumatic event. Exposure therapy (EXP) is a well-supported treatment strategy for combat-related PTSD (EXP; Goodson, et. al., 2011; Haagen, Smid, Knipscheer, & Kleber, 2015). EXP entails repeated and sustained contact with the TM or feared stimuli via narrative or imagination, and is sometimes augmented by virtual reality (VR). The goal of EXP is to achieve fear extinction (the absence of fear in the presence of previously feared stimuli), and ultimate reduction of PTSD symptoms (Craske et al., 2008). Sustained contact with traumatic or feared stimuli is often conducted using an intensive (flooding) approach, where extended exposure to aversive stimuli leads to reductions in anxiety and fear (Frueh, Turner, & Beidel, 1995). Notably, intensive EXP is an effective treatment for combat veterans in promoting reductions in trauma re-experiencing, intrusive images, nightmares, cognitions, anxiety, and depression (Beidel, Frueh, Neer, Bowers, et al., 2017; Beidel, Frueh, Uhde, Wong, & Mentrikoski, 2011; Cooper & Clum, 1989; Fairbank & Keane, 1982; Goodson, Lefkowitz, Helstrom, & Gawrysiak, 2013; Haagen et al., 2015; Rauch, Sheila, Eftekhari, & Ruzek, 2012; Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001). While there is substantial support for the use of EXP to effectively treat PTSD, less is known about the potential impact of limited traumatic event recall on the process of extinction learning.

Several viable theoretical frameworks of EXP have emerged to explain the mechanism of EXP. Emotional processing theory (Foa & Kozak, 1986) asserts that emotions are tied to

information stored in memory, and by accessing memory structures that underlie emotion and coupling it with incompatible information, emotions within the memory structure can be effectively altered. These changes are achieved therapeutically through activation of a fear structure (i.e., recall of the traumatic event) in the absence of the feared consequence (e.g., physical injury or death) until habituation occurs within and between EXP sessions (Foa & Kozak, 1986). In emotional processing theory, fear activation, within-session habituation (WSH), and between-session habituation (BSH), are considered necessary for emotional processing. A second model, the habituation model asserts three indispensable conditions for optimal benefits of EXP: fear activation, minimization of anxiety-reducing behavior, and habituation (Benito & Walther, 2015). Hence, the emotional processing theory and habituation model suggest that recalling the trauma (activating the fear structure) is crucial to the EXP process of fear activation and habituation.

Another theoretical framework, the inhibitory learning model (Craske et al., 2008), has been applied in various clinical contexts such as treatment of phobias and other anxiety disorders. It claims that fear extinction is the result of fear tolerance, rather than fear reduction. With the inhibitory learning model approach, expectancy violation is emphasized in the exposure process to facilitate the pairing of new inhibitory associations. In pairing new inhibitory associations, fear tolerance develops, whilst the original conditioned association remains intact. Furthermore, habituation is deemphasized as a non-essential component of EXP (Craske et al., 2008). Although there are mixed findings on the role of habituation in the exposure process (Rupp, Doebler, Ehring, & VossbeckElsebusch, 2017), a recent study on EXP for PTSD indicates that BSH, in particular, is related to treatment outcome (Sripada & Rauch, 2015). An

investigation comparing the process variables of EXP for combat-related PTSD is beyond the scope of this study; however, despite differences in conceptualization across frameworks, the importance of memory and learning are critical components across all three models.

The underlying mechanisms of EXP for PTSD suggests that incomplete recall of the traumatic event (i.e, the individual is unable to retrieve all aspects of the original trauma) could result in less vivid memory recall, and therefore less fear activation, which may impede or attenuate the EXP process (Harvey & Bryant, 1999; Mota et al., 2015). However, conclusions about the relationship between limited recall of the traumatic event and the exposure process are not clear given that research in this area is scarce.

Examining the range of traumatic event recall ability and the underlying process variables of EXP could inform clinical practice. Knowledge of how extensively an individual is able to recall a TM and its impact on the EXP process could guide researchers in when and how to use EXP, leading to individualized and improved treatment outcomes. Given the paucity of research in this area coupled with the potential implications of how the inability to recall specific aspects of the traumatic event might affect the EXP process, further examination of this relationship could prove beneficial. In this paper, we examine whether the extent to which one recalled aspects of the traumatic event affected the process of EXP (achievement of WSH and BSH) and ultimate treatment outcomes for veterans of Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn. Consistent with emotional processing theory and the habituation model, we predicted that the inability to recall aspects of the trauma would impede the EXP process of habituation and extinction and would negatively impact treatment outcome. Specifically, we examined the effects of incomplete trauma recall on pre-treatment PTSD

severity, Initial Fear Activation (IFA), Overall Fear Activation (OFA), WSH, BSH (overall extinction), average length of EXP sessions, number of EXP sessions, and post-treatment PTSD severity.

CHAPTER 2: METHOD

Participants

The sample is drawn from a larger treatment study assessing the efficacy of a 3- and 17-week multicomponent behavioral treatment program (Beidel, Frueh, Uhde, et al., 2011; Beidel et al., 2017; Beidel, Frueh, Neer, & Lejuez, 2017). Data represent a post-hoc analysis of 166 veterans of Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn, with combat-related PTSD who participated in either a 3- or 17-week outpatient treatment (see Treatment). Only individuals who met DSM-IV diagnostic criteria of combat-related PTSD as determined by the Clinician-Administered PTSD Scale for DSM-IV (CAPS) were included in the study.

CHAPTER 3: MEASURES

Clinician-Administered PTSD Scale for DSM-IV

Because the study was initiated prior to the publication of the Diagnostic and Statistical Manual-5th Edition (APA, 2013), the CAPS for DSM-IV was used to determine PTSD diagnosis and assess the severity of PTSD (Weathers, Ruscio, & Keane, 1999). It contains 30 items that coincide with the 17 symptoms of PTSD in Criterion B, C, and D, of the DSM-IV with separate scales to assess the frequency (0-4) and intensity (0-4) of each symptom. The CAPS has excellent reliability and validity, and is sensitive to symptom improvement in treatment studies (Weathers et al., 1999; Weathers, Keane, & Davidson, 2001). The CAPS was administered by a licensed clinical psychologist or master's level doctoral clinician. Interviews were videotaped and 20% of the interviews in each treatment condition (3-week and 17-week) were rated by a second clinician to determine inter-rater reliability, which was $\kappa = 1.00$ for diagnosis of PTSD in both groups. Pre- and post-treatment scores reflect the omission of item 8, which assesses for the ability to recall a traumatic event.

PTSD Checklist Military Version

The PTSD Checklist Military Version (PCL-M; Weathers, Huska, & Keane, 1991) is a 17-item self-report military-specific measure that was used to assess pre- and post-treatment PTSD severity. Pre- and post-treatment scores reflect the omission of item 8, which assesses for the ability to recall a traumatic event.

Trauma Recall Difficulty

The extent of recall was measured by combining the frequency and intensity rating for item 8 of the CAPS (Weathers et al., 1999), which assesses how much of the TM can be recalled from 0 (*none*) to 4 (*most or all aspects not remembered*) and perceived difficulty recalling important parts of the event, from 0 (*none*) to 4 (*extreme, completely unable to recall important aspects of the event*). These scores were combined to create a composite severity score of trauma recall. Due to non-normal distribution of scores and sample limitations, we were unable to analyze recall as a continuous variable. We collapsed this category into four groups according to endorsements on the frequency and intensity ratings ($F + I$) for item 8: veterans who endorsed *none* or *minimal* ($F + I \leq 1$; $n = 74$); *mild* ($F + I = 2$ - 3; $n = 20$); *moderate* ($F + I = 4$ - 5; $n = 38$); and *severe* ($F + I = 6$-8; $n = 34$).

Subjective Units of Distress (SUDs)

Subjective Units of Distress (SUDs) are self-report ratings of subjective fear and anxiety that are rated on a scale ranging from 0 (*none*) to 8 (*extreme*). SUDs were elicited by the therapist during exposure every 5-minutes and were used to calculate the exposure process variables. Exposure processing variables used in the current study are the same as definitions used in previous research (Turner, Beidel, Long, & Greenhouse, 1992; Ragsdale et al., 2017). Definitions are presented in Table 1.

Table 1: Operationalization of EXP Process Variables

Process Variable	Operationalization
Initial fear activation (IFA)	Baseline SUDs subtracted from peak SUDs during the first imaginal session
Overall fear activation (OFA)	Peak SUDs subtracted from lowest SUDs across all sessions
Within-session habituation (WSH)	Return to baseline SUDs, or at least a 50% reduction of fear activation (dichotomous variable)
Between-session habituation (BSH)	A 50% reduction from first session peak SUDs to final session peak SUDs (i.e., overall extinction; dichotomous variable)

Note: EXP = Exposure Therapy; SUDs = Subjective Units of Distress

Treatment

Treatment for the 3- and 17-week protocol was structured in an outpatient format and consisted of up to 14 EXP sessions. All treatment sessions were conducted by a trained licensed clinical psychologist or master's level clinician. All therapists were supervised weekly by a licensed clinical psychologist and treatment sessions were audio and videotaped. Twenty-percent of the sessions were randomly selected to assess treatment fidelity and no protocol violations were noted. Similar to prolonged exposure, EXP was conducted using the patient's TM from combat experience. However, unlike prolonged exposure, clinicians continued exposure until WSH was achieved (SUDs decrease by at least 50%), and the sessions do not include breathing retraining and emotional processing following the exposure.

The 3-week treatment involved daily individual VR-assisted EXP using Bravemind Virtual Iraq/Afghanistan (Rizzo, Reger, Gahm, Difede, & Rothbaum, 2009; Rizzo & Shilling, 2017). VR EXP scenes were created using veterans' most distressing traumatic event and incorporated relevant VR visual, auditory, and olfactory stimuli. Sessions were discontinued when WSH was achieved and therapist observed behaviors and cognitions were consistent with veterans' SUDs reports and reduced distress. Veterans also participated in fourteen 90-minute social skills group sessions that occurred in the afternoon, and comprised of modules for social skills, anger management training, and behavioral activation for depression. Veterans also received homework assignments to complete between exposure sessions (e.g., watching war movies, speaking with other veterans or loved ones about war experiences, going to crowded places). Once BSH during individual VR EXP sessions was achieved, VR EXP sessions were terminated and veterans began therapist-accompanied in vivo EXP tasks to address behavioral avoidance. Thus, VR EXP sessions concluded following BSH or 14 sessions total, whichever came first.

Veterans in the 17-week treatment engaged in imaginal EXP (augmented by VR) three times per week over five weeks. Similar to the 3-week treatment, veterans began in vivo exposure once BSH was achieved and were assigned homework assignments to complete between sessions. Upon conclusion of EXP, group treatment occurred twice per week for the first two weeks, and then once per week (14 group sessions total). Consistent with the randomized controlled study from which this data set was derived, veterans in the 17-week treatment were randomized into one of two group treatments (Beidel et al., 2017). Thirty-seven veterans received 14 group sessions identical to those described above, whereas, 27 veterans

received seven group sessions consisting of didactic presentations of PTSD psychoeducation and seven group sessions of unstructured discussion groups. Notably, group treatment did not significantly impact PCL-M scores at post-treatment (Beidel et al., 2017).

CHAPTER 4: RESULTS

Preliminary Analyses

Upon initial examination of the dependent variables, six outliers were identified as exceeding 2 standard deviations from the mean number of sessions in the 17-week group. Of these six cases, none were excluded following examination of Mahalanobis distance. The following analyses reflect the inclusion of the outliers. All analyses were conducted in IBM SPSS version 23. The sample consisted of 166 veterans of Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn. No significant demographic differences were found across recall groups. See Table 2 for sample descriptive statistics.

Table 2: Demographic Characteristics of the Sample

	None/Minimal Recall Difficulty (*n* =74)		Mild Recall Difficulty (*n* = 20)		Moderate Recall Difficulty (n = 38)		Severe Recall Difficulty (n = 34)		Total Sample (*N* = 166)		
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*f*
Age	37.08	11.21	36.60	8.11	36.58	9.55	36.91	6.65	36.85	9.59	0.03
	N										X^2
Sex											4.00
Male	71	95.9%	20	100%	35	92.1%	30	88.2%	156	94.0%	
Female	3	4.1%	0	0.0%	3	7.9%	4	11.8%	10	6.0%	
Race											17.01
Caucasian	45	60.8%	17	85.0%	27	71.1%	17	50.0%	106	63.9%	
African-American	6	8.1%	0	0.0%	6	15.8%	4	11.8%	16	9.6%	
Hispanic	16	21.6%	3	15.0%	5	13.2%	9	26.5%	33	19.9%	
Asian	1	1.4%	0	0.0%	0	0.0 %	1	2.9%	2	1.2%	
Other	6	8.1%	0	0.0%	0	0.0 %	3	8.8%	9	5.4%	
TBI[a]											.48
No	39	53.4%	12	60.0%	22	57.9%	20	58.8%	93	56.4%	
Yes	34	46.6%	8	40.0%	16	42.1%	14	41.2%	72	43.6%	
Education											7.04
High School	10	13.5%	3	15.0%	4	10.5%	8	23.5%	25	15.1%	
Some College	44	59.5%	14	70.0%	22	57.9%	21	61.8%	101	60.8%	
Bachelors	13	17.6%	3	15.0%	7	18.4%	3	8.8%	26	15.7%	
Masters or Doctoral	7	9.5%	0	0.0%	5	13.2%	2	5.9%	14	8.4%	
Marital Status											4.45
Single	17	23.0%	4	20%	9	23.7%	6	17.6%	36	21.7%	
Married	40	50.1%	12	60%	19	50.0%	15	44.1%	86	51.8%	
Separated	8	10.8%	2	10%	3	7.9%	5	14.7%	18	10.8%	
Divorced	9	12.2%	2	10%	7	18.4%	8	23.5%	26	15.7%	
Military Branch											11.60
Marine Corps	8	10.8%	5	25.0%	7	18.4%	3	8.8%	23	13.9%	
Army	56	75.7%	11	55.0%	27	71.1%	24	70.6%	118	71.1%	
Navy	2	2.7%	2	10.0%	2	5.3%	3	8.8%	9	5.4%	
Air Force	6	8.1%	2	10.0%	1	2.6%	4	11.8%	13	7.8%	
Coast Guard	1	1.4%	0	0.0%	0	0.0%	0	0.0%	1	0.6%	
Contractor	1	1.4%	0	0.0%	1	2.6%	0	0.0%	2	1.2%	

Note. [a]N =165. TBI = Traumatic Brain Injury.

We assessed whether it was necessary to use treatment group (TG) as a moderator in our main analyses by examining whether TG was significantly associated with outcome variables (i.e., pre-treatment CAPS, pre-treatment PCL-M, IFA, OFA, average length of EXP, average number of EXP sessions, post-treatment CAPS scores, and post-treatment PCL-M scores). Tests of normality were conducted for continuous dependent variables within each TG (3-week or 17-week) using Shapiro-Wilk's tests. Variables that failed parametric assumptions of normality (all variables except average length of session) were not effectively normalized using various transformations (e.g., log transformations), and were analyzed using non-parametric tests. Original means and standard deviations were reported with non-parametric data to improve interpretation of results.

T-tests and Mann-Whitney U tests were used to determine whether TG would be used as a moderator in subsequent analyses of continuous variables. Results are displayed in Table 3. Due to significant associations with TG and several of the outcome variables, TG was treated as a moderator in analyses of pre-treatment CAPS scores, WSH, average length of EXP, and average number of EXP sessions. TG was excluded as a variable in analyses of pre-treatment PCL-M scores, IFA, OFA, BSH, and post-treatment CAPS scores.

Table 3: Results of t-, Mann-Whitney U, and Chi-Square tests for EXP Variables by TG

	Treatment Group					
	3-week n = 102		17-week n = 64		Test Statistic	
	M(SD)		M(SD)		U/t(df)/X^2(df)	r
Pre-treatment CAPS	92.23(14.70)		80.76(17.23)		U = 4,602.0***	.34
Pre-treatment PCL-M	60.92(9.57)		58.21(11.06)		U = 3,319.5	.11
IFA	2.98(1.72)		3.14(1.89)		U = 3,006.5	-.05
OFA	6.66(1.12)		6.36(1.29)		U = 3,760.0	.13
Average Length of EXP	66.07(13.64)		60.13(11.95)		t(164) = -2.86**	.22
Number of EXP sessions	13.09(1.29)		10.70(3.23)		U = 4,714.5***	.39
Post-Treatment CAPS	42.40(24.83)		38.26(22.07)		U = 2,867.5	.03
Post-treatment PCL-M	42.48(15.41)		35.52(13.05)		U = 3,438.5**	.20
	N	%	N	%		
Achievement of WSH[a] (across all sessions)	52	51	44	69	X^2(1) = 4.22*	.16
Achievement of BSH	59	59	36	56	X^2(1) = 0.04	.02

Note. *p < .05 **p < .01 ***p< .001. EXP = Exposure Therapy. TG = Treatment Group. CAPS = Clinician-Administered PTSD Scale for DSM-IV. PCL-M = PTSD Checklist Military Version. IFA = Initial Fear Activation. OFA = Overall Fear Activation. WSH = Within-Session Habituation. BSH = Between-Session Habituation. [a]WSH was not achieved in every session for each participant for various reasons (e.g., unforeseen time constraints, patients reporting exhaustion during exposure); however no sessions were terminated during ascension or peak SUDS ratings.

Main Analyses

Pre-treatment PTSD Severity

A two-level ordinary least squares (OLS) regression was used to test the hypothesis that pre-treatment severity is associated with the level of trauma recall difficulty, and that TG moderated that relationship. In the first step, TG and trauma recall were entered. In the second step, the interaction terms between TG and each level of recall difficulty were entered. As displayed in Table 4, the effect of TG was significant, suggesting that pre-treatment PTSD symptom severity was significantly different between groups; however this effect was modified by a significant interaction between TG and mild recall difficulty. Notably, the interactions

among TG and moderate and severe recall difficulty were nonsignificant, which suggested that recall difficulty and TG did not consistently predict pre-treatment PTSD severity as measured by the CAPS.

Table 4: Linear model of Pre-treatment CAPS scores

Variable	**B** ***[CI]***	***SE***	***β***	***t***
Step 1				
Intercept	79.47 [75.03, 83.90]	2.24		35.41***
TG	11.08 [6.11, 16.06]	2.52	0.32	4.40***
Trauma Recall Difficulty	1.36 [-.65, 3.36]	1.02	0.10	1.34
Step 2				
Intercept	78.45 [73.20, 83.71]	2.66		29.47***
TG	14.73 [7.68, 21.79]	3.57	0.43	4.13***
Trauma Recall Difficulty	2.31 [-1.06, 5.68]	1.71	0.17	1.35
TG x Mild Recall Difficulty	-10.96 [-21.28, -0.64]	5.23	-0.18	-2.10*
TG x Moderate Recall Difficulty	-7.85 [-18.47, 2.76]	5.38	-0.16	-1.46
TG x Severe Recall Difficulty	-3.43 [-16.17, 9.30]	6.45	-0.07	-0.53
R^2	0.12			
ΔR^2	-0.03			

Note. $*p < .05$ $**p < .01$ $***p < .001$. CAPS = Clinician-Administered PTSD Scale for DSM-IV; TG = Treatment Group. $N = 166$.

We also examined pre-treatment PTSD symptom severity using the PCL-M. Due to violations in normality, a non-parametric Kruskal-Wallis Test was used to assess trauma recall and pre-treatment PCL-M scores. There were no significant differences between extent of trauma recall and pre-treatment PCL-M scores $H(3) = 5.64$, $p = .130$ (none/minimal trauma recall

difficulty, *M* = 57.97, *SD* = 11.14; mild trauma recall difficulty, *M* = 58.30, *SD* = 10.68; moderate trauma recall difficulty *M* = 60.11, *SD* = 9.52; severe trauma recall difficulty *M* = 63.03, *SD* = 10.33). Consistent with the pre-treatment CAPS, these findings suggests that the extent to which one cannot remember specific details of the traumatic event does not influence pre-treatment PTSD severity.

Fear Activation

Imaginal EXP requires a patient to visualize the traumatic event for a sustained period of time. The visualization of the event elicits fear associated with the event that is experienced by the patient during EXP. An increase in SUDs ratings (from baseline) during the first EXP session suggests the presence of IFA. A Kruskal-Wallis Test was used to assess forgetting and IFA. There was a significant difference between trauma recall and IFA, $H(3) = 14.13$, $p = .003$. Specifically, individuals with severe trauma recall difficulty (*M* = 2.26, *SD* = 1.68) experienced significantly less IFA compared to individuals with mild (*M* = 3.95, *SD* = 1.47, $p = .003$, $r = .48$) and moderate (*M* = 3.41, *SD* = 1.80, $p = .046$, $r = .31$) recall difficulty. No significant differences were found between individuals with severe recall difficulty (*M* = 2.26, *SD* = 1.68) and those with none/minimal recall difficulty on IFA, (*M* = 2.93, *SD* = 1.81, $p = .304$, $r = .19$). Notably, trauma recall difficulty did not consistently predict IFA, particularly between extreme groups (none/minimal trauma recall difficulty versus severe trauma recall difficulty). Additionally, statistically significant differences in SUDs ratings during the first imaginal session between individuals with severe recall difficulty versus those with moderate and mild difficulty were less than 2 SUDs units, which may not reflect clinically significant differences in fear/anxiety,

particularly when using subjective ratings. In sum, the extent of trauma recall does not appear to be a precise and clinically significant predictor of IFA. Notably, analyses of IFA were conducted with baseline SUDS as a covariate (ANCOVA) to account for possible ceiling effects in SUDS ratings. ANCOVA results were non-significant.

We also compared OFA (i.e., comparing the lowest baseline and highest peak SUDS regardless of the session they occurred). Due to violations in normality, a non-parametric Kruskal-Wallis Test was used. Results indicated that all groups experienced similar OFA during EXP, $H(3) = .47$, $p = .923$, regardless of severity of trauma recall (none/minimal recall difficulty, $M = 6.66$, $SD = 1.14$; mild recall difficulty, $M = 6.55$, $SD = 1.10$; moderate recall difficulty $M = 6.61$, $SD = 1.24$; severe recall difficulty $M = 6.50$, $SD = 1.29$). This suggests that OFA is similar despite limited trauma recall.

Habituation

Per treatment protocol, an imaginal EXP session may be concluded by the therapist once WSH was achieved. However, post-hoc analyses revealed that some sessions were terminated prior to reaching a return to baseline SUDs, or at least a 50% reduction of fear activation for various reasons (e.g., unforeseen time constraints). A logistic regression was used to test whether severity of trauma recall difficulty influenced achievement of WSH. Recall difficulty was not associated with achievement of WSH, Wald $\chi^2(3, N = 166) = 2.71$, $p = .44$, which suggested that participants experienced similar WSH, regardless of extent of trauma recall.

Across sessions, many veterans (57% in our sample) achieved BSH (exhibit a 50% reduction from first session peak SUDS to final session peak SUDS) during imaginal EXP. Once

BSH is achieved, treatment protocol dictated that in vivo exposures take the place of imaginal EXP. Thus, some individuals engage in fewer imaginal EXP sessions. A chi-square test was used to examine whether extent of trauma recall was associated with BSH. Results showed that BSH was unrelated to recall, $\chi^2(3, N = 166) = 3.03$, $p = .39$, suggesting that the extent of trauma recall does not affect the achievement of BSH in EXP.

EXP sessions

A two-level OLS regression was used to test the hypothesis that average length of EXP (minutes) is associated with the severity of trauma recall difficulty, and that TG moderated the relationship between average session length and trauma recall difficulty. In the first step of the regression analysis, TG and trauma recall ability were entered. In the second step, the interaction terms between TG and each level of recall ability were entered. As displayed in Table 5, the effect of TG was significant, which suggested that average length of session was influenced by TG. The interaction between TG and trauma recall difficulty was not significant, which suggest that severity of recall difficulty does not influence length of EXP session.

As mentioned previously, treatment protocol dictated that veterans transition to in vivo EXP in lieu of imaginal EXP upon achievement of BSH. Therefore, some veterans engaged in fewer imaginal EXP sessions. A two-level OLS regression was used to test the hypothesis that the number of exposure sessions is influenced by the severity of trauma recall difficulty, and that TG moderated the relationship between pre-treatment CAPS scores and trauma recall difficulty. In the first step, TG and trauma recall difficulty were entered. In the second step, the interaction terms between TG and each level of recall difficulty were entered. As displayed in Table 6, TG

was significant, which suggested that the number of exposure sessions between treatments significantly differed (by approximately 3 EXP sessions). There were no significant interactions between TG and trauma recall difficulty, which suggest that veterans with greater difficulty recalling a traumatic event did not require a greater number of EXP sessions than those with less difficulty.

Table 5: Linear model of Average Length of EXP Session

Variable	***B*** ***[CI]***	***SE***	***β***	***t***
Step 1				
Intercept	59.77 [56.09, 63.44]	1.86		32.12***
TG	5.87 [1.74, 9.99]	2.09	0.22	2.81**
Trauma Recall Difficulty	0.34 [-1.32, 2.00]	0.84	0.03	0.41
Step 2				
Intercept	58.98 [54.59, 63.36]	2.22		26.57***
TG	7.88 [2.003, 13.763]	2.98	0.29	2.65**
Trauma Recall Difficulty	1.08 [-1.73, 3.89]	1.42	0.10	0.76
TG x Mild Recall Difficulty	-7.59 [-16.20, 1.01]	4.36	-0.15	-1.74
TG x Moderate Recall Difficulty	-.33 [-10.01, 7.56]	4.48	-0.01	-0.07
TG x Severe Recall Difficulty	-4.64 [-15.26, 5.98]	5.38	-0.13	-0.86
R^2	0.05			
ΔR^2	0.02			

Note. $*p < .05$ $**p < .01$ $***p < .001$. EXP = Exposure Therapy; TG = Treatment Group. $N = 166$.

Table 6: Linear model of Number of EXP Sessions

Variable	***B*** ***[CI]***	***SE***	***β***	***t***
Step 1				
Intercept	10.50 [9.85, 11.15]	0.33		32.05***
TG	2.33 [1.60, 3.06]	0.37	0.44	6.34***
Trauma Recall Difficulty	.10 [-0.19, 0.40]	0.15	0.05	0.69
Step 2				
Intercept	10.17 [9.40, 10.95]	0.39		25.95***
TG	2.97 [1.93, 4.01]	0.53	0.57	5.65***
Trauma Recall Difficulty	.41 [-.08, 0.91]	0.25	0.20	1.64
TG x Mild Recall Difficulty	-.86 [-2.38, 0.66]	0.77	-0.09	-1.12
TG x Moderate Recall Difficulty	-1.30 [-2.86, 0.27]	0.79	-0.17	-1.64
TG x Severe Recall Difficulty	-1.34 [-3.21, 0.54]	0.95	-0.19	-1.41
R^2	.20			
ΔR^2	0.01			

Note. $*p < .05$ $**p < .01$ $***p < .001$. EXP = Exposure Therapy; TG = Treatment Group. $N = 166$.

Post-treatment PTSD Severity

We also assessed whether forgetting influenced post-treatment CAPS scores. Due to violations in normality, a non-parametric Kruskal-Wallis Test was used. Results suggested that extent of trauma recall did not affect post-treatment outcomes on the CAPS, $H(3) = 2.00$, $p = .57$, $r = .004$ (none/minimal trauma recall difficulty, $M = 41.57$, $SD = 24.54$; mild recall difficulty, $M = 35.70$, $SD = 24.81$; moderate recall difficulty $M = 38.17$, $SD = 23.64$; severe recall difficulty $M = 43.29$, $SD = 24.18$).

An OLS regression was used to assess the moderating effect of TG on the direct effect of trauma recall on post-treatment PCL-M scores. In the first step, TG and trauma recall difficulty were entered. In the second step, the interaction terms between TG and each level of trauma recall were entered. As shown in Table 7, there was a significant main effect of TG on Post-PCL-M scores, which suggests that individuals in the 3-week TG had significantly higher post-PCL-M scores than individuals in the 17-week group (7 point difference). However, there were no significant interactions between TG and severity of trauma recall difficulty, which suggests that the extent of forgetting details of the traumatic event does not predict post-treatment PTSD severity, as measured by the PCL-M.

Notably, extreme group analyses were conducted on the study variables (none/minimal recall difficulty versus severe recall difficulty) and did not affect results. Furthermore, the above analyses were conducted using the CAPS item 8 frequency rating (excluding the intensity rating) for TR difficulty, and did not affect results.

Table 7: Linear model of Post-PCL-M

Variable	***B*** ***[CI]***	***SE***	***β***	***t***
Step 1				
Intercept	35.21			
	[30.94, 39.47]	2.16		16.31***
TG	6.69		0.22	
	[1.92, 11.46]	2.42		2.77**
Trauma Recall Difficulty	0.25		0.02	
	[-0.65, 3.36]	0.98		0.26
Step 2				
Intercept	34.81	2.61		13.33***
	[29.66, 39.97]			
TG	7.96	3.43	0.26	2.32*
	[1.19, 14.73]			
Trauma Recall Difficulty	0.62	1.68	0.05	0.37
	[-2.69, 3.94]			
TG x Mild Recall Difficulty	-3.48	5.21	-0.06	-0.67
	[-13.78, 6.82]			
TG x Moderate Recall Difficulty	-3.57	5.30	-0.08	-0.67
	[-14.03, 6.90]			
TG x Severe Recall Difficulty	-0.92	6.36	-0.02	-0.15
	[-13.48, 11.65]			
R^2	0.05			
ΔR^2	0.01			

Note. $*p < .05$ $**p < .01$ $***p < .001$. PCL-M = PTSD Checklist Military Version; TG = Treatment Group. $N = 152$.

CHAPTER 5: DISCUSSION

Prevailing frameworks of EXP for PTSD suggest that the activation of a fear structure is necessary in the process of fear extinction. Often, the fear structure is represented by the patient's TM, suggesting that TM recall difficulty may affect access to critical components of the memory, and attenuate emotional processing of fear-related cues. No prior studies have examined how extensive or complete the trauma recall must be in order for EXP to be effective. The mechanisms of effective treatments are of particular interest to the National Institute of Mental Health and clinicians alike to elucidate *how* and *for whom* effective treatments work. The results of this study contribute to this goal.

The above findings did not support the original hypotheses that incomplete recall of a traumatic event would negatively impact the EXP process of habituation and extinction, and negatively impact treatment outcome. Results indicate that incomplete trauma recall does not attenuate veterans' participation in EXP as measured by IFA, OFA, WSH and BSH. Furthermore, limited trauma recall is also unrelated to longer EXP sessions, more EXP sessions, and attenuated treatment response as measured by the CAPS and PCL-M at post-treatment. In line with theoretical frameworks of EXP, this suggests that the emotions associated with the TM can be effectively accessed and altered with EXP regardless of TM recall difficulty. Furthermore, these findings suggest that limited TM recall does not attenuate the process of new learning.

With regard to statistically significant findings, results appeared to lack clinical significance. Trauma recall difficulty did not consistently predict pre-treatment PTSD severity

and IFA. Furthermore, differences in SUDs ratings among groups for whom there were significant differences in IFA were less than 2 units, which may not reflect a clinically significant difference. Overall, these findings suggest that veterans who are unable to recall many aspects of their traumatic experience can benefit from EXP akin to veterans who experience less difficulty recalling the details of their experience.

Particularly unexpected were findings that fear activation occurred similarly across trauma recall groups. In prolonged exposure and in EXP in TMT, a TM represents a fear structure. A primary method of fear activation in PTSD is imaginal exposure, which requires the patient to recall/recount their trauma in some manner (out loud, imagining) (Riggs, Cahill, & Foa, 2006; Turner, Beidel, & Frueh, 2005). It was predicted that less vivid TM recall would result in reduced activation of the fear structure and dampen fear activation. However, veterans who reported remembering fewer details of their traumatic event experienced similar IFA and OFA as veterans who remembered more details of their traumatic event. In sum, the patient's TM, regardless of its completeness, is sufficient to activate the fear structure and elicit fear activation, which is an essential component of EXP.

Although results of the current study did not support the original hypotheses, they are largely congruent with recent studies investigating EXP and traumatic brain injury (TBI) in combat-related PTSD (Ragsdale et al., 2017). Head injuries such as TBI may impair memory consolidation, retrieval, and processing (Boehnlein & Hinton, 2016; Palombo et al., 2015), which could impede habituation and extinction in this population (difficulty retrieving, holding, and processing the memory). However, previous research indicates that TBI does not impact IFA,

OFA, number of EXP sessions, WSH, or BSH (Ragsdale & Voss Horrell, 2016; Ragsdale et al., 2017; Sripada & Rauch, 2015). This is particularly relevant considering TBI is experienced by veterans at increasing rates (Shively & Perl, 2012), and the appropriateness of EXP with TBI survivors was in question (Sripada et al., 2013). Notably, 72 veterans in our sample (44%) met criteria for TBI (mild, moderate, or severe).

To offer a possible explanation for the above findings, veterans in the current study with less recall ability may have exhibited similar EXP outcomes to veterans with greater recall ability as a result of their level of emotional engagement in EXP. For example, recent literature on imagery vividness during EXP for PTSD suggest that higher imagery vividness is associated with better EXP outcomes (Mota et al., 2015). Mota and colleagues (2015) asked participants to rate the vividness of their TM during imaginal EXP. Overall, participants who reported high levels of imagery vividness experienced the greatest reductions in PTSD severity as determined by the CAPS. Notably, Mota and colleagues (2015), did not examine recall ability. Furthermore, EXP in the current study utilized VR when appropriate, which may have enhanced trauma imagery vividness, thus resulting in effective treatment across TM groups. Considered together, these findings suggest that level of immersion during EXP may be more influential to the EXP process than the amount of the trauma remembered. Future research examining EXP imagery vividness while controlling for TM forgetting is needed to further elucidate the mechanisms of EXP.

Furthermore, an alternative consideration is that fear learning and extinction learning is believed to involve unconscious, low-level processes, as well as higher-order cognitive processes

(e.g., perception of harm) (Hofmann, 2008). Memory research suggests that fear acquisition can occur in the absence of declarative memory (Menzies & Clarke, 1995), and that fear extinction is influenced by processes of memory encoding that are mediated by the hippocampus and do not require higher order cognitive functions (Henke, 2010). If fear extinction can occur in the absence of higher-order cognitive processes, then the ability to recall all aspects of the traumatic event may not be necessary for positive treatment outcome. These results suggest this possibility. Overall, research suggests that despite the lack of full recall of the traumatic event, individuals who can sustain basic attentional processes (e.g., visualizing the traumatic event, paying attention) during EXP are likely to achieve fear activation, WSH, BSH, and symptom improvement (Ragsdale et al., 2017; Sripada et al., 2015).

Methodological limitations of the current study should be noted. First, due to uneven distribution of trauma recall difficulty, this variable was analyzed as a categorical, rather than a continuous, variable. Future studies should analyze trauma recall data of a larger sample size in order to determine if a more continuous distribution exists and if so, utilize continuous variables, thereby avoiding related statistical impacts such as loss of precision in estimated means, loss of power, and increases degrees of freedom as a result of dummy variables. Notably, the cut-points for TM recall categories coincide with severity rating scores and descriptions for item 8 on the CAPS, and can be easily replicated in future research. Furthermore, while a sample containing a larger quantity of veterans experiencing severe levels of recall difficulty is ideal, it is possible that the current sample resembles the population distribution of veterans who report difficulty recalling important details of their traumatic event, and coinciding analyses reflect the effects of TM recall on EXP.

The present study utilized a clinician-administered method of assessing trauma recall ability that was limited by a single, two-part item on the CAPS. Arguably, self-report may be superior to rater-based measures in the context of recall. Future research may consider utilizing additional items to assess the extent of recall. For example, measures may integrate items assessing recall ability of sensory stimuli (e.g., scents, sounds, tactile, and visual images), to further assess extent of recall.

The results of the current study suggest that inability to recall every aspect of a traumatic event does not attenuate the EXP process. These novel findings highlight the broad utility of EXP among populations with limited trauma recall ability. Furthermore, the findings bolster prior research demonstrating the appropriateness of EXP in populations that have experienced impairment during memory encoding (e.g., due to TBI). Future efforts to address the limitations mentioned above and further elucidate the mechanisms that underlie EXP effectiveness for individuals with both good and poor trauma recall ability are needed.

APPENDIX: APPROVAL LETTER

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Deborah Casamassa Beidel**
Date: **July 21, 2016**

Dear Researcher:

On 07/20/2016 the IRB approved the following human participant research until 07/19/2017 inclusive:

Type of Review:	Submission Response for IRB Continuing Review Application Full Board Review
Project Title:	Trauma Management Therapy for OEF and OIF Combat Veterans
Investigator:	Deborah Casamassa Beidel
IRB Number:	SBE-10-07066
Funding Agency:	DOD/Army
Grant Title:	
Research ID:	1048785

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 07/19/2017, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of five years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Patria Davis on 07/21/2016 12:24:40 PM EDT

IRB Coordinator

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