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TITLE: **Virtual Reality and Cellular Phones as a Complementary Intervention for Veterans with PTSD and Substance Use Disorders**

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14. ABSTRACT

The primary aim of this study was to conduct a preliminary randomized controlled trial to evaluate the feasibility, acceptability, and preliminary efficacy a novel adjunctive behavioral intervention for Veterans (N = 38) with PTSD and co-occurring addiction. The experimental intervention was conducted during 10 weeks of prolonged exposure (PE) for PTSD, and used a virtual reality-based cue exposure platform to reduce craving to addiction-related cues coupled with cellular phones to deliver reminders of learning to extinguish cravings. Participants were randomized to receive PE alone or PE augmented by exposure with portable extinction reminders. Results indicate that the intervention is feasible to implement and acceptable to participants as an adjunct to standard PE. There were no significant between-group differences in attrition during treatment. Self-reported ratings of satisfaction with treatment were high across treatment conditions, with no between-group differences. Preliminary efficacy of the novel intervention also was demonstrated. Specifically, both conditions were associated with significant reductions in PTSD symptoms and substance from pre- to post-treatment. Extinction reminders were associated with significant reductions in cravings assessed via cellular phones.

15. SUBJECT TERMS Post-Traumatic Stress Disorder, Substance Abuse, Substance Dependence, Virtual Reality, Extinction					
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Project Title: Virtual Reality and Cellular Phones as a Complementary Intervention for Veterans with PTSD and Substance Use Disorders

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Principal Investigator: Mark Z. Rosenthal, Ph.D.

1. Introduction

In the present project, we have been testing a novel adjunctive intervention designed to complement exposure-based therapies for combat veterans with posttraumatic stress disorder (PTSD) and co-morbid substance use disorders (SUDs). The novel intervention is adjunctive to prolonged exposure for PTSD and uses virtual reality as a cue exposure platform to extinguish cravings to drug-related cues, and cellular phones to deliver extinction reminders, in order to transfer learning effects from exposure/extinction in the clinic to adaptive responses in high-risk contexts for drug use in everyday life. It is hypothesized that: (a) the complementary intervention will be acceptable and feasible and (b) compared to participants receiving exposure therapy alone, those receiving exposure therapy plus the complementary intervention will have better treatment outcomes at post-treatment and follow-up, as evidenced by lower PTSD symptoms, less substance use, and greater retention in treatment.

2. Keywords

Post-Traumatic Stress Disorder (PTSD), Substance Abuse, Substance Dependence, Virtual Reality, Phones, Exposure, Extinction

3. Overall Project Summary

Tasks Outlined in the Statement of Work

Unfortunately due to the delay in study start up including all necessary regulatory approvals, we had requested a No Cost Extension (NCE) for an additional fifth year for the study, extending the study end date from 10/28/12 to 10/28/13. The final, fifth year of the project continued to be dedicated to recruitment and completion of treatment for all participants. Analyses of primary hypotheses have been finalized in the NCE period.

Participant Recruitment

Participant recruitment began in February, 2010. Recruitment methods included posting flyers at the Durham VAMC and at selected treatment and community centers in the Durham area, advertisements on the DUMC website and local free newspaper, and direct referrals from VA clinicians. Over 37 months, we completed 402 screening phone calls, yielding 184 individuals eligible to be scheduled for a diagnostic assessment. Recruitment ended on 3/15/13.

The primary reasons for ineligibility at the phone screen are shown in Table 1.

Table 1.

Reason participants did not qualify at phone screen	*Frequency*
Not Interested	53
No substance or alcohol use	32
Conflict with current treatment	30
Manic	23

Psychotic	16
Homeless	15
No military trauma	12
Not a veteran	9
Need court mandated treatment	7
Too old	4

Diagnostic Evaluations and In-Person Study Eligibility Assessment
We conducted diagnostic interviews as part of the comprehensive in-person eligibility assessment with 125 participants, 54 met study inclusion criteria, and 53 were randomized. The reasons for exclusion at the diagnostic assessment are described below in Table 2.

Table 2.

Reason participants did not qualify	*Frequency*
Unreachable after phone screen	59
Did not meet criteria for current PTSD	31
Did not meet criteria for substance dependence	15
History of psychosis	11
Attempted suicide within the last 6 months	3
Primary trauma was not military related	3
Did not want to discontinue current treatment	2
Did not finish the assessment	2
Met criteria for current mania	1
Not a veteran	1
Other	1
Deceased before assessment happened	1

Although 54 individuals qualified for the study, 14 did not return to the clinic to begin treatment. Six of the 14 individuals were not ready for treatment and the other 8 were lost to contact after assessment (unreachable via phone or letters). Of the remaining 40 enrolled individuals who returned to begin treatment, 2 subjects were deemed inappropriate by the clinical team (including the PI, study therapists, and clinical supervisor) to begin PE. Subject # 9199 was randomized to PE only however, never started PE because both the study therapist and team felt he was too severe for treatment because of other mental health issues. Subject # 9239 was randomized to the VR+PE condition however never started the treatment intervention because he had too severe of a substance use problem. Accordingly, the intent to treat (ITT) sample included 38 participants who initiated at least one sessions of PE.

Symptom Severity Evaluations
Symptom severity measures have been completed along with the diagnostic evaluations, described above.

Urine Testing
We conducted urine sampling with enrolled study participants. Urine testing was conducted whenever possible 3 times a week, as stated in the study protocol.

Treatment
Treatment for enrolled study participants was carried out by trained study therapists. New study therapists were also trained to join the treatment team as needed. All therapists participated in weekly supervision

led by Dr. Eric Crawford, a national trainer in Prolonged Exposure for PTSD in military populations. Therapist adherence to the treatment model was evaluated by a coder who was trained to reliability by Dr. Crawford.

Data Management, Statistical Analyses, and Statistical Consultation

Data collection started in the second year of the project and continued through the final NCE year of the project. Screening data, diagnostic and symptom severity data, urine data, and weekly therapy-related assessments have all been collected for individuals who have had contact with the project. All data is entered into statistical software within a few days of being collected. No participant names are connected to unique ID numbers across all documentation, save for a single password protected electronic file used to maintain contact information, as described in the protocol. Statistical consultation has been between the biostatistician, Dr. Strong, and Dr. Rosenthal, to facilitate effective and accurate data collection.

We have examined results regarding recruitment, retention, feasibility, acceptability, and outcome for the project. Out of the 38 ITT participants, 18 completed the treatment portion of the study (9 VR+PE and 9 PE only). Of those assigned to the VR+PE condition, 10 of 19 participants (53%) dropped out of treatment. Similarly, 10 of the 19 (53%) of participants in the PE alone condition dropped out, suggesting that the addition of VR to standard PE does not alter the treatment retention typically seen in PE. Reasons for dropout by condition are presented below in Table 3. Out of the 20 who dropped out of treatment in the study, 3 participants withdrew from the study and did not return for follow-up visits. The reasons for dropping the study are included in Table 3.

Twenty-nine of the 38 ITT participants completed their post treatment (f/u #1) visit. Twenty-four of the 38 ITT participants completed their 6 month follow-up (f/u #2) visit.

Table 3.

ID#	Condition	# Sessions	Reason for dropout
9005	PE	2.00	Lost contact
9030	PE	4.00	Dropped study because he thought the study was making the drinking worse
9043	PE	2.00	Chose to receive other tx
9093	PE	6.00	Time/Travel
9103	PE	4.00	Personal life problems
9110	PE	3.00	Time/Travel
9155	PE	4.00	Moved out of the country
9209	PE	3.00	Lost contact
9273	PE	2.00	Lost contact
9288	PE	1.00	Medical problems
9094	PE+VR	2.00	Dropped study; found study too difficult
9097	PE+VR	3.00	Participant couldn't get past the fear of talking about his past trauma and didn't want to experience PE at this time
9182	PE+VR	2.00	PI decision-participant was dropped because his current substance use was too severe for PE; dropped study and refused

			to return for his 6 month follow-up
9223	PE+VR	6.00	PI & Therapist decision-participant was not endorsing any trauma nor PTSD symptoms. Team and PI felt the study was not appropriate for participant
9254	PE+VR	3.00	No show after session 2
9264	PE+VR	2.00	No show after session 2 & no response to calls or letter
9265	PE+VR	1.00	Decided to discontinue treatment because of conflicts with work
9294	PE+VR	3.00	Dropped after session 1 due to health; No response & no contact after he got out of the hospital.
9306	PE+VR	2.00	PI Drop-Study team and parole officer all believed it was better for subject continue his current substance abuse treatment 3x week (which participant did not mention on screening day)
9360	PE+VR	1.00	No show after session 7; no response to letters/phone calls

Descriptive Analyses. Forty participants attended at least one treatment session (although as noted above two needed more intensive treatment and were referred out, never beginning PE or being included in final ITT sample). The mean age of the sample was 43.98 years (*SD* = 11.76). The sample was primarily formed of African American (67.5%) males (92.5%) who were married (32.5%), had at least some college education (50%), and made less than $50.000/year (78.9%). No one in our sample was of Hispanic descent. There were no significant differences between conditions in age ($t(38) = 1.43$, $p = .16$), gender ($\chi^2(1) = 3.24$, $p = .07$), racial background ($\chi^2(1) = 1.03$, $p = .31$), highest education achieved ($\chi^2(7) = 5.00$, $p = .66$), marital status ($\chi^2(4) = 8.48$, $p = .08$), and personal income ($\chi^2(7) = 4.61$, $p = .71$). Therefore, demographic variables were not used as covariates in any of the subsequent analyses. All participants included met criteria for PTSD and substance dependence. The majority of participants (72.5%) had additional comorbid diagnoses. With regards to primary substance dependence diagnosis, 7 of these participants (17.5%) met criteria for primary tobacco dependence (4 in PE and 3 in PE-VR), 19 (47.5%) met criteria for primary alcohol dependence (9 in PE, and 10 in PE-VR), 6 (15.0%) met criteria for primary cannabis dependence (3 in each condition), and 8 (20.0%) met criteria for primary cocaine dependence (4 in each condition). Detailed clinical descriptive are presented in Table 4.

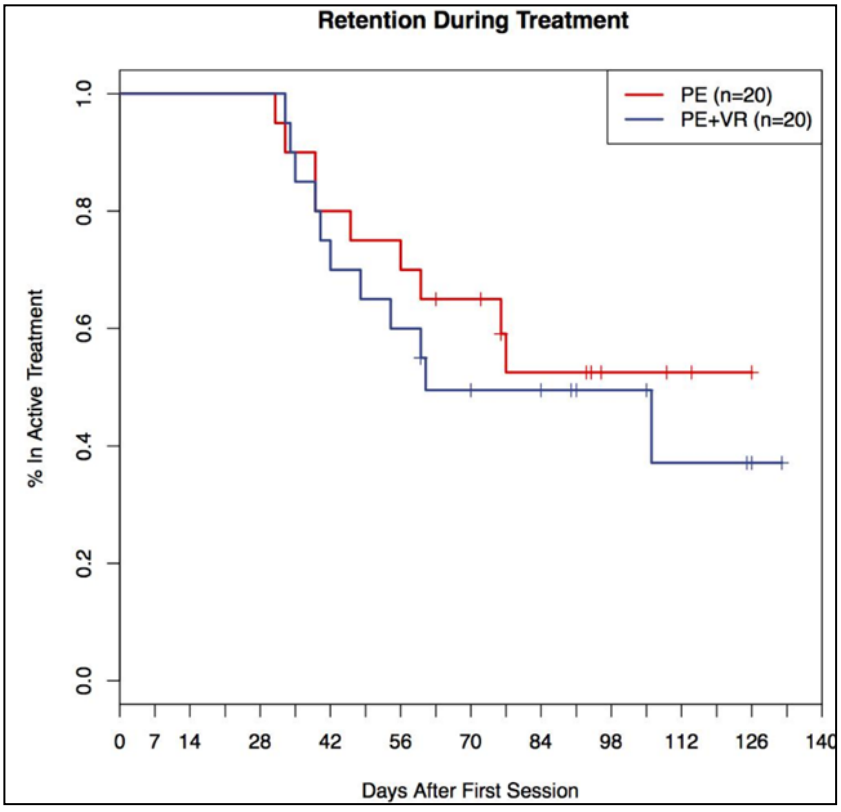
Table 4. *Clinical Descriptives by Condition*

	PE	PR-VR
Current Disorder		
Major Depressive Disorder	55%	60%
Dysthymia	5%	5%
Substance Induced MD[1]	10%	0%
Anxiety Disorders		
Panic Disorder	15%	15%
Agoraphobia	0%	0%
Social Phobia	5%	0%
Specific Phobia	0%	0%
OCD[2]	5%	15%
GAD[4]	15%	0%

Substance Abuse/Dependence		
Alcohol	45%	60%
Sedative	0%	0%
Cannabis	20%	10%
Stimulant	0%	0%
Opioid	0%	5%
Cocaine	5%	20%
Hallucinogen	0%	0%
Other	25%	25%
Body Dysmorphic	5%	0%
Eating Disorders	0%	0%
Lifetime Disorder		
Depression	75%	85%
Anxiety	100%	100%

Note.[1]Mood Disorder; [2]Obsessive Compulsive Disorder; [3]Post Traumatic Stress Disorder; [4]Generalized Anxiety Disorder;

Hypothesis 1 (Acceptability and feasibility).



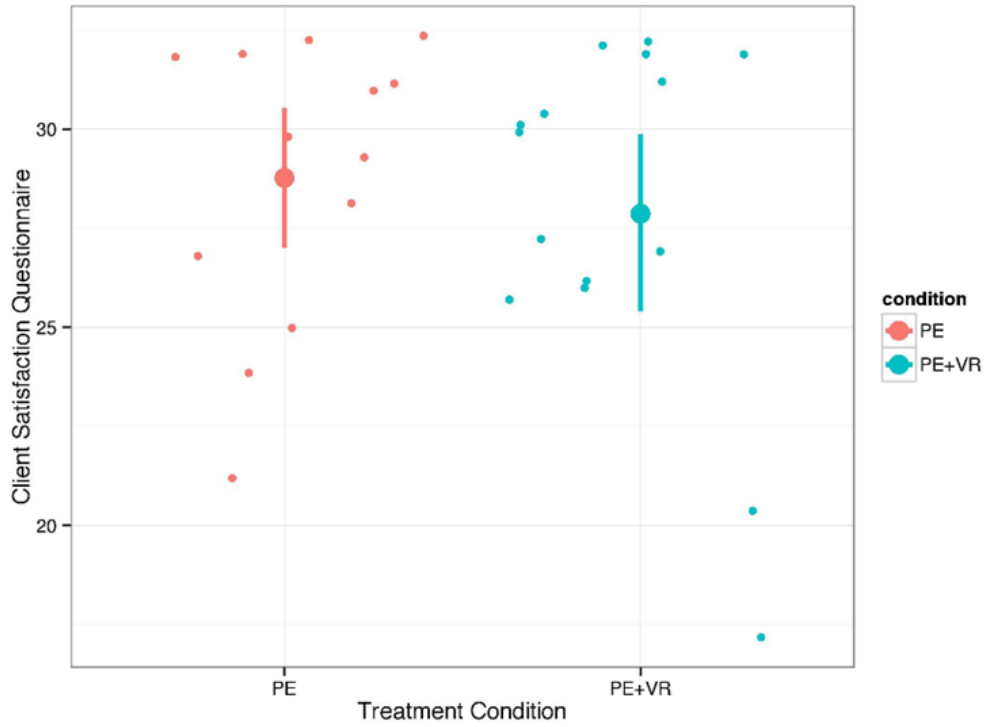
In order to assess whether the novel intervention was acceptable and feasible to implement in this population, we examined between condition differences in rates of session attendance, rates of retention in treatment and in the study, exit interview ratings of the helpfulness of the treatment, and results from the client satisfaction questionnaire. One participant in each condition did not receive PE as part of the study due to the severity of their symptoms and need for a higher level of treatment than could be provided by the study. Therefore, these two participants were excluded from further analyses.

Examining the 38 ITT participants, there was no significant difference between conditions in the number of sessions attended in the PE alone condition (M = 6.05, SD = 3.35; IQR 25% = 3; IQR 75% = 9) or in the PE+VR condition (M = 5.65, SD = 4.00; IQR 25% = 2; IQR 75% = 10), $t(1) = 0.34$, p=.74. There was no significant difference between conditions in numbers of treatment drops (N_{PE} = 10; N_{PE+VR} = 11; χ^2 (1) = 0.10, $p < .99$) and number of study withdrawals (N_{PE} = 1; N_{PE+VR} = 2; χ^2 (1) = 0.36, $p < .99$). A survival analysis (Figure 1) also showed no significant difference between conditions in likelihood to drop out of treatment during the study (Hazard Ratio = 1.31, 95% CI = 0.54 – 3.16, $p < .55$). All participants were equally likely to drop out of treatment, irrespective of condition. Ten participants in PE and 12 in PE-VR provided exit interview data. Analyses indicated that there was no difference between conditions in ratings of how helpful the treatment program in general was (t(19.94)

= 0.34, p = .74), how helpful the individual therapy was (t(19.93) = 0.44, p = .44), how satisfied one was with study assessments (t(6.91) = -1.07, p = .32), and whether the participant believed condition assignment mattered (t(16.59) = -1.73, p = .10). On a 0 to 100 scale, participants rated the treatment program in general as being highly helpful (M = 86.05; SD = 18.25), the individual therapy as highly helpful (M = 89.64; SD = 17.90), and high overall satisfaction with the study assessments (M = 92.64; SD =11.88). Specific condition assignment was rated as having limited importance (M =26.96; SD =38.78).

Thirteen people in PE and 15 in PE-VR completed the Client Satisfaction Questionnaire (CSQ; Larson et al., 1979) at the end of treatment. There was no significant difference between conditions in reported total satisfaction with treatment (t (25.84) = 0.59, p = .56). Overall, participants reported that both interventions were satisfactory. (See Figure 2 for means and standard deviations on these variables for the client satisfaction questionnaire between conditions.)

Figure 2.

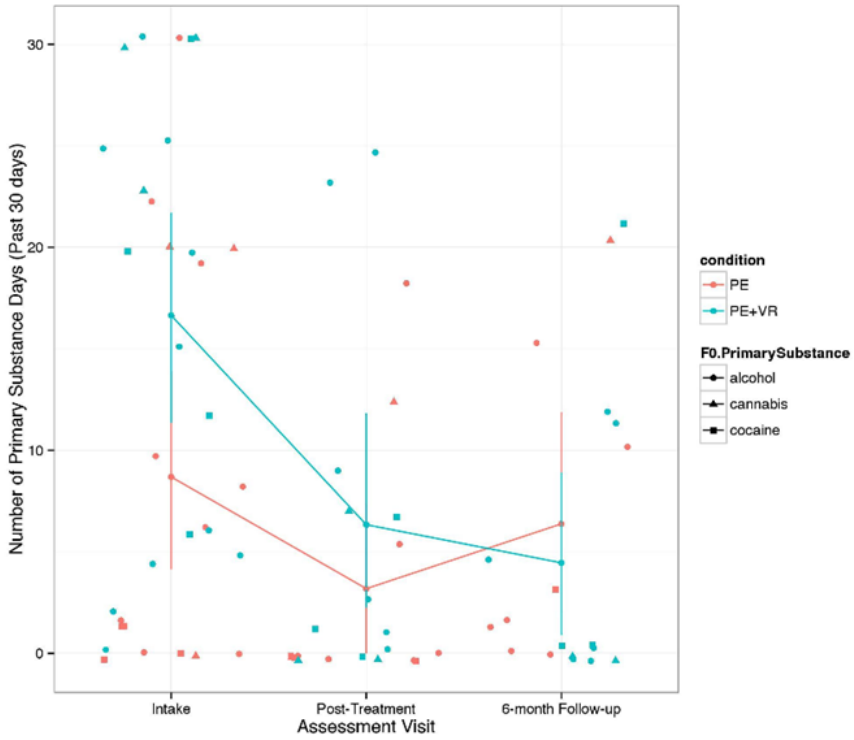


Hypothesis 2 (Changes in Substance Use).
We hypothesized that participants who received the PE-VR intervention would demonstrate significantly reductions in substance use and cravings throughout the study and at follow up when compared to participants in the PE intervention. We therefore conducted analyses assessing between-condition longitudinal differences in number of days during which the primary substance was used (excluding participants dependent on tobacco) using the Addiction Severity Index (ASI; McLellan et al., 1980). We also assessed end of treatment and follow up differences in urinalyses results, and changes in daily craving as reported on the phone. In all of these analyses the last observation carry forward (LOCF) method was used to account for missing data. Since primary smokers were excluded from these analyses we also examined over time changes in the level of nicotine dependence as measured by the Fagerstrom self-report (FTND; Heatherton et al.,1991).

Because there were significant pretreatment differences between conditions in addiction severity, longitudinal growth models excluded pretreatment from the analysis and used these values as covariates. Therefore, condition and time effects presented in this report reflect only the post treatment and follow up data. To assess pre-post changes in substance use severity we also conducted a pre-post paired samples *t*-test combining data across conditions.

Two linear mixed effects negative binomial models were conducted to assess between condition differences over time in addiction severity for the most problematic substance (excluding tobacco). Both models used the baseline assessment of severity as a covariate and modeled a random intercept. One model included the main effects only (condition and time); the second model also included the condition by time interaction effect. Figure 3 shows averages at each time point by condition of the outcome measure included in these analyses. Data from 31 participants was included in this analysis. The first model showed no main effect of baseline (*estimated effect*= .04; *S.E.* = .03; p = .12), no main effect of time (*estimated effect*= -.08; *S.E.* = .26; p = .76), and no main effect of condition (*estimated effect*= -.14; *S.E.* = .59; p = .81). The second model showed a non-significant trend for a significant time by condition interaction (*estimated effect*= -.86; *S.E.* = .51; p = .10). Pre-post *t*-test on this measure showed a significant difference from pre (M_{PRE} = 12.59; SD_{PRE} = 11.40) to post (M_{POST} = 5.41; SD_{PRE} = 7.74) treatment across all participants, $t(21)$ = 2.48; p = .02. Taken together, these results suggest that all participants significantly improved in their substance use by the end of the study for the primary substance problem. All participants maintained these gains at follow up. There was no significant difference between conditions, although there was a trend for PE-VR participants to continue to improve at follow up while PE-only participants tended to worsen from post treatment to follow up.

Figure 3.



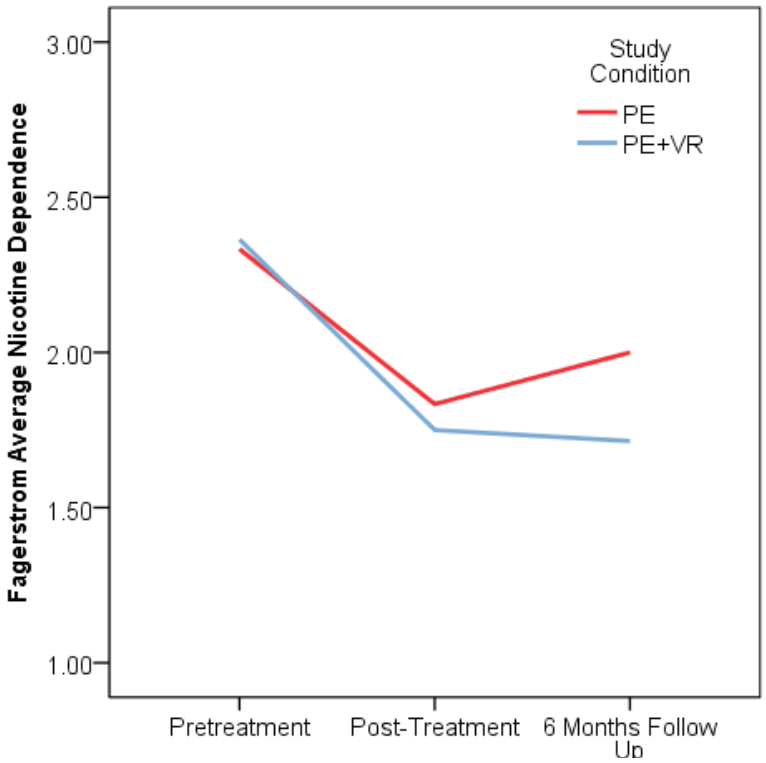
To assess naturalistic changes in craving as a function of time and of extinction reminder availability we also examined the data collected with the cellular phones. All participants in the study received a phone and were called three times daily to assess craving and to offer the option to listen to the extinction reminder if the craving was above a predetermined cut off and were part of the PE-VR condition.

Participants who were part of the PE condition received a prerecorded message if their craving was high, but did not have access to the extinction reminder. Overall 10 participants in each condition provided data that could be used in this analysis. Craving for the most problematic substance was rated on a 0 (not at all) to 9 (very high) scale. In the PE-VR condition there was a decrease in cravings in 20.2% of the calls compared to a 4.9% of calls in PE-only where a decrease in cravings was observed. Mean changes in craving ratings were -0.33 (SD = 1.22) in the PE-VR condition and 0.06 (SD = 0.80) in the PE only condition. A linear mixed effects model using number of days since the participants received the phone as a covariate and level of craving as outcome showed a significant main effect of condition (*estimated effect*= 3.27; *S.E.* = .79; $p < .001$), a trend for a significant main effect of the covariate (*estimated effect*= 0.04; *S.E.* = .02; $p = .05$) and a trend for a significant time by condition interaction (*estimated effect*= -.37; *S.E.* = .19; $p = .05$). There was no significant main effect of time (*estimated effect*= 0.05; *S.E.* = .14; $p = .75$). In this analysis, time is represented by the pre and post assessment of craving during the same call. This suggests that the mean change in craving from the beginning to the end of the call was .37 points lower for participants who had access to the extinction reminder when compared to participants who did not, and there was a trend for this difference to be significant. In addition, participants in the PE-VR condition overall reported higher cravings over the phone ($M_{pre} = 3.19$; $SD_{pre} = 2.85$; $M_{post} = 2.83$; $SD_{post} = 2.69$) than participants in the PE condition alone ($M_{pre} = 2.05$; $SD_{pre} = 2.94$; $M_{post} = 2.10$; $SD_{post} = 3.01$). This analysis modeled random effects for intercepts and slopes. Additional random effects for nested assessments within days was initially included but was not significant; therefore it was not included in the final model.

In addition, we conducted two chi square analyses to compare the condition differences in the percent of positive biochemical assessments of drug use at the end of treatment and at the six-month follow up. To account for missing data, we counted missing UAs as positive. At the end of treatment, 6 participants in each condition gave UA data. At the follow up assessment, 3 participants in PE and 4 in PE-VR gave UA data. There was no significant difference between conditions in percentage of negative UAs at end of treatment ($\%NEGATIVE_{PE} = 26.3$; $\%NEGATIVE_{PE\text{-}VR} = 36.8$; $\chi^2(1) = 1.02$; $p = .31$) , and at follow up ($\%NEGATIVE_{PE} = 47.4$; $\%NEGATIVE_{PE\text{-}VR} = 37.0$; $\chi^2(1) = 0.0$; $p = 1.0$).

We also conducted a hierarchical linear model analysis to assess between condition differences in the self reported level of nicotine dependence across all participants (Figure 4). There was no significant main effect of time (*estimated effect*= -0.46; *S.E.* = .33; $p = .18$), or condition (*estimated effect*= -0.14; *S.E.* = .47; $p = .78$) and no time by condition interaction (*estimated effect*= -0.08; *S.E.* = .52; $p = .88$). These results suggest that when assessing all the participants in the study there was no significant change in level of tobacco dependence over time. Nevertheless, when examining only those for whom tobacco use was the most problematic substance we found that level of dependence based on the FTND was much higher in PE-VR (M = 3.00; SD = 1.73) than in PE alone (M = 1.67; SD = 1.15), although given the small sample size (N = 6) this difference was not significant ($t(4) = -1.11$, $p = .33$). At post treatment, the level of dependence in PE-VR (M = 1.67; SD = 1.15) and in PE-only (M = 1.50; SD = 0.71) was equivalent, $t(3) = -.18$, $p = .87$. At follow up, because of missing data, the difference could not be computed. The between condition difference in the change in the level of dependence from pre to post treatment corresponds to a moderate effect size ($d = .80$).

Figure 4.



Hypothesis 3 (Changes in Post Traumatic Stress Disorder Symptoms Severity).

We also hypothesized that compared to participants who received PE alone, those who received PE-VR would report lower PTSD symptom severity by the end of treatment and at follow up. Therefore, we assessed between condition longitudinal differences in the Davidson Trauma Scale (DTS; Davidson et al., 1997; self-report measure) and in the Clinician Administered PTSD Scale (CAPS; Blake et al., 1995; an interview). We used the DTS total score and the CAPS past month severity of symptoms as outcome measures. Two linear mixed-effect model analyses were conducted for each outcome. All models included the pretreatment score as a covariate and time in the study and condition as main effect. The second model for each outcome added to the main effects a time by condition interaction effect. Last observation available was carried forward to account for missing data.

Because the longitudinal growth models excluded pretreatment from the analysis and used these values as covariates, the condition and time effects presented in this report reflect only the post treatment and follow up data. To assess pre-post changes in PTSD severity we also conducted a pre-post paired samples *t*-test combining data across conditions.

Figure 5 presents a visual display of the DTS self report data. There was a non-significant trend for a main effect of time (*estimated effect*= 0.51; *S.E.* = 0.28; $p = .08$), but no significant main effect of condition (*estimated effect*= 1.44; *S.E.* = 11.00; $p = .16$), or condition by time interaction for the DTS

score (*estimated effect*= 0.68; *S.E.* = .55; p = .23). Pretreatment values significantly affected outcome scores for this measure (*estimated effect*= 0.08; *S.E.* = 0.02; p < .001). Pre-post paired samples *t*-test indicated that there was a significant decrease in DTS overall score from before (M = 69.64; SD = 26.58) to after (M = 51.36, SD = 40.31) treatment, $t(24) = 2.76$, p = .01. Taken together, these findings suggest that across conditions all participants improved in PTSD severity over time in treatment. There was a trend for some of these improvements to be lost at follow-up, although from pre treatment to the 6 months follow up participants still improved ($M_{Follow\ Up}$ = 57.45, $SD_{Follow\ Up}$ = 42.96). There was no difference between conditions in PTSD symptom severity improvement.

Figure 6 presents a visual display of the CAPS data. There was a main effect of baseline assessment (*estimated effect*= 1.25; *S.E.* = 0.31; p < .001), but no significant main effect of time (*estimated effect*= -2.47; *S.E.* = 2.97; p = .42), condition (*estimated effect*= 1.06; *S.E.* = 8.93; p = .91), or time by condition interaction (*estimated effect*= -2.37; *S.E.* = 6.14; p = .70). Pre-post paired samples *t*-test indicated that there was a significant decrease in CAPS past month symptom severity score from before (M = 73.02; SD = 16.46) to after (M = 48.00, SD = 30.98) treatment, $t(27) = 6.25$, p< .001. Taken together these findings suggest that across conditions participants improved in PTSD severity over time in treatment and maintain these gains at follow up. However, there was no difference between conditions in PTSD severity improvements over time.

Figure 5.

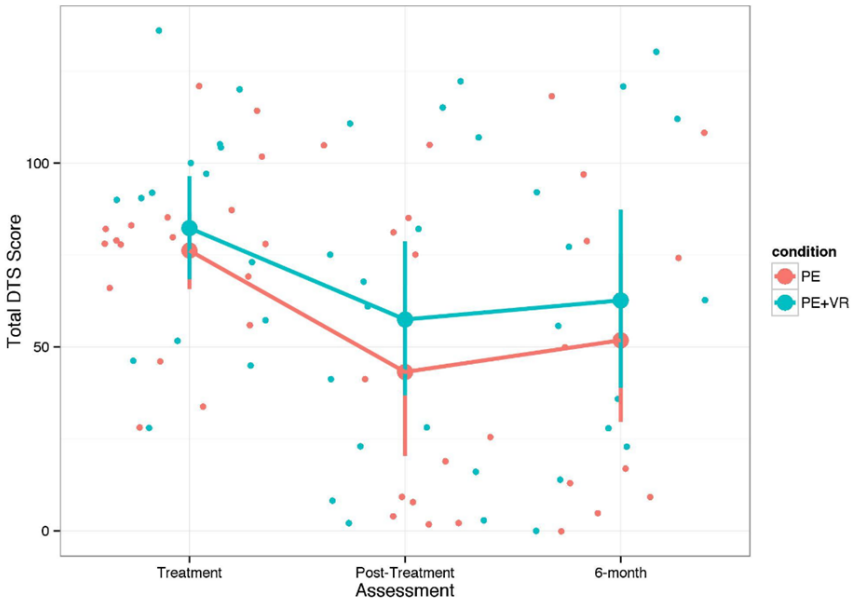
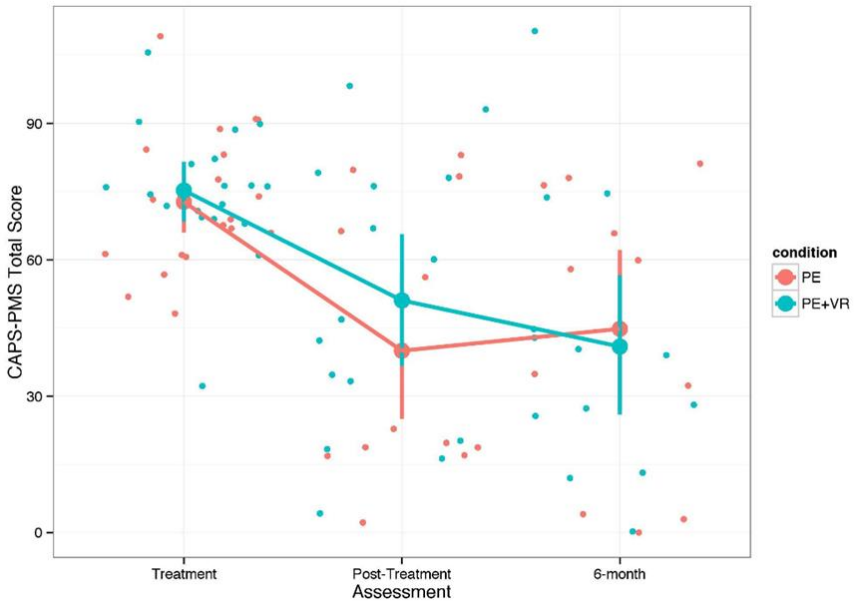


Figure 6.



4. Key Research Accomplishments

- One of the first treatment studies to use PE for PTSD *and* co-occurring addiction
- First behavioral therapy conducted using VR to reduce substance use in Veterans
- First time exposure has been paired with the use of portable extinction reminders in adults with PTSD and co-occurring addiction
- Demonstration of feasibility, acceptability, and preliminary efficacy of the novel intervention provides key pilot data needed to more rigorously evaluate the adjunctive intervention

5. ***Conclusions***

The results from this pilot study suggest that when used adjunctively with PE, the novel intervention using VR and extinction reminders is feasible to implement and acceptable to participants. There were no serious adverse events related to the interventions in either of the two treatment conditions. Rates of retention were equivalent between the two conditions, suggesting that the novel intervention is not associated with differential attrition when conducted as part of PE. Because PTSD and addiction are highly co-morbid and there are few interventions explicitly designed to address this co-morbid presentation, new interventions are needed that are capable of being implemented in this sample without resulting in increased attrition beyond what would be expected from existing treatments. Additional

evidence suggesting that the novel intervention is feasible and acceptable was observed in the self-reported ratings of satisfaction with treatment. Data from both the exit interview and the Client Satisfaction Questionnaire indicated that there were no significant differences between groups in ratings of satisfaction with treatment, and that across conditions participants rated treatment as being highly helpful and satisfying.

In addition to being feasible and acceptable, the results from this study suggest that the novel intervention is promising as a complementary approach when used with PE to reduce PTSD symptoms and substance use. Across participants, both treatment conditions were associated with a significant reduction in PTSD symptoms and substance use. There were no significant differences between the groups in changes in PTSD or substance use over time. However, this preliminary study was not powered to detect statistically significant group by time interaction effects examining PTSD and substance use changes.

In sum, the data examining primary hypotheses indicates that this novel intervention is feasible, acceptable, and holds promise when used adjunctively with PE in Veterans with PTSD and substance dependence. The results from this study warrant more rigorous investigation of the adjunctive intervention in a larger trial powered by the effect size estimates generated from this pilot trial.

6. Publications, Abstracts, and Presentations

No manuscripts have been submitted yet based on data from this trial. We anticipate the submission of a manuscript detailing the novel intervention, study design, and results from primary hypotheses in Spring 2014. The only presentations of this research have been done at TATRC product line reviews throughout the course of the project period.

7. Inventions, Patents and Licenses

Nothing to report

8. Reportable Outcomes

We believe that the primary results indicating support for the feasibility, acceptability, and preliminary efficacy of the adjunctive intervention using VR and cellular phones to help treat PTSD with co-occurring addiction will help advance the field.

9. Other Achievements

Based in part on work supported by this award, the PI has received funding from NIDA and NIMH to conduct related research evaluating the efficacy of reminders of learning using cellular phones.

10. *References*

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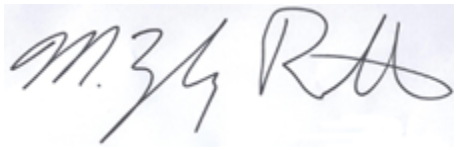

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