



# Reductions in reported persecutory ideation and psychotic-like experiences during exposure therapy for posttraumatic stress disorder<sup>☆</sup>



Benjamin Buck<sup>a,b,c,\*</sup>, Aaron Norr<sup>c,d</sup>, Andrea Katz<sup>c</sup>, Gregory A. Gahm<sup>e</sup>, Greg M. Reger<sup>c,d</sup>

<sup>a</sup> Health Services Research & Development (HSR&D) Denver-Seattle Center of Innovation (COIN), Seattle, WA, USA

<sup>b</sup> Department of Health Services, School of Public Health, University of Washington, Seattle, WA, USA

<sup>c</sup> Puget Sound VA Health Care System: Seattle Division, Seattle, WA, USA

<sup>d</sup> Department of Psychiatry and Behavioral Sciences, University of Washington, School of Medicine, Seattle, WA USA

<sup>e</sup> National Center for Telehealth and Technology, Tacoma, WA, USA

## ARTICLE INFO

### Keywords:

PTSD

Psychosis

Prolonged exposure

## ABSTRACT

While psychotic-like experiences (PLEs), including persecutory ideation and auditory or visual hallucinations, are common in PTSD, questions remain about their relationships to core PTSD symptoms and responsiveness to treatment. This study examined data from a waitlist (WL) controlled clinical study of the effect of virtual reality (VR) and prolonged exposure (PE) in a sample of active-duty service members with deployment-related trauma ( $n = 161$ ). PLEs were assessed and examined with regard to their responsiveness to trauma focused treatment (combining conditions) relative to the WL, as well as their relationships to PTSD symptoms. Persecutory ideation symptoms, which were most closely related to PTSD Cluster C (avoidance and numbing) symptoms, were reduced post-treatment in the trauma-focused condition relative to WL. Auditory and visual hallucinations—which were most closely associated with PTSD re-experiencing—decreased from baseline to post-treatment assessments for WL and exposure therapy participants. The presence of PLEs at baseline did not predict a reduced PTSD symptom response to treatment. Trauma-focused treatments appear effective in addressing psychotic-like experiences that can emerge in individuals with PTSD.

## 1. Introduction

Though their hallmark features differ, there is a complex conceptual overlap between disorders associated with posttraumatic stress and psychosis (Gibson et al., 2016). While psychosis involves chronic recurrence of anomalous beliefs and sensory experiences disconnected from reality, both sets of disorders share similar underlying factors (Freeman et al., 2013): intrusive thoughts and memories, fixed beliefs about a dangerous world, low self-esteem, self-blame, safety behaviors, and anomalous internal experiences (Gracie et al., 2007). Beyond similarities in presentation, these disorders may have shared etiology.

Traumatic events (Hardy et al., 2005), and the emergence of post-traumatic stress disorder (PTSD) symptoms (Alsawy et al., 2015; Calvert et al., 2008), increase an individual's risk for a future diagnosis of a psychotic disorder. At least half of individuals with a psychotic disorder have survived a traumatic experience (Bebbington et al., 2011; Read et al., 2005a), and an even larger portion of those at ultra-high risk (UHR) for a first psychotic episode have experienced early traumatic events (86.8%; Kraan et al., 2015).

Some models (Morrison et al., 2003) suggest that it is specifically the experience of trauma that alters stress sensitivity and increases the likelihood of an individual presenting with a continuum of experiences

<sup>☆</sup> This secondary analysis was made possible by a study supported by Grant W81XWH-08-2-0015 from the U.S. Army Medical Research Medical Program and Materiel Command Military Operational Medicine Research Program. This material is the result of work supported with resources and the use of facilities at VA Puget Sound Health Care System. The contents do not represent the views of the U.S. Department of Veterans Affairs, Department of Defense, or the United States Government. This research is also supported by the Department of Veterans Affairs Office of Academic Affiliations Advanced Fellowship Program in Mental Illness Research and Treatment, the Medical Research Service of the Veterans Affairs Puget Sound Health Care System, and the Department of Veterans Affairs Northwest Mental Illness Research, Education, and Clinical Center (MIRECC). Dr. Buck is currently supported by a VA Academic Affiliations' Advanced Fellowship in Health Services Research and Development (TPH 61-000-24). The authors would like to thank all of the collaborators of the original clinical trial, which made this study possible.

\* Corresponding author at : Health Services Research & Development (HSR&D) Center of Innovation (COIN), VA Puget Sound Health Care System, 1600 S. Columbian Way, Seattle, WA, USA.

E-mail address: [buckbe@uw.edu](mailto:buckbe@uw.edu) (B. Buck).

<https://doi.org/10.1016/j.psychres.2018.12.022>

Received 15 August 2018; Received in revised form 3 December 2018; Accepted 3 December 2018

Available online 12 December 2018

0165-1781/ Published by Elsevier B.V.

along the psychotic spectrum (*traumagenic neurodevelopmental model of psychosis*; Read et al., 2014). Because phenomena on the psychotic continuum (e.g. persecutory ideation, or brief auditory hallucinations; Shevlin et al., 2017) may or may not meet criteria for full-blown psychotic disorder, they are referred to as psychotic-like experiences (PLEs; van Os et al., 2009; Cannon and Kelleher, 2011). PLEs are understood to be transdiagnostic occurrences of experiences that in their most severe forms present in full-blown psychotic disorders. These phenomena may be linked to or comorbid with phenomena that are hallmark features of other disorders, like PTSD. This transdiagnostic perspective suggests that PTSD and psychosis could be “similar entities that are a part of a broader spectrum of reactions to trauma” (p. 116, Powers et al., 2016). This is supported by evidence that individuals with PTSD and psychotic disorders present with similar biological changes (van Winkel et al., 2008) as well as psychological factors (Freeman and Fowler, 2009) which can maintain persecutory beliefs or worsen their functional impact.

Given these links, some researchers have taken note of PLEs that often emerge in PTSD, including auditory and visual hallucinations (Kozarić-Kovačić and Borovečki, 2005) or persecutory ideation at varying levels of intensity (Freeman et al., 2011). Shevlin and colleagues (Shevlin et al., 2011) demonstrated in a large epidemiological sample not only that a lifetime PTSD diagnosis increased an individual's risk of PLEs, but also identified a distinct homogenous subtype with elevated levels of hyperarousal, avoidance, and general psychopathology. The prevalence of these phenomena have led researchers to examine whether a discrete clinical entity—posttraumatic stress disorder with secondary psychotic features (PTSD-SP; Braakman et al., 2009)—has its own coherent and distinct phenomenology and clinical course. PTSD-SP describes individuals who present with hallucinations and delusions after the emergence of PTSD symptoms without any history of psychotic symptoms. Preliminary research suggests that individuals with this presentation are more likely to identify as racial or ethnic minorities (Frueh et al., 2002), and to present with a higher burden of disease (Hamner, 1997; Hamner et al., 1999; Lindley et al., 2014) though some studies show similar PTSD symptom severity relative to those without psychotic features (Hamner et al., 1999). An ongoing question pertains to how to best characterize and taxonomize PLEs, namely whether they are severe forms of certain core PTSD symptoms. It remains unclear whether there exist theory-consistent links of PLEs to PTSD symptoms such as whether paranoia emerges from exaggerated hypervigilance or hallucinations from persistent re-experiencing (Kastelan et al., 2007).

A second gap pertains to the responsiveness of PLEs to treatment. Very few studies have examined the impact of trauma-focused treatments on PLEs (van Minnen et al., 2015a), due in part to widely reported clinical concerns about destabilization (Becker et al., 2004; Frueh et al., 2006). Consequently, one of the most common exclusion criteria in clinical trials examining trauma-focused treatments is current or past psychosis (Ronconi et al., 2014). Only recently have studies worked to empirically test whether trauma-focused treatment does indeed exacerbate psychotic symptoms. This emerging line of research has demonstrated trauma-focused treatments for individuals with a primary psychotic disorder and comorbid PTSD symptoms to be feasible (De Bont et al., 2013), safe (van den Berg et al., 2015), and effective relative to waitlist control in both reducing PTSD-related (van den Berg et al., 2015), and psychotic symptoms (De Bont et al., 2013). Previous studies of patients with PTSD and a psychotic disorder suggest promise, but few studies have examined outcomes among patients with PTSD and more common PLEs in the absence of a comorbid psychotic disorder (Powers et al., 2010). Thus, the secondary benefits of trauma-focused treatments in addressing these phenomena are not clear. In other words, there is a gap in the extant literature in assessing the extent to which trauma-focused treatments reduce auditory and visual hallucinations and persistent persecutory ideation.

## 1.1. Aims of the study

The present study addresses the identified gaps in the literature in a sample of active duty service members diagnosed with PTSD who have served in military conflicts in Iraq or Afghanistan. The present study builds on prior work by (1) characterizing the nature and extent of PLEs in this sample and the associated characteristics that predict them, (2) examining whether empirically-supported trauma focused treatments are effective in reducing comorbid PLEs in a primary PTSD sample, and (3) determining whether baseline presence of PLEs interferes with or reduces the efficacy of trauma-focused treatment.

## 2. Methods

### 2.1. Subjects

The present study is a secondary analysis of data collected in a randomized controlled trial of two trauma focused treatments—prolonged exposure (PE) and virtual reality exposure (VRE)—compared against a minimal attention waitlist control condition (see Reger et al., 2016 for full methodology). Active duty U.S. Army soldiers ( $N = 162$ ) with a diagnosis of PTSD based on the Clinician Administered PTSD Scale for DSM-IV (CAPS; Blake et al., 1995) related to combat trauma experienced during a deployment to Iraq or Afghanistan were randomized to 10 sessions of an exposure therapy (PE or VRE) or a 5-week wait list control condition. Inclusion criteria included (1) that index trauma not be sexual assault, (2) and that it occurred at least 3 months before the baseline assessment (3) in an environment similar to those available in the virtual reality exposure software. It was also required that participants not initiate other psychotherapy for PTSD or new medications during the study. Exclusion criteria were (1) a change in the type or strength of medication in the last month, (2) hospitalization in the past six months for suicidal risk or self-harm, (3) ongoing threat to safety (i.e. domestic violence), (4) current drug or alcohol dependence, a history of (5) seizures, (6) prior PE treatment, or (7) current ongoing treatment for PTSD, (8) any physical condition that would interfere with the ability to engage in the VR interface, (9) a history of loss of consciousness for longer than 15 minutes since entering active-duty military service, and most importantly for the current study, (10) past or current schizophrenia, bipolar disorder, or psychotic disorder. Participants were largely male (96%,  $n = 156$ ). The majority were Caucasian (60%,  $n = 97$ ) and had some college education (66%,  $n = 107$ ).

### 2.2. Measures

#### 2.2.1. Psychotic-like experiences (PLEs)

The Behavior and Symptom Identification Scale, Revised (Cameron et al., 2007) (BASIS-24) is a 24-item patient self-reported assessment of a range of symptoms of psychopathology and functional outcomes that are assessed for the past week. Participants identify how frequently or severely (on a 0 to 4 Likert scale) they have experienced a range of symptoms. In the present study, the BASIS Psychosis Items were used from the baseline and post-treatment assessments. Four items comprise the Psychosis Scale, including one item assessing grandiosity (“think you had special powers”), an item assessing auditory and visual hallucinations (“hear voices or see things”), and two items related to persecutory ideation (“think people were watching you” and “think people were against you”). The Psychosis Scale of the BASIS-24 has adequate internal consistency in both inpatient ( $n = 2,656$ ;  $\alpha = 0.77$ ) and outpatient settings ( $n = 3,222$ ;  $\alpha = 0.77$ ), discriminates between individuals with and without chart diagnoses of psychotic disorders, and is responsive to therapeutic change (Eisen et al., 2004). Given the low frequency of reported grandiosity in the sample (see Table 1), and specific interest in PLEs most common to PTSD (Braakman et al., 2009), we focused specifically on the hallucinations and persecutory ideation

**Table 1**  
Response frequencies and relationships to CAPS and PCL-C scores for each BASIS-24 psychosis item at baseline.

	Never	Rarely	Sometimes	Often	Always	CAPS ( <i>r</i> )	PCL-C ( <i>r</i> )
Auditory/visual hallucinations: (“Hear voices or see things”)	98 (60.9%)	31 (19.1%)	26 (16.0%)	6 (3.7%)	0 (0.0%)	0.12	<b>0.22**</b>
Grandiosity: (“Think you had special powers”)	147 (91.3%)	7 (4.3%)	4 (2.5%)	1 (0.6%)	2 (1.2%)	−0.07	0.05
Paranoia #1: (“Think people were watching you”)	31 (19.1%)	25 (15.4%)	57 (35.2%)	33 (20.4%)	16 (9.9%)	<b>0.26**</b>	<b>0.36**</b>
Paranoia #2: (“Think people were against you”)	26 (16.0%)	37 (22.8%)	61 (37.7%)	26 (16.0%)	12 (7.4%)	<b>0.28***</b>	<b>0.32***</b>

Note. Intercorrelations between paranoia items  $r = 0.56$ ,  $p < .001$ . AVH item significantly correlated with paranoia (watching)  $r = 0.27$ ,  $p < .001$ , but not significantly related to paranoia (people against)  $r = 0.15$ ,  $p = .06$ .

\* $p < .05$ .

\*\*  $p < .01$ .

\*\*\*  $p < .001$ .

items. The persecutory ideation items were averaged to create a “paranoia composite” score.

### 2.2.2. PTSD symptoms

The Clinician Administered PTSD Scale (CAPS; Blake et al., 1995) is a structured clinical interview that assesses the presence and severity of PTSD according to *DSM-IV* criteria. The frequency and intensity of each symptom is coded on a scale ranging from 0 to 4 (0 = Never; None; 4 = Daily or almost every day; Extreme distress). In the present analyses, CAPS scores were gathered at baseline prior to randomization and post-treatment with a “last week” reference, given the potential for only 2.5 and 5 weeks of treatment at the mid- and post-treatment assessments, respectively. This allowed for the assessments to assess change during the study period. CAPS raters achieved an acceptable level of reliability in rating PTSD symptoms ( $\kappa > 0.80$ ) defined by agreement with a trauma expert.

The PTSD Checklist, Civilian Version (PCL-C, Weathers et al., 1994; Wortmann et al., 2016) is a 17-item self-report measure of PTSD symptoms. Participants rate—on a 5-point Likert scale (ranging from 1 representing “not at all” to 5 representing “extremely”)—the severity of their symptoms in the past month (“how much have you been bothered by your PTSD symptoms?”). The PCL-C is widely used in trauma research, is a standard measure used in U.S. postdeployment assessments, and has demonstrated strong internal consistency, test–retest reliability, and convergent validity (Blanchard et al., 1996; Bliese et al., 2008). This study used baseline and post-treatment PCL-C scores.

## 2.3. Procedure

### 2.3.1. Treatment

In the present study, the prolonged exposure intervention (Foa et al., 2007) consisted of ten 90 to 120-minute sessions. The first two sessions provide patients psychoeducation related to breathing retraining, normalizing reactions to traumatic events, and the rationale for the treatment. In vivo exposure begins after session 2, as patients are assigned homework assignments to approach avoided situations, places, and circumstances between sessions. Imaginal exposure begins in session 3, where patients recount their trauma memory repeatedly for 30 to 60 minutes. In this study, virtual reality exposure (or VRE) was administered with an identical protocol, except participants utilized the Virtual Iraq/Afghanistan system as they conducted their imaginal exposure. A clinician customized the virtual environment, in real time, as patients recounted their trauma memory. Primary analyses from this study’s randomized controlled trial demonstrated that both PE and VRE were effective in reducing PTSD symptoms (Reger et al., 2016), with limited evidence for superiority for either condition at post-treatment; thus, in the present analyses, the VR and standard PE conditions are combined into one *trauma-focused treatment* condition.

### 2.3.2. Data analytic plan

Relationships between baseline PLEs and demographic characteristics—including age, gender, race, ethnicity, number of traumatic

events experienced—were examined with Pearson correlations, independent samples *t*-tests and  $\chi^2$  tests. Hierarchical regressions were used to examine the relationships of baseline PLEs to specific PTSD symptom clusters, predicting each psychotic-like experience variable from total scores of each PTSD symptom cluster on the CAPS and PCL-C. Given differing distributions between each PLE and the fact that the hallucinations score was derived from one Likert scale item, PLUM logistic ordinal regressions were used to examine hallucinations and hierarchical linear regressions to examine the paranoia composite. Treatment effects were examined using generalized estimating equations (again with a logistic ordinal model for hallucinations and linear model for paranoia composite). Two models were examined for each PLE; one that examined the effect of time, treatment condition and the interaction predicting each PLE (to assess treatment effects) and another that examined, time, treatment condition, baseline rate of each respective PLE and all interactions predicting CAPS scores (to assess the extent to which baseline PLEs may interfere with PTSD treatment effectiveness). Further, a reduced model—predicting each outcome only from measurement time—was examined, to allow for an unbiased examination of changes over time across groups.

## 3. Results

### 3.1. Frequencies and distributions of PLEs

Response frequencies for each item (separating each paranoia sub-scale item) are reported in Table 1. Baseline frequency distributions differed considerably between the paranoia items and the item assessing the experience of auditory or visual hallucinations. The modal response for each paranoia item was a response of 2 (i.e. “sometimes”), and a low proportion of respondents gave a response of 0 (i.e. “never”; 19.1% and 16.0% respectively). For the hallucinations item, a significant portion of the sample (60.5%) reported never having difficulty with auditory or visual hallucinations. Distributions for both paranoia items were within acceptable ranges with regard to skewness (0.12 and 0.21 respectively) and kurtosis (−0.58 and −0.40), however, the hallucinations item was positively skewed. Given low frequency of the highest response category at baseline ( $n = 6$  [3.7%], for “often”) the top two levels of this item (“sometimes” and “often”) were combined in all analyses examining auditory/visual hallucinations; our analytic strategy accounted for this non-normality by employing logistic ordinal models. At post-treatment the attrition rate (as defined by completion of BASIS) for the trauma-focused treatment group was 43%, while the dropout rate for the waitlist group was 15%.

### 3.2. Demographic characteristics

Relationships of responses to PLE items to demographic characteristics—including age, gender, race, years of services, and years of education—were examined using Pearson correlations for continuous variables (age, years of service, years of education) and  $\chi^2$  tests for dichotomous variables (race and gender). There were no significant

**Table 2**  
Models predicting PLEs at baseline from CAPS and PCL-C scores.

Predicting BASIS-24: Hallucinations						Predicting BASIS-24: Paranoia composite					
CAPS	B	SE	Wald	df	p	PCL-C	B	SE	Wald	df	p
Re-experiencing	0.29	0.18	2.61	1	0.11	Re-experiencing	0.68	0.27	6.21	1	0.01*
Avoidance and numbing	-0.21	0.30	0.49	1	0.48	Avoidance and numbing	-0.06	0.26	0.06	1	0.81
Hypervigilance	0.33	0.31	1.12	1	0.29	Hypervigilance	0.03	0.32	0.01	1	0.92

CAPS	B	SE	Beta	t	p	PCL-C	B	SE	Beta	t	p
Re-experiencing	0.11	0.09	0.10	1.28	0.204	Re-experiencing	0.17	0.12	0.12	1.34	0.18
Avoidance and numbing	0.37	0.15	0.21	2.51	0.01*	Avoidance and numbing	0.41	0.12	0.27	3.32	0.001**
Hypervigilance	0.27	0.15	0.15	1.78	0.08	Hypervigilance	0.08	0.15	0.05	0.56	0.58

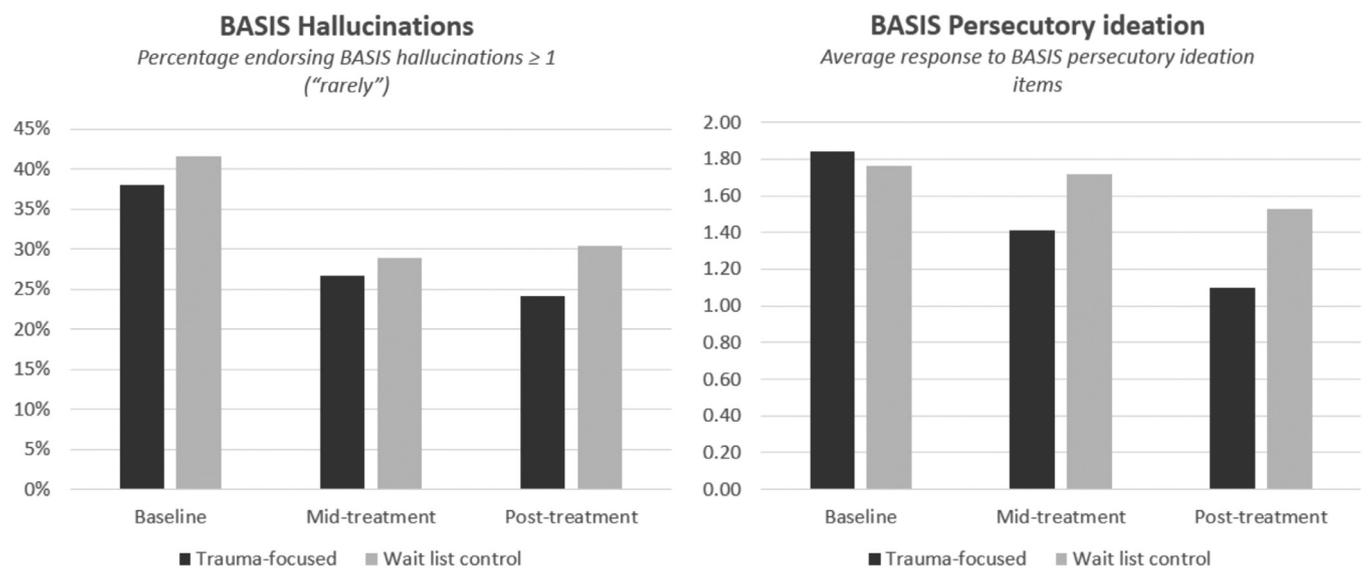
PLUM ordinal regression with a logit link function, predicting baseline hallucinations score (combining “often” with “sometimes”).

Hierarchical linear regression, predicting baseline paranoia composite scores.

Note. BASIS-24 = Behavior and Symptom Identification Scale, Revised; CAPS = Clinician Administered PTSD Scale; PCL-C = PTSD Checklist, Civilian Version.

\*  $p < .05$ .

\*\*  $p < .01$ , \*\*\* $p < .001$ .



**Fig. 1.** Treatment effects of trauma-focused treatments on auditory/visual hallucinations (% reporting auditory/visual hallucinations) and persecutory ideation (mean response on persecutory ideation items) from baseline to post-test.

relationships between any demographic characteristic and any PLE. Detailed demographic characteristics of this sample are reported elsewhere (Reger et al., 2016).

3.3. Relationships of PLEs to PTSD symptoms

Correlations of PLE items to PCL-C and CAPS scores are reported in Table 1. Both paranoia items were significantly related to both PCL-C and CAPS total scores, while the auditory/visual hallucinations item was only associated with PCL-C total score. To examine specific relationships to PTSD symptom clusters, we examined full regression models for each PLE of interest (paranoia composite and auditory/visual hallucinations). With a hierarchical linear regression for paranoia and a PLUM logistic ordinal regression model for auditory/visual hallucinations, we examined relationships of baseline PTSD symptom categories to each reported baseline PLE (see Table 2). Level of hallucinations was significantly predicted by participants’ level of re-experiencing symptoms, as assessed by the PCL-C. No predictors from the CAPS were associated with report of hallucinations. For the paranoia composite score, participant CAPS and PCL-C cluster C PTSD symptoms (avoidance and numbing symptoms) significantly predicted paranoia composite scores on the BASIS. No other symptom cluster was associated with paranoia composite on either measure.

3.4. Treatment effect and interference

Using generalized estimating equations, we examined the effect of trauma-focused treatments on PLEs. First, with regard to persecutory ideation, our reduced model revealed a significant main effect for time ( $B = -.26$ ,  $SE = .05$ ,  $Wald \chi^2 = 25.14$ ,  $p < .001$ ) and the full model revealed a significant interaction of time and treatment ( $B = .26$ ,  $SE = .10$ ,  $Wald \chi^2 = 6.92$ ,  $p = .009$ ). This indicates that persecutory ideation significantly decreased over time on average across both groups, and a significantly greater decrease over time in the trauma-focused condition. Second, examining treatment changes in hallucinations, there was a reduced-model main effect of time ( $B = -.38$ ,  $SE = .12$ ,  $Wald \chi^2 = 11.51$ ,  $p = .001$ ), but there was no significant time by treatment interaction in the full model ( $p = .42$ ). This reflects that while the frequency of report of auditory/visual hallucinations dropped from baseline ( $n = 63$ , 39.1% of sample endorsing this item “rarely” or above) to post-treatment ( $n = 29$ , 26.8%), these decreases were not specific to the trauma-focused treatment condition. Of note, the most precipitous decrease occurred from baseline to mid-treatment ( $n = 35$ , 27.6% endorsing at mid-treatment). This change was not solely attributable to study attrition, as there was not an over-representation of study dropouts amongst those who reported hallucinations at baseline vs. (31.7% attrition amongst those reporting hallucinations at baseline vs.

33.7% amongst those who did not) (Fig. 1).

Third, we examined whether baseline report of each PLE was associated with a reduced treatment effect on PTSD symptoms. There was no significant three-way interaction between time, treatment, and baseline PLE symptom level for either reported PLE, persecutory ideation ( $p = .35$ ) or hallucinations ( $p = .44$ ).

#### 4. Discussion

While prior research has taken note of PLEs that present in the course of PTSD (Braakman et al., 2009; Lindley et al., 2014), little work has focused specifically on their relationships to PTSD symptom clusters and responsiveness to treatment. The present study demonstrated that such experiences, including auditory/visual hallucinations and persecutory ideation, are associated with specific symptom clusters of post-traumatic stress disorder, and are responsive to trauma-focused treatments. Previous research (De Bont et al., 2016; Van Den Berg et al., 2016) suggests that individuals with a primary psychotic disorder in trauma-focused treatment similarly experience reductions in both psychotic and trauma symptoms. The present study extends this research by focusing specifically on individuals with primary PTSD and no comorbid psychotic disorder.

Amongst a sample of active duty soldiers with PTSD and without a history of a psychotic disorder diagnosis, a significant portion reported the experience of auditory or visual hallucinations (approximately 39%), and a majority reported frequent (“sometimes” or more) experiences of persecutory ideation related to being watched (approximately 65%) or targeted by others (approximately 61%). Less than a fifth of the sample reported that they never experienced persecutory ideation in the week prior to the baseline visit. It is notable that these symptoms, as assessed by a psychometrically-validated patient-reported outcome measure, are reported by 40% of a sample for which past or present psychotic disorder was an exclusion criterion. Second, each of these PLEs was related to a different PTSD symptom cluster. Hallucinations were specifically linked with self-reported trauma re-experiencing symptoms, while persecutory ideation was associated with Cluster C (avoidance and numbing) symptoms. These results are consistent with theoretical models of each disorder, suggesting that paranoia emerges from negative beliefs or expectations about self, others, and the world (Freeman and Garety, 2014). The present study raises questions, however, if such experiences should be classified on a psychotic disorder continuum, as exclusively features of PTSD, or both. The traumagenic model of psychosis (Read et al., 2014, 2005b) suggests these two views of PLEs are not mutually exclusive, as some of the cognitive, emotional and behavioral phenomena that are core to PTSD increase an individual's psychosis risk. This view is bolstered by findings that individuals with PTSD have increased risk of later presenting with a full-blown psychotic disorder (Alsawy et al., 2015; Calvert et al., 2008). While future research should examine the risk conferred by PLEs longitudinally, our results provide evidence for their common occurrence in a sample of individuals with military-related trauma and theory-consistent relationships to PTSD symptom clusters.

Second, our results suggest that trauma-focused treatment reduces persecutory ideation. Participants in the trauma focused treatment condition demonstrated more significant decreases in persecutory ideation over time than those in the waitlist condition. These findings are consistent with models of prolonged exposure (with and without VR), and trauma-related belief change has consistently been shown to mediate successful PTSD symptom reduction due to prolonged exposure (Cooper et al., 2017). With regard to hallucinations, there were precipitous decreases in reported hallucinations over time, but these decreases were not specific to either trauma-focused treatment or the waitlist condition. This provides no evidence for the specific efficacy of trauma-focused psychotherapy in reducing auditory or visual hallucinations, and raises additional questions about the stability of these symptoms. It is possible that follow-up assessments detected ordinary

fluctuations, or that reductions in hallucinations could be attributed to non-specific factors. Lastly, and importantly, individuals with elevated baseline levels of PLEs were just as likely to receive treatment benefit as individuals without. Our data provided no support for the hypothesis that PLEs might inhibit or disrupt trauma-focused treatments. This adds additional support to the view that symptoms along the psychotic symptom spectrum do not impact the feasibility, safety, or effectiveness of trauma-focused treatments in reducing PTSD symptoms (De Bont et al., 2016; van den Berg et al., 2015).

This study is not without limitations. Participants in the present study are older than is typical for individuals in the risk period for psychotic disorder ( $M_{age} = 30.27$  [6.66]). Although this study may provide useful information about treating PLEs in individuals with PTSD at risk for future psychotic disorder, it is possible that risk is diminished in the current sample given their age. This is also qualified by observations that traumas associated with psychosis risk often occur in childhood (Reininghaus et al., 2016). Future research should examine psychosis risk longitudinally amongst individuals with traumatic experiences only in adulthood. Our study sample also consisted of active duty military members (96% male) with combat-related trauma, which may limit generalizability of the findings to other populations (e.g. women, civilians, individuals with non-military trauma). Second, there was a significant dropout rate from baseline to post test, which might have affected treatment results. While missing data were addressed in a manner consistent with best practices (i.e. maximum likelihood estimation; Graham, 2009) this study's attrition might have impacted study results. It was the case however, that there were similar rates of attrition comparing subgroups of individuals with PLEs to the overall sample (Reger et al., 2016). A third limitation pertains to the measurement of PLEs. Though the BASIS-24 has demonstrated evidence of psychometric validity (Eisen et al., 2004), the present study results depend on responses to a relatively few number of items. This limits our interpretation of the etiology and presentation of PLEs, and suggests future research targets specifically these symptoms and employs more in-depth instruments. This is particularly challenging given persisting questions about the nature of PLEs in psychosis, namely, the extent to which they represent expressions of re-experiencing, true psychotic symptoms, or a combination of both. PTSD re-experiencing symptoms are specific to the traumatic experience, whereas auditory and visual hallucinations common in psychosis are more persistent and tend to transcend domains. Our data support a relationship between report of hallucinations and re-experiencing in our sample, but they preclude more in-depth qualitative examination of the content of these hallucinations. It is a broader theoretical and empirical question the extent to which these experiences ought to be regarded on the psychotic disorder continuum. Finally, assessments used in the study to assess PTSD symptoms are designed for DSM-IV definitions of illness, and thus results are limited in the extent to which they speak to relationships between PLEs and DSM-5 clusters.

Overall, these findings suggest that many individuals with PTSD experience psychotic-like phenomena, and these experiences are non-interfering with and responsive to trauma-focused treatment. This has supportive implications for the effectiveness of trauma-focused treatments on a broader array of psychiatric symptoms. Even in a sample of individuals who were screened for current or past psychotic disorder, a significant portion report persecutory beliefs (related to avoidance and numbing symptoms) and auditory and visual hallucinations (related to PTSD re-experiencing). Individuals receiving prolonged exposure (with or without VR) experienced reduced persecutory ideation at post-treatment relative to waitlist. Individuals with PLEs (regardless of whether hallucinations or persecutory ideation) also were just as likely to receive PTSD symptom benefit over the course of the study. These results add to a body of research evidence addressing concerns about risks for individuals with comorbid PLEs receiving trauma-focused treatments. On the contrary, these results suggest that trauma-focused treatments might in fact effectively reduce these phenomena. Given

that brief, subthreshold psychotic symptoms identify a psychotic disorder risk state (Kelleher and Cannon, 2011), it is of interest to understand how effective treatments for PTSD might address these subthreshold experiences. Through this lens, the present results suggest that trauma-focused treatments might even reduce this risk by impacting the frequency and severity of PLEs.

## References

- Alsawy, S., Wood, L., Taylor, P.J., Morrison, A.P., 2015. Psychotic experiences and PTSD: Exploring associations in a population survey. *Psychol. Med.* 45, 2849–2859. <https://doi.org/10.1017/S003329171500080X>.
- Bebbington, P., Jonas, S., Kuipers, E., King, M., Cooper, C., Brugha, T., et al., 2011. Childhood sexual abuse and psychosis: Data from a cross-sectional national psychiatric survey in England. *Br. J. Psychiatry* 199, 29–37. <https://doi.org/10.1192/bjp.bp.110.083642>.
- Becker, C.B., Zayfert, C., Anderson, E., 2004. A survey of psychologists' attitudes towards and utilization of exposure therapy for PTSD. *Behav. Res. Ther.* 42 (3), 277–292. [https://doi.org/10.1016/S0005-7967\(03\)00138-4](https://doi.org/10.1016/S0005-7967(03)00138-4).
- Blake, D.D., Weathers, F.W., Nagy, L.M., Kaloupek, D.G., Gusman, F.D., Charney, D.S., et al., 1995. The development of a Clinician-Administered PTSD Scale. *J. Trauma. Stress* 8, 75–90. <https://doi.org/10.1007/BF02105408>.
- Blanchard, E.B., Jones-Alexander, J., Buckley, T.C., Forneris, C.A., 1996. Psychometric properties of the PTSD checklist (PCL). *Behav. Res. Ther.* 34, 669–673. [https://doi.org/10.1016/0005-7967\(96\)00033-2](https://doi.org/10.1016/0005-7967(96)00033-2).
- Bliese, P.D., Wright, K.M., Adler, A.B., Cabrera, O., Castro, C.A., Hoge, C.W., 2008. Validating the primary care posttraumatic stress disorder screen and the posttraumatic stress disorder checklist with soldiers returning from combat. *J. Consult. Clin. Psychol.* 76, 272–281. <https://doi.org/10.1037/0022-006X.76.2.272>.
- Braakman, M.H., Kortmann, F.A.M., Van Den Brink, W., 2009. Validity of “posttraumatic stress disorder with secondary psychotic features”: A review of the evidence. *Acta Psychiatr. Scand.* 119 (1), 15–24. <https://doi.org/10.1111/j.1600-0447.2008.01252.x>.
- Calvert, C., Larkin, W., Jellicoe-Jones, L., 2008. An exploration of the links between trauma and delusional ideation in secure services. *Behav. Cogn. Psychother.* 36, 589–604. <https://doi.org/10.1017/S1352465808004621>.
- Cameron, I.M., Cunningham, L., Crawford, J.R., Eagles, J.M., Eisen, S.V., Lawton, K., et al., 2007. Psychometric properties of the BASIS-24© (behaviour and symptom identification scale-revised) mental health outcome measure. *Int. J. Psychiatry Clin. Pract.* 11, 36–43. <https://doi.org/10.1080/13651500600885531>.
- Cooper, A.A., Clifton, E.G., Feeny, N.C., 2017. An empirical review of potential mediators and mechanisms of prolonged exposure therapy. *Clin. Psychol. Rev.* 56, 106–121. <https://doi.org/10.1016/j.cpr.2017.07.003>.
- De Bont, P.A.J.M., Van Den Berg, D.P.G., Van Der Vleugel, B.M., De Roos, C., De Jongh, A., Van Der Gaag, M., et al., 2016. Prolonged exposure and EMDR for PTSD v. a PTSD waiting-list condition: Effects on symptoms of psychosis, depression and social functioning in patients with chronic psychotic disorders. *Psychol. Med.* 46, 2411–2421. <https://doi.org/10.1017/S0033291716001094>.
- De Bont, P.A.J.M., Van Minnen, A., De Jongh, A., 2013. Treating PTSD in patients with psychosis: A within-group controlled feasibility study examining the efficacy and safety of evidence-based PE and EMDR protocols. *Behav. Ther.* 44, 717–730. <https://doi.org/10.1016/j.beth.2013.07.002>.
- Eisen, S.V., Normand, S.-L., Belanger, A.J., Spiro, A., Esch, D., 2004. The Revised Behavior and Symptom Identification Scale (BASIS-R). *Med. Care* 42, 1230–1241. <https://doi.org/10.1097/00005650-200412000-00010>.
- Foa, E.B., Hembree, E.A., Rothbaum, B.O., 2007. *Prolonged Exposure Therapy for PTSD: Emotional Processing of Traumatic Experiences: Therapist Guide, Treatments That Work*. Oxford University Press, New York.
- Freeman, D., Fowler, D., 2009. Routes to psychotic symptoms: Trauma, anxiety and psychosis-like experiences. *Psychiatr. Res.* 169 (2), 107–112.
- Freeman, D., Garety, P., 2014. Advances in understanding and treating persecutory delusions: A review. *Soc. Psychiatry Psychiatr. Epidemiol.* 49, 1179–1189. <https://doi.org/10.1007/s00127-014-0928-7>.
- Freeman, D., McManus, S., Brugha, T., Meltzer, H., Jenkins, R., Bebbington, P., 2011. Concomitants of paranoia in the general population. *Psychol. Med.* 41, 923–936. <https://doi.org/10.1017/S0033291710001546>.
- Freeman, D., Thompson, C., Vorontsova, N., Dunn, G., Carter, L.A., Garety, P., Kuipers, E., Slater, M., Antley, A., Glucksman, E., Ehlers, A., 2013. Paranoia and posttraumatic stress disorder in the months after a physical assault: A longitudinal study examining shared and differential predictors. *Psychol. Med.* 43, 2673–2684. <https://doi.org/10.1017/S003329171300038X>.
- Frueh, B.C., Cusack, K.J., Grubaugh, A.L., Sauvageot, J.A., Wells, C., 2006. Clinicians' perspectives on cognitive-behavioral treatment for PTSD among persons with severe mental illness. *Psychiatr. Serv.* 57, 1027–1031. <https://doi.org/10.1176/appi.ps.57.7.1027>.
- Frueh, B.C., Hamner, M.B., Bernat, J.A., Turner, S.M., Keane, T.M., Arana, G.W., 2002. Racial differences in psychotic symptoms among combat veterans with PTSD. *Depress. Anxiety* 16, 157–161. <https://doi.org/10.1002/da.10068>.
- Gibson, L.E., Alloy, L.B., Ellman, L.M., 2016. Trauma and the psychosis spectrum: A review of symptom specificity and explanatory mechanisms. *Clin. Psychol. Rev.* 49, 92–105. <https://doi.org/10.1016/j.cpr.2016.08.003>.
- Gracie, A., Freeman, D., Green, S., Garety, P.A., Kuipers, E., Hardy, A., et al., 2007. The association between traumatic experience, paranoia and hallucinations: A test of the predictions of psychological models. *Acta Psychiatr. Scand.* 116, 280–289. <https://doi.org/10.1111/j.1600-0447.2007.01011.x>.
- Graham, J.W., 2009. Missing data analysis: Making it work in the real world. *Annu. Rev. Psychol.* 60, 549–576. <https://doi.org/10.1146/annurev.psych.58.110405.085530>.
- Hamner, M.B., 1997. Psychotic features and combat-associated PTSD. *Depress. Anxiety* 5, 34–38. [https://doi.org/10.1002/\(SICI\)1520-6394\(1997\)5:1<34::AID-DA6>3.0.CO;2-5](https://doi.org/10.1002/(SICI)1520-6394(1997)5:1<34::AID-DA6>3.0.CO;2-5).
- Hamner, M.B., Frueh, B.C., Ulmer, H.G., Arana, G.W., 1999. Psychotic features and illness severity in combat veterans with chronic posttraumatic stress disorder. *Biol. Psychiatry* 45, 846–852. [https://doi.org/10.1016/S0006-3223\(98\)00301-1](https://doi.org/10.1016/S0006-3223(98)00301-1).
- Hardy, A., Fowler, D., Freeman, D., Smith, B., Steel, C., Evans, J., Garety, P., Kuipers, E., Bebbington, P., Dunn, G., 2005. Trauma and hallucinatory experience in psychosis. *J. Nerv. Ment. Dis.* 193, 501–507. <https://doi.org/10.1097/01.nmd.0000172480.56308.21>.
- Kastelan, A., Francisković, T., Moro, L., Roncević, G.I., Grković, J., Jurcan, V., et al., 2007. Psychotic symptoms in combat-related posttraumatic stress disorder. *Mil. Med.* 172, 273–277.
- Kelleher, I., Cannon, M., 2011. Psychotic-like experiences in the general population: Characterizing a high-risk group for psychosis. *Psychol. Med.* 41 (1), 1–6. <https://doi.org/10.1017/S0033291710001005>.
- Kozarić-Kovačić, D., Borovečki, A., 2005. Prevalence of psychotic comorbidity in combat-related posttraumatic stress disorder. *Mil. Med.* 170, 223–226. <https://doi.org/10.7205/MILMED.170.3.223>.
- Kraan, T., Velthorst, E., Smit, F., de Haan, L., van der Gaag, M., 2015. Trauma and recent life events in individuals at ultra high risk for psychosis: Review and meta-analysis. *Schizophr. Res.* 161 (2–3), 143–149. <https://doi.org/10.1016/j.schres.2014.11.026>.
- Lindley, S.E., Carlson, E.B., Hill, K.R., 2014. Psychotic-like experiences, symptom expression, and cognitive performance in combat veterans with posttraumatic stress disorder. *J. Nerv. Ment. Dis.* 202, 91–96. <https://doi.org/10.1097/NMD.000000000000077>.
- Morrison, A.P., Frame, L., Larkin, W., 2003. Relationships between trauma and psychosis: A review and integration. *Br. J. Clin. Psychol.* 42 (Pt 4), 331–353. <https://doi.org/10.1348/01446650322528892>.
- Powers, A., Fani, N., Cross, D., Ressler, K.J., Bradley, B., 2016. Childhood trauma, PTSD, and psychosis: Findings from a highly traumatized, minority sample. *Child Abuse. Negl.* 58, 111–118. <https://doi.org/10.1016/j.chiabu.2016.06.015>.
- Powers, M.B., Halpern, J.M., Ferenschak, M.P., Gillihan, S.J., Foa, E.B., 2010. A meta-analytic review of prolonged exposure for posttraumatic stress disorder. *Clin. Psychol. Rev.* 30 (6), 635–641. <https://doi.org/10.1016/j.cpr.2010.04.007>.
- Read, J., Fosse, R., Moskowitz, A., Perry, B., 2014. The traumagenic neurodevelopmental model of psychosis revisited. *Neuropsychiatry (London)* 4, 65–79. <https://doi.org/10.2217/npv.13.89>.
- Read, J., Os, J., van, Morrison, A.P., Ross, C.A., Van Os, J., Morrison, A.P., Ross, C.A., 2005a. Childhood trauma, psychosis and schizophrenia: A literature review with theoretical and clinical implications. *Acta Psychiatr. Scand.* 112, 330–350. <https://doi.org/10.1111/j.1600-0447.2005.00634.x>.
- Read, J., Van Os, J., Morrison, A.P., Ross, C.A., 2005b. Childhood trauma, psychosis and schizophrenia: A literature review with theoretical and clinical implications. *Acta Psychiatr. Scand.* 112 (5), 330–350. <https://doi.org/10.1111/j.1600-0447.2005.00634.x>.
- Reger, G.M., Koenen-Woods, P., Zetocha, K., Smolenski, D.J., Holloway, K.M., Rothbaum, B.O., et al., 2016. Randomized controlled trial of prolonged exposure using imaginal exposure vs. virtual reality exposure in active duty soldiers with deployment-related posttraumatic stress disorder (PTSD). *J. Consult. Clin. Psychol.* 84, 946–959. <https://doi.org/10.1037/ccp0000134>.
- Reininghaus, U., Gayer-Anderson, C., Valmaggia, L., Kempton, M.J., Calem, M., Onyejiaka, A., et al., 2016. Psychological processes underlying the association between childhood trauma and psychosis in daily life: an experience sampling study. *Psychol. Med.* 46, 2799–2813. <https://doi.org/10.1017/S003329171600146X>.
- Ronconi, J.M., Shiner, B., Watts, B.V., 2014. Inclusion and exclusion criteria in randomized controlled trials of psychotherapy for PTSD. *J. Psychiatr. Pract.* 20, 25–37. <https://doi.org/10.1097/01.pra.0000442936.23457.5b>.
- Shevlin, M., Armour, C., Murphy, J., Houston, J., Adamson, G., 2011. Evidence for a psychotic posttraumatic stress disorder subtype based on the National Comorbidity Survey. *Soc. Psychiatry Psychiatr. Epidemiol.* 46, 1069–1078. <https://doi.org/10.1007/s00127-010-0281-4>.
- Shevlin, M., McElroy, E., Bentall, R.P., Reininghaus, U., Murphy, J., 2017. The psychosis continuum: Testing a bifactor model of psychosis in a general population sample. *Schizophr. Bull.* 43, 133–141. <https://doi.org/10.1093/schbul/sbw067>.
- van den Berg, D.P.G., de Bont, P.A.J.M., van der Vleugel, B.M., de Roos, C., de Jongh, A., Van Minnen, A., et al., 2015. Prolonged exposure vs eye movement desensitization and reprocessing vs waiting list for posttraumatic stress disorder in patients with a psychotic disorder: A randomized clinical trial. *JAMA Psychiatry* 72, 259–267. <https://doi.org/10.1001/jamapsychiatry.2014.2637>.
- Van Den Berg, D.P.G., De Bont, P.A.J.M., Van Der Vleugel, B.M., De Roos, C., De Jongh, A., Van Minnen, A., et al., 2016. Trauma-focused treatment in PTSD patients with psychosis: Symptom exacerbation, adverse events, and revictimization. *Schizophr. Bull.* 42, 693–702. <https://doi.org/10.1093/schbul/sbv172>.
- van Minnen, A., Zoellner, L.A., Harned, M.S., Mills, K., 2015a. Changes in comorbid conditions after prolonged exposure for PTSD: A literature review. *Curr. Psychiatry Rep.* 17 (17), 1–16. <https://doi.org/10.1007/s11920-015-0549-1>.
- van Os, J., Linscott, R.J., Myin-Germeys, I., Delespaul, P., Krabbendam, L., 2009. A systematic review and meta-analysis of the psychosis continuum: evidence for a psychosis-proneness-persistence-impairment model of psychotic disorder. *Psychol. Med.* 39, 179–195. <https://doi.org/10.1017/S0033291708003814>.
- Van Winkel, R., Stefanis, N.C., Myin-Germeys, I., 2008. Psychosocial stress and psychosis. A review of the neurobiological mechanisms and the evidence for gene-stress interaction. *Schiz. Bull.* 34 (6), 1095–1105.
- Weathers, Litz, Huska, Keane, 1994. *PCL-C for DSM-IV. Natl. Cent. PTSD-Behav. Sci. Div.*
- Wortmann, J.H., Jordan, A.H., Weathers, F.W., Resick, P.A., Dondanville, K.A., Hall-Clark, B., et al., 2016. Psychometric analysis of the PTSD checklist-5 (PCL-5) among treatment-seeking military service members. *Psychol. Assess.* 28, 1392–1403. <https://doi.org/10.1037/pas0000260>.