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Beyond symptom self-report: Use of a computer “avatar” to assess post-traumatic stress disorder (PTSD) symptoms

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Abstract

Post-traumatic stress disorder (PTSD) can occur in the wake of exposure to a traumatic event. Currently, PTSD symptoms are assessed mainly through self-report in the form of questionnaire or clinical interview. Self-report has inherent limitations, particularly in psychiatric populations who may have limited awareness of deficit, reduced attention span, or poor vocabulary and/or literacy skills. Diagnosis and evaluation of treatment efficacy would be aided by behavioral measures. A viable alternative may be virtual environments, in which the participant guides an on-screen “avatar” through a series of onscreen events meant to simulate real-world situations. Here, a sample of 82 veterans, self-assessed for PTSD symptoms was administered such a task, in which the avatar was confronted with situations that might evoke avoidant behavior, a core feature of PTSD. Results showed a strong correlation between PTSD symptom burden and task performance; in fact, the ability to predict PTSD symptom burden based on simple demographic variables (age, sex, combat exposure) was significantly improved by adding task score as a predictor variable. The results therefore suggest that virtual environments may provide a new way to assess PTSD symptoms, while avoiding at least some of the limitations associated with symptom self-report, and thus might be a useful complement to questionnaire or clinical interview, potentially facilitating both diagnosis and evaluation of treatment efficacy.

Keywords

Post-traumatic stress disorder (PTSD); avoidance; behavioral inhibition; assessment tools; diagnosis; anxiety; virtual reality

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Declaration of Interest

The authors affirm that they have no relationships that could constitute potential conflict of interest.

Introduction

Following exposure to a traumatic event, some individuals develop post-traumatic stress disorder (PTSD); symptoms include re-experiencing or intrusive recollection, cognitive and behavioral avoidance, emotional numbing, and physiological arousal. Lifetime prevalence of PTSD has been estimated at around 7–8% in the general population (Kessler et al., 1995), but rates may be considerably higher among some populations such as veterans (Dohrenwend et al., 2006). In addition, many trauma victims who do not meet full symptom criteria for PTSD diagnosis present with subclinical PTSD symptoms, which may cause significant distress and functional impairment (Mylle & Maes, 2004; Yarvis & Schiess, 2008).

As with many psychiatric disorders, the ability to diagnose PTSD – and assess effectiveness of therapy – is hindered by the absence of objective markers. Currently, symptoms are assessed mainly by self-report, via questionnaire or clinical interview. Of course, self-report is vulnerable to demand characteristics; some patients may over-report symptoms to obtain benefits such as disability compensation or to conform to an accepted sick role, while others may under-report symptoms in order to avoid social stigma associated with mental disorders. Another concern is that psychiatric populations may not have particularly good insight into their own behavior, or accurate understanding of implicit social norms against which to compare that behavior. For example, individuals with PTSD may be impaired at accurate self-report, due to a tendency to overgeneralize autobiographical memories (e.g., Moradi et al., 2012; Ono, Devilly & Shum, 2016).

For all these reasons, it would be valuable to supplement self-report with objective behavioral measures, such as observing how the participant behaves in real-world social and non-social situations. An approximation to this ideal may be interactive virtual environments, which allow the user to experience simulated situations via an “avatar,” a graphical representation of the user whose behavior the user controls (Blascovich et al., 2002). Such environments are common in online computer gaming, and are increasingly used in social networking (Bente et al., 2008) and educational platforms (e.g., Foster, 2008; Danforth et al., 2009). An emerging body of literature suggests that users tend to create and deploy avatars that are reasonably accurate representations of their real or perceived self (e.g., Ducheneaut et al., 2009; Sung et al., 2011).

Recently, we developed a computer-based platform in which the user guides an on-screen avatar through a series of scenarios representing novel social situations with defined choice points that might invoke avoidant behavior (Myers et al., 2016). In a sample of healthy young adults, task performance was strongly correlated with temperamental tendency for avoidant behavior, assessed via the Adult Measure of Behavioural Inhibition (AMBI; Gladstone & Parker, 2005), a scale which correlates with anxiety proneness (Gladstone & Parker, 2005) and with PTSD symptom severity in veterans (Myers, VanMeenen & Servatius, 2012).

In the current study, we considered whether avoidant behavior on the avatar task can likewise predict PTSD symptom severity in a group of veterans.

Methods

Participants

Eighty-four veterans were recruited at VA NJHCS via flyers and word-of-mouth referral. Of this sample, one participant was enrolled but failed to complete the testing session due to fatigue; a second participant completed testing but was later determined to lack veteran status. Data from these two participants were excluded from analysis. The remaining sample included 68 males and 14 females, with mean age 54.1 years (SD 11.1) and mean education 14.9 years (SD 2.3). Fifty participants self-identified race as Black/African-American, 14 as White/Caucasian, and 18 as Mixed Race/Other; 5 participants self-identified ethnicity as Hispanic and one reported “not sure” about ethnicity. Veterans were not excluded based upon medical or psychiatric history.

Asked about conflicts in which they had served, 31 veterans reported service in Vietnam, 13 in Gulf War/Operation Desert Storm, 12 in Operation Enduring Freedom/Operation Iraqi Freedom, 8 in another conflict (e.g. Beirut, Somalia, Bosnia), and 27 in peacetime or no specific conflict. (Numbers sum to greater than 82 due to some veterans with service spanning multiple conflicts.)

Level of exposure to combat was quantified using the Combat Exposure Scale or CES (Keane, Fairbank & Caddell, 1989). Unsurprisingly, mean CES scores were higher in male than female veterans (Males: $M=8.8$, $SD=9.8$; Females: $M=3.1$, $SD=6.9$; Mann-Whitney $U=306$, $p=.031$, $r^2=.057$). Following prior studies (e.g., Ginsberg et al., 2008), veterans with a CES score of 0–7 were classified as non-combat, while those with a score of 8+ were classified as having a history of exposure to combat. Based on this metric, 28 males and 2 females met criterion for history of exposure to combat.

Participants received \$20/hour compensation for their participation in a single two-hour session. Written informed consent was obtained from all participants before initiation of any testing. Experimental procedures were approved by the Institutional Review Board at VA NJHCS and were conducted in accordance with the Declaration of Helsinki and guidelines established by the U. S. Federal Government for protection of human subjects.

Questionnaires

All participants completed the PTSD Checklist (PCL; Blanchard et al., 1996), a self-report questionnaire that queries presence and frequency of PTSD symptoms in response to stressful experiences. Several versions of the PCL are available, including a military version (PCL-M), which specifically asks about stressful events related to military service; however, given that our veteran participants had often completed their military service decades earlier, we wanted to be sure to capture traumatic events that might have happened after (or before) the period of military service, and that might be contributing to current PTSD symptoms. Thus, in this study, we used the civilian version (PCL-C) which is identical to the PCL-M except that it does not specify that the traumatic event necessarily be related to military service.

Specific PCL questions correspond to *DSM-IV* symptom clusters including cluster B (re-experiencing the traumatic event), cluster C (avoidance/numbing, now considered separate clusters in *DSM-5*), and cluster D (hyperarousal). In addition to generating scores indicative of total PTSD symptom burden, PCL scores can be used to predict clinical status.

Specifically, PCL scores of 50+ predict PTSD in military samples (Blanchard et al., 1996; Weathers et al., 1993). Accordingly, we also categorized participants according to presence or absence of current, severe PTSD symptoms (PTSS) based on this cutoff.

Participants also completed the AMBI (Gladstone & Parker, 2005), a sixteen-item questionnaire to assess temperamental tendency for avoidance behavior.

Most participants also completed one or more additional unrelated tasks as permitted within the time constraints of the two-hour session; those additional results are not reported here.

Computer-Based Task

The computer-based task was as previously described (Myers et al., 2016); an open-access version of the task software is available at Open Science Framework www.osf.io/zf3jv. The task took about 10 minutes for participants to complete.

First, participants saw a screen with a selection of male and female avatars (Figure 1A), and were asked to choose one to represent them in the task.

The task itself consisted of two scenarios, which described attending a party full of strangers and volunteering to help on a charity building project. The script included 20 choice points; each choice point presented a short text description and an image showing the avatar experiencing this event, and the participant was presented with three response options. The options included relatively avoidant, relatively non-avoidant, and neutral actions (Figure 1B, C). The script was designed so that the same sequence of events and response options appeared for all participants, regardless of their responses, although this lack of contingency should not have been obvious to the participant. Notably, the task does not query anything specifically related to trauma or PTSD symptoms.

At each choice point, the participant received 2 points for selecting the avoidant option, 1 for the intermediate option, and 0 for the non-avoidant option. Total scores could range from 0 (least avoidant) to 40 (most avoidant). The total set of 20 scored questions showed good inter-item reliability in this sample (Cronbach's $\alpha=.798$).

Following completion of the computer-based task, participants were given a short post-test questionnaire (Myers et al., 2016) which asked them to rate, on a four-point scale (none, a little, moderate, high), their familiarity with computers, whether they ever played computer games (yes/no), and if so what type. Participants were also asked to rate how much they cared about what happened to the avatar in the game (not at all, a little bit, somewhat, a lot), and whether they made decisions in the game that were similar to the way they normally act in real life (not at all, a little bit, mostly, exactly like me). Participants were also asked whether they had been able to find an avatar which they liked to represent them.

Data Analysis

The primary analysis was bivariate correlation (Pearson's r) to determine whether task scores are related to PTSD symptom burden assessed as PCL scores. For comparison against prior studies, correlation was also assessed between AMBI and task scores, and between PCL and AMBI.

We also planned several secondary analyses. First, in addition to total symptom burden, PCL responses can also be used to predict PTSD status in terms of whether the participant has severe PTSD symptoms (PTSS) consistent with the clinical disorder. Univariate ANOVA was used to determine whether task scores differ as a function of PTSS (alone or interacting with sex or combat history).

Next, we determined whether the ability of available demographic variables (age, sex, education, combat exposure) to predict PTSD symptom burden (PCL total score) could be significantly improved by addition of task score as a predictor variable (hierarchical multiple regression, assessing R^2 -of-the-change following addition of a new predictor).

Finally, since this is the first report considering this task in a veteran population, where computer experience might be lower than in other traditional study populations such as college students, we examined the data for any sign of a trend that task performance is affected by self-reported computer familiarity, experience with role-playing games, or attachment to the avatar, as reported on the post-task questionnaire. Multiple t-tests were used, with Bonferroni correction to protect against inflated risk of Type I error under multiple significance tests (corrected alpha is only reported for p-values at or approaching significance).

Analyses were conducted using SPSS statistical software. Normality was assessed via Kolmogorov-Smirnov test and assumptions of equality of variance were assessed via Levene's test; where significant deviations were detected, appropriate tests or corrections were used (e.g. Mann-Whitney for non-normal data, Welch's t-test for unequal variance). For all tests, the threshold for significance was set at $\alpha=.05$ (two-tailed).

Sample size was determined based on *a priori* power analysis for our primary analysis. Although our prior article (Myers et al., 2016) found a strong correlation between task and AMBI scores ($r=.783$, $r^2=.613$), we did not have preliminary data regarding correlations with PCL scores. Accordingly, we based power calculations on the sample size needed to detect a medium effect size ($r=.3$, $r^2=.09$) at 80% power, if such an effect exists. Using G*Power 3.0.10's calculator for *a priori* power of one-sample correlation, required sample size was calculated to be $n=84$. Therefore, in order to adequately power our study, we recruited and tested $n=84$ participants, of whom 2 were later excluded from analysis as described above. Data collection was stopped once this target was reached.

Results

Summary of Questionnaire Results

In our sample of veterans, mean PCL score was 54.9 (SD 16.5, range 17–85); scores did not differ as a function of sex or combat status (2-way ANOVA, all $F < 1.7$, all $p > .200$). Based on PCL scores, 56 veterans were classed as PTSS (68.3% of sample), which included 44 of 68 males and 12 of 14 females.

Mean AMBI score was 20.1 (SD 5.6, range 6–32); scores were significantly higher in veterans with a history of exposure to combat (combat: $M = 21.2$, SD 6.3; non-combat $M = 19.5$, SD 5.0; 2-way ANOVA, $F(1,78) = 4.24$, $p = .043$, partial $\eta^2 = .052$) but there was no effect of sex ($F(1,78) = 1.72$, $p = .194$) and no sex-combat interaction ($F(1,78) = 2.20$, $p = .142$). As in prior studies (e.g. Myers, VanMeenen & Servatius, 2012), AMBI and PCL scores were strongly correlated ($r = .577$, $p < .001$, $r^2 = .333$).

Computer task

Mean score on the avatar task was 21.9 (SD 6.3, range 2–37). Task scores were strongly correlated with PCL scores ($r = .59$, $p < .001$, $r^2 = .35$), as shown in Figure 2A. As in our prior study, task scores were also strongly correlated with AMBI scores (Figure 2B; $r = 0.72$, $p < .001$, $r^2 = .52$). Figure 2 also shows one outlier who scored only 2 points on the avatar task; none of the above results are meaningfully changed if this outlier's data are excluded (all $p < .001$).

Considering participants classed with severe PTSD symptoms (PTSS) vs. few/no symptoms (noPTSS), as well as classification by sex and history of combat exposure, 3-way ANOVA on task scores again revealed a significant effect of PTSS status (Figure 3; $F(1,74) = 6.12$, $p = .016$, partial $\eta^2 = .076$), but no effects of combat status or sex and no interactions (all $F < 2.2$, all $p > .100$).

Considering the prediction of PCL scores based on available variables, multiple regression analysis with demographic variables entered at the first step (age, sex, education, CES scores) generated a model that was able to significantly predict PCL scores ($R = .362$, $R^2 = .131$, $p = .027$; betas: sex .260, age $-.106$, education $-.202$, CES .279). When avatar scores were added in as a predictor at the second step, the model prediction improved ($R = .658$, $R^2 = .432$, $p < .001$; betas: sex .204, age $-.123$, education $-.164$, CES .198, avatar .555). This was a significant improvement over the prior model (R^2 -change = .302, $F(1,76) = 40.38$, $p < .001$).

Post-task questionnaire

One participant failed to complete the post-test questionnaire. Among the remaining 81 participants, 24 rated themselves as having little or no experience with computers while 57 reported moderate or high familiarity. Task scores did not differ in these subgroups ($t(79) = 1.29$, $p = .200$).

While 35 participants reported regularly playing computer games, only 8 participants reported engaging in role-playing games (e.g. World of Warcraft, Call of Duty). Again, task

scores did not differ between gamers and non-gamers ($t(79)=1.26$, $p=.213$) or among gamers who played role-playing games vs. other types of games ($t(33)=1.72$, $p=.095$).

82.7% of participants reported that they had been able to find an avatar they liked. Asked whether they cared what happened to their avatar in the game, 67.9% reported caring “somewhat” or “a lot”; and all but two participants reported that their behaviors in the game were “mostly” or “exactly” how they would normally act in real life. In no case did any of these variables affect task score (comparing “somewhat” or “a lot” vs. “a little” or “not at all” responses, all $t<1$, all $p>.100$).

Discussion

This study showed that performance on a computer-based task, in which participants control an onscreen avatar as it navigates several scripted scenarios, correlates with self-reported PTSD symptoms in veterans, even though the task does not specifically query anything related to trauma or PTSD symptoms. In fact, a regression model including task score and simple demographic variables was able to account for over 43% of the variance in PTSD symptom scores. The study therefore suggests that virtual reality platforms may have utility in assessing or diagnosing PTSD symptoms, while avoiding or at least mitigating some of the limitations of subject self-report, particularly self-report questionnaire.

The study also replicated prior findings (Myers et al., 2016) that task performance predicts participants’ self-reported tendency to engage in avoidant behavior, assessed by AMBI. The prior study examined a sample that was younger, more educated, and highly computer literate. The consistency between that study and the current one suggests that the correlation between AMBI scores and task performance is robust to these variables. Perhaps more importantly, the study strongly suggests a relationship between avoidant behavior in everyday life situations – not necessarily related to trauma or fear – and PTSD symptoms, suggesting that avoidance in PTSD may reflect a more general cognitive bias to withdraw from or avoid novelty. This is consistent with our prior findings of a strong correlation between AMBI and PCL scores in veterans (Myers, VanMeenen & Servatius, 2012), which was also observed here.

Although the current population was diverse and included individuals who reported “little or no” experience with computers, as well as a majority who reported not regularly playing computer games, most found the game simple and engaging, as reflected by the large majorities who reported “liking” their avatar and/or caring “somewhat” or “a lot” what happened to that avatar. Thus, the task format seemed engaging for most subjects and, in some cases at least, appeared less burdensome to administer than the 1–2 page paper-and-pencil questionnaires assessing PTSD symptoms.

There are several limitations to the current study. First, PTSD symptomatology was based on self-report questionnaire, rather than interview-based diagnosis. Although the PCL questionnaire is highly predictive of clinician-rated PTSD in veterans (Lunney, Schnurr & Cook, 2014; Weathers et al., 1993), clinician-administered structured diagnostic interview nevertheless remains the “gold standard” for diagnosing PTSD. While some of our

participants did have clinically-diagnosed PTSD, absence of a formal diagnosis cannot necessarily be taken to imply absence of the disorder; conversely, presence of previously-diagnosed PTSD cannot necessarily be assumed to imply current symptom burden. This issue can only be satisfactorily addressed if participants are given clinical interview to confirm presence/absence of diagnosis at the time of behavioral testing. Future work could therefore administer structured interview, e.g. CAPS, to all participants as part of the testing session, to determine which have current PTSD and – equally important – which do not. It would also be informative to compare those with current clinically-diagnosed PTSD against those with other disorders involving avoidance, such as anxiety disorders and substance abuse disorders.

Another limitation of the current study is the high male/female ratio in our sample. While this sex distribution accurately reflects the veteran population under study, it does limit generalizability of conclusions about females. Indeed, females may have a different course and expression of PTSD symptoms than males (Iversen et al., 2008; Maes et al., 1998; Ranasinghe & Levy, 2007). PTSD may also be different in military vs. non-military populations, for whom deployment-related stressors appear even more strongly related to PTSD symptoms than combat exposure (Booth-Kewley et al., 2010). Thus, important future work will be to examine this task as it applies to civilian samples with greater inclusion of females.

The most important open question raised by the current results is whether the tendency to exhibit avoidant behavior on the task represents a marker for current PTSD symptoms, or reflects a relatively stable personality trait which might predate exposure to trauma and development of PTSD symptoms. Future longitudinal studies are therefore indicated to track whether avoidant behavior on the task waxes and wanes with PTSD symptoms, particularly in individuals undergoing therapy for PTSD. If so, then the task could potentially be used as a tool to help assess PTSD symptom burden as a more objective complement to symptom self-report via questionnaire or clinical interview, and track changes in behavior as a result of therapy. Since avoidant behavior is also a core symptom of all anxiety disorders, future studies could extend this work beyond PTSD to other psychiatric populations. Finally, more advanced platforms might be developed as therapeutic tools providing a “safe” virtual environment for patients to practice engaging in non-avoidant behavior, as a complement to traditional therapeutic approaches.

In conclusion, the current work presents a short, computer-based task in which participants guide an “avatar” through a set of highly-controlled, onscreen scenarios designed to evoke relatively avoidant or non-avoidant behaviors. To our knowledge, this is the first investigation using a computer avatar to assess avoidant behavior in participants with PTSD symptoms. Participants’ behavior on the task correlates strongly with self-reported PTSD symptom burden. As such, this computer task may be a useful complement to traditional interview and questionnaire assessment, particularly in populations where traditional symptom self-report may be problematic.

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References

- Bente G, Rüggenberg S, Krämer NC, Eschenburg F. Avatar-mediated networking: Increasing social presence and interpersonal trust in net-based collaborations. *Hum Commun Res.* 2008; 34(2):287–318.
- Blanchard EB, Jones-Alexander J, Buckley TC, Forneris CA. Psychometric properties of the PTSD checklist (PCL). *Behav Res Ther.* 1996; 34(8):669–673. [PubMed: 8870294]
- Blascovich J, Loomis J, Beall A, Swinth K, Hoyt C, Bailenson JN. Immersive virtual environment technology as a methodological tool for social psychology. *Psychol Inq.* 2002; 13:103–124.
- Booth-Kewley S, Larson GE, Highfill-McRoy RM, Garland CF, Gaskin TA. Correlates of posttraumatic stress disorder symptoms in Marines back from war. *J Traum Stress.* 2010; 23(1):69–77.
- Danforth D, Procter M, Heller R, Chen R, Johnson M. Development of virtual patient simulations for medical education. *J Virtual Worlds Res.* 2009; 2(2)
- Dohrenwend BP, Turner JB, Turse NA, Adams BG, Koenen KC, Marshall R. The psychological risks of Vietnam for U.S. veterans: A revisit with new data and methods. *Science.* 2006; 313(5789):979–982. [PubMed: 16917066]
- Ducheneaut, N.; Wen, M-H.; Yee, N.; Wadley, G. Proceedings of the SIGCHI Conference on Human Factors in Computer Systems (CHI 2009). Boston, MA: ACM; 2009. Body and mind: A study of avatar personalization in three virtual worlds; p. 1151-1160.
- Foster A. Using Second Life as a platform for education: Professor Avatar. *Education Digest.* 2008; 73:12–17.
- Ginsberg JP, Ayers E, Burriss L, Powell DA. Discriminative delay Pavlovian eyeblink conditioning in veterans with and without posttraumatic stress disorder. *J Anxiety Disord.* 2008; 22(5):809–823. [PubMed: 17913453]
- Gladstone GL, Parker G. Measuring a behaviorally inhibited temperament style: Development and initial validation of new self-report measure. *Psychiatry Res.* 2005; 135:133–143. [PubMed: 15922458]
- Iversen AC, Fear NT, Ehlers A, Hacker Hughes J, Hull L, Earnshaw M, Greenberg N, Rona R, Wessely S, Hotopf M. Risk factors for post-traumatic stress disorder among UK Armed Forces personnel. *Psychol Med.* 2008; 38(4):511–522. [PubMed: 18226287]
- Keane TM, Fairbank JA, Caddell JM. Clinical evaluation of a measure to assess combat exposure. *Psychol Assess.* 1989; 1:53–55.
- Kessler RC, Sonnega A, Bromet E, Hughes M, Nelson CB. Posttraumatic stress disorder in the National Comorbidity Survey. *Arch Gen Psychiatry.* 1995; 52:1048–1060. [PubMed: 7492257]
- Lunney CA, Schnurr PP, Cook JM. Comparison of clinician- and self-assessments of posttraumatic stress symptoms in older versus younger veterans. *J Traum Stress.* 2014; 27(2):144–151.
- Maes M, Delmeire L, Schotte C, Janca A, Creten T, Mylle J, Struyf A, Pison G, Rousseeuw PJ. Epidemiologic and phenomenological aspects of post-traumatic stress disorder: DSM-III-R diagnosis and diagnostic criteria not validated. *Psychiatry Res.* 1998; 81(2):179–193. [PubMed: 9858035]
- Moradi AR, Abdi A, Fathi-Ashtiani A, Dalgleish T, Jobson L. Overgeneral autobiographical memory recollection in Iranian combat veterans with posttraumatic stress disorder. *Behav Res Ther.* 2012; 50(6):435–441. [PubMed: 22542534]

- Myers CE, Kostek JA, Ekeh B, Sanchez R, Ebanks-Williams Y, Krusznis AL, Weinflash N, Servatius RJ. Watch what I do, not what I say I do: Computer-based "avatars" to assess behavioral inhibition, a vulnerability factor for anxiety disorders. *Comput Hum Behav.* 2016; 55:804–816.
- Myers CE, VanMeenen KM, Servatius RJ. Behavioral inhibition and PTSD symptoms in veterans. *Psychiatry Res.* 2012; 196:271–276. [PubMed: 22397911]
- Mylle J, Maes M. Partial posttraumatic stress disorder revisited. *J Affect Disord.* 2004; 78:37–48. [PubMed: 14672795]
- Ono M, Devilly GJ, Shum DH. A meta-analytic review of overgeneral memory: The role of trauma history, mood, and the presence of posttraumatic stress disorder. *Psychol Trauma.* 2016; 8(2):157–164. [PubMed: 25961867]
- Ranasinghe PD, Levy BR. Prevalence of and sex disparities in posttraumatic stress disorder in an internally displaced Sri Lankan population 6 months after the 2004 Tsunami. *Disaster Med Public Health Prep.* 2007; 1(1):34–41. [PubMed: 18388601]
- Sung Y, Moon JH, Kang M, Lin J-S. Actual self vs. avatar self: The effect of online social situation on self-expression. *J Virtual Worlds Res.* 2011; 4:No 1.
- Weathers, FW.; Litz, BT.; Herman, DS.; Huska, JA.; Keane, TM. The PTSD checklist (PCL): Reliability, validity, and diagnostic utility. San Antonio, TX: Annual Meeting of the International Society for Traumatic Stress Studies; 1993.
- Yarvis JS, Schiess L. Subthreshold posttraumatic stress disorder (PTSD) as a predictor of depression, alcohol use, and health problems in veterans. *J Workplace Behavioral Health.* 2008; 23:395–424.

Figure 1.

Example screenshots from the computer-based task (Myers et al., 2016). (A) Participants choose a character ("avatar") to represent them in the game; here, the male figure at upper right is selected. (B) In the first scenario, the avatar is invited to a party where s/he will not know any of the people present except his/her cousin; here, the avatar reaches the party before the cousin and can choose to enter the party alone or wait on the sidewalk until social support arrives. (C) The second scenario describes participation in a volunteer activity, where the participant has to interact with other volunteer workers. In both scenarios, at each choice point, response options include relatively avoidant, relatively non-avoidant, or intermediate behaviors.

Figure 2.

Total scores on the computer task were strongly correlated with both (A) PCL scores ($r = .59$) and (B) AMBI scores ($r = .72$).

Figure 3.

Task scores were also significantly higher in participants reporting severe PTSD symptoms (PTSS group, $n=56$) than in those reporting fewer or no PTSD symptoms (noPTSS group, $n=26$). Bars show group means; error bars show 95% CI for each mean. Asterisk indicates statistically significant difference ($p=.016$).