A computer-based avatar task designed to assess behavioral inhibition extends to behavioral avoidance but not cognitive avoidance

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ABSTRACT

Avoidance is a common feature of post-traumatic stress disorder (PTSD) as well as anxiety and depressive disorders. Avoidance can be expressed behaviorally as well as cognitively. Most personality assessments for avoidance involve self-report inventories which are susceptible to biased responding. The avatar task (*Myers et al., 2016a*) was developed as an objective measure of behavioral inhibition (BI) which is defined as a tendency for avoidance of unfamiliar people and situations. The avatar task has been demonstrated to screen avoidant behaviors related to BI, PTSD, as well as harm avoidance (HA) as measured by the Tridimensional Personality Questionnaire (TPQ). In the current work, the avatar task was tested with cognitive as well as behavioral avoidance as measured by the cognitive-behavioral avoidance scale (CBAS; *Ottenbreit & Dobson, 2004*). The CBAS includes four subscales which measure behavioral social (BS) avoidance, behavioral non-social (BN) avoidance, cognitive social (CS) avoidance, and cognitive non-social (CN) avoidance. It was hypothesized that avatar scores would be significantly positively related to behavioral, but not cognitive, avoidance. In addition, it was also hypothesized that performance on the avatar task would be more related to social than non-social behavioral avoidance. Participants completed the avatar task, the HA scale of the TPQ and the CBAS. Pearson's product moment correlations revealed that avatar scores were significantly related to CBAS total scores as well as BS and BN scores, but not CS and CN scores. In addition, BS has a stronger relationship with avatar scores than BN avoidance which fits with the social aspects of the scenarios in the avatar task. A median split of the avatar scores produced a significant difference in scores on the behavioral but not the cognitive subscales. Overall, the current results supported the idea that the avatar task is measuring behavioral avoidance, specifically in social situations, rather than cognitive avoidance. Future work could adapt the avatar task to include scenarios similar to the cognitive items on the CBAS to create an objective measure of cognitive avoidance which may be relevant in measuring avoidance in depression and behavioral avoidance associated with PTSD as well as anxiety disorders.

INTRODUCTION

Avoidance is a key symptom of post-traumatic stress disorder (PTSD) and anxiety disorders (*American Psychiatric Association, 2013*). In addition, avoidance is also related to depression (*Ferster, 1973*; *Folkman & Lazarus, 1986*; *Kuyken & Brewin, 1994*; *Spurrell & McFarlane, 1995*). Recent work has focused on avoidance-related personality temperaments such as behavioral inhibition (BI) or harm avoidance (HA) which are risk factors for the development of PTSD, anxiety disorders, and depression. BI is defined as a tendency for avoidance of unfamiliar people and situations (*Kagan, Reznick & Snidman, 1987*; *Morgan, 2006*). HA is defined as a tendency to avoid harmful stimuli including situations involving punishment, novelty, and non-reward (*Cloninger, 1986*; *Cloninger, 1987*). This work has examined a learning diathesis model of PTSD in which personality temperaments are associated changes in avoidance (e.g., *Sheynin et al., 2014*) and associative learning (e.g., *Allen, Myers & Servatius, 2014*) which may increase vulnerability to the development and maintenance of PTSD. As will be detailed, inhibited temperaments are related to the development of PTSD, anxiety disorders, and depression.

To satisfy the *DSM-5* criterion C for PTSD, an individual must persistently avoid either external reminders of trauma (i.e., behavioral avoidance) or trauma-related thoughts or feelings (i.e., cognitive avoidance), or both (*American Psychiatric Association, 2013*). While avoidance of traumatic or stressful situations is usually adaptive, avoidance can become maladaptive and disrupt normal life functioning. Avoidance behaviors have been identified as a significant predictor of PTSD (*Charlton & Thompson, 1996*; *Marmar, 1996*; *Chang et al., 2003*) as well as distinguishing between those at risk and not at risk for development of PTSD (*North et al., 1999*; *Barlow, 2002*; *Karamustafalioglu et al., 2006*; *Marshall et al., 2006*; *O'Donnell et al., 2007*). Avoidant tendencies (as measured by BI) are related to PTSD. Specifically, childhood BI is a risk factor for the later development of adult PTSD (*North et al., 1999*; *Fincham et al., 2008*; *Kashdan, Morina & Priebe, 2009*). BI also correlates with severity of PTSD symptoms (*Myers et al., 2012*; *Myers, VanMeenen & Servatius, 2012*; *Servatius et al., 2017*). In addition, *Richman & Frueh (1997)* reported high levels of HA in veterans with combat related PTSD. More specifically, high levels of HA are a risk factor for PTSD (*Cloninger, Svrakic & Przybeck, 2006*; *Gil, 2005*) while low levels are associated with resilience (*Simeon et al., 2007*).

Inhibited temperament is also linked to anxiety disorders. The relationship between PTSD and anxiety disorders is complicated in that PTSD is currently categorized as a trauma and stressor related disorder, but in the previous edition of the DSM (*American Psychiatric Association, 2000*) PTSD was categorized as an anxiety disorder. Avoidance of feared situations or stimuli is a symptom of anxiety disorders in the DSM-5 (*American Psychiatric Association, 2013*). BI has been identified as a vulnerability for the development of anxiety disorders such that childhood BI increases the risk for an individual to develop anxiety disorders in adulthood (*Hirshfeld et al., 1992*; *Biederman et al., 1993*; *Svihra & Katzman, 2004*; *Pérez-Edgar et al., 2010*) specifically, social inhibition (*Kupper et al., 2011*) and social anxiety disorder (*Chronis-Tuscano et al., 2009*; *Lahat, Hong & Fox, 2011*; *Kupper & Denollet, 2014*).

Avoidance has also been put forth as a symptom of depression. However, the relationship between avoidance and depression is not as well-established as that with PTSD and anxiety disorders. *Leventhal (2008)* proposed that depression comes about when maladaptive avoidance limits positive experiences. Following a negative event, a person may avoid similar situations to avoid further potentially negative events. By avoiding situations that have the potential for an undesirable outcome, the person misses out on the opportunity for possible desirable outcomes, and thus falls deeper into depression. This idea was supported by findings in which the relationship between avoidance and depression is mediated by reinforcement (*Carvalho & Hopko, 2011*), the relationship between negative life events and depression is moderated by cognitive avoidance in females, but not males, and the relationship between anxiety sensitivity and depression is mediated by experiential avoidance (*Tull & Gratz, 2008*). In addition, BI was found to lead to depression (*Gladstone & Parker, 2006*), but this relationship was moderated by social inhibition. HA has also been linked to depression (*Brown et al., 1992*; *Svrakic, Przybeck & Cloninger, 1992*; *Strakowski et al., 1995*; *Chen et al., 2015*). *Jacobson & Newman (2014)* conducted a study of the longitudinal development between anxiety and depression that revealed that avoidance is a mediator between early anxiety and depression over ten years later. Thus, avoidance and anxiety interact in the development of depression.

As can be seen from the literature reviewed, there is a strong overlap in regards to avoidance between PTSD, anxiety disorders, and depression. Specifically, the avoidance-related temperaments of BI and HA increase the risk of PTSD, anxiety disorders, and depression. One concern with measures of both BI and HA is that they are self-report paper and pencil questionnaires. BI is measured by the Adult and Retrospective Measures of Behavioural Inhibition (AMBI/RMBI; *Gladstone & Parker, 2005*). HA is measured with a subscale of the Tridimensional Personality Questionnaire (TPQ; *Cloninger, Przybeck & Svrakic, 1991*; *Cloninger, Svrakic & Przybeck, 1993*). However, the tendency to avoid inherent in both BI and HA may affect the accuracy of self-report. Some participants in military or veteran populations may exaggerate their responses towards non-avoidance related choices to avoid the diagnosis of PTSD. Emergency responders who develop PTSD may fear losing their jobs and thus avoid participation in research with PTSD questionnaires (*Clohessy & Ehlers, 1999*). In addition, some individuals may exaggerate responses towards avoidance related choices to receive a diagnosis of PTSD and increase disability benefits (*Freeman, Powell & Kimbrell, 2008*). Recent alternatives to paper and pencil self-report inventories assessing avoidance have included both behavioral avoidance tasks as well as computer-based assessments.

There has been some work on developing behavioral measures of avoidance in humans. Animal paradigms have utilized approach-avoidance paradigms in which approaching a reward (i.e., food or water) is in conflict with avoiding a punishment (i.e., an electric shock) as well as avoidance tasks in which a response (i.e., a lever press) to a warning signal avoids an impending aversive event (i.e., an electric shock). These animal paradigms have been adapted in studies of human avoidance which have employed computer-based avoidance tasks involving a loss of points or monetary reward or a negatively affective stimulus as the aversive event to be avoided (e.g., *Aupperle et al., 2011*; *Sheynin et al., 2014*). Specifically, a

computer-based approach—avoidance task developed by *Aupperle et al. (2011)*—involved the participant moving an avatar along a runway between a positive and negative affective stimulus to indicate the participant's preference for a specific outcome (either a reward of points or a punishment of a negatively affective picture). Approach behavior on the task was correlated with a self-reported tendency to approach reward and avoid punishment as measured by the Behavioral Inhibition/Activation Scale (BIS/BAS; *Carver & White, 1994*). This paradigm focused more on the conflict between approach and avoidance rather than avoidance per se and also did not involve a learning component.

A computer based avoidance learning task developed by *Molet, Leconte & Rosas (2006)* and adapted by *Sheynin et al. (2014)* does include a learning component. In this task, participants maneuver and spaceship to score points. A warning signal (a light) indicates an impending aversive event that results in points loss. Participants learn that they can avoid a points loss by hiding their spaceship in a safe zone in response to the warning signal. Importantly, subjects received no direct instructions, the warning signal or on how to escape from or avoid point loss. The vast majority of the participants learned the escape response with the aversive event, while most of them also learned to completely avoid point loss by performing an avoidance response to the warning signal (*Sheynin et al., 2014*). Enhanced avoidance responding was exhibited by HA individuals (*Sheynin et al., 2014*) and individuals self-reporting PTSD symptoms (*Sheynin et al., 2017*). Thus, this human avoidance task not only measures learning of an avoidance response, but also is sensitive to inhibited temperaments.

An alternative to using computer-based behavioral tasks to assess avoidance, is the use of a graphical representation of the user within an interactive virtual environment (i.e., an avatar) which has been put forth as a viable alternative to paper and pencil self-report questionnaires (*Blascovich et al., 2002*). The use of an avatar task to assess avoidance behaviors fits with an increased interest in the use of computer-based virtual reality in psychology and behavioral neuroscience for a variety of purposes including exposure therapy for anxiety disorders (for review see: *Parsons & Rizzo, 2008*), social interaction (*Hoyt, Blascovich & Swinth, 2003*), social skill training (*Park et al., 2011*), and sensation and perception (*Waller, Beall & Loomis, 2004*).

In addition, virtual reality tasks have been used for behavioral assessment of traumatic brain injury (TBI) or stroke patients as a substitute for paper and pencil inventories and simple motor tasks which have been criticized as not testing patients in a practical manner relevant to the real world (*Lee et al., 2003*). Avatar-based programs have also been used to assess aspects of schizophrenia including social anxiety (*Park et al., 2009*) and cognitive flexibility (*Han, Kim & Kim, 2012*). Thus, avatars and virtual reality have been successfully applied to a variety of psychological topic including assessment.

Continuing in this line of research using avatars or virtual reality for assessment, *Myers et al. (2016a)* developed a computer-based task avatar task as an alternative to paper and pencil self-report based inventories assessing avoidance related personality. In this avatar task, participants selected and guided an avatar through two scenarios in which they indicate how they would respond in real life when interacting with strangers. The scenarios in the avatar task were based on the items in the AMBI (*Gladstone & Parker, 2005*).

Performance on the avatar task predicted scores on the AMBI in a sample of undergraduates. The relationship between scores on the avatar task and the AMBI was stronger when individuals were instructed to act as they would in real life as compared to when instructed to act like a typical university student. *Allen, Jameson & Myers (2017)* reported that scores on the avatar task also had a strong relationship with another measure of inhibited temperament, HA as measured with the TPQ in an undergraduate sample. The avatar task has also been tested in a sample of veterans self-reporting PTSD symptoms on the PTSD Checklist (PCL; *Blanchard et al., 1996*). *Myers et al. (2016b)* found that scores on the avatar task were strongly related to avoidance symptoms (i.e., criterion 3 of the DSM-5). Overall these limited studies have provided evidence that the avatar task measures some aspect of avoidance related to inhibited temperaments and PTSD, but one issue concerning the avatar task, much like self-report inventories, is whether it might not measure distinct concepts, but rather, a higher order construct (*Suls & Bunde, 2005*; *Ketterer et al., 2002*). The ability of the avatar task to assess BI, HA and PTSD symptoms may reflect an overall avoidance construct rather than individual distinct concepts.

In an attempt to determine if the avatar task assesses distinct concepts of avoidance, the current study tested the avatar task with cognitive avoidance, as well as behavioral avoidance. Behavioral avoidance involves escaping or avoiding a stressful situation while cognitive avoidance involves attempts to avoid or escape thinking about traumatic situations or problems (*Ottenbreit & Dobson, 2004*). Cognitive avoidance can take a range of forms, including intentional attempts at thought/memory suppression, efforts to dissociate from the emotions related to the traumatic experience, and engaging in rumination (*Ehlers & Clark, 2000*). A paper and pencil measure that assesses both behavioral and cognitive avoidance is the cognitive behavioral avoidance scale (CBAS; *Ottenbreit & Dobson, 2004*). The CBAS is a 31 item self-report measure of avoidance consisting of four subscales: Behavioral social (BS), behavioral non-social (BN), cognitive social (CS), and cognitive non-social (CN) that are summed to a total CBAS score. *Ottenbreit & Dobson (2004)* suggested that the use of self-report measures are a limitation and called for the development of a behavioral avoidance task that would be related to real life avoidance strategies. The avatar task is an attempt in the development of a behavioral avoidance task that incorporates real life scenarios that can be compared to performance on the CBAS.

In the current study, the author explored the relationship between the CBAS and the avatar task. The current study utilized in a convenience sample of undergraduates which corresponds to the development of the CBAS (*Ottenbreit & Dobson, 2004*) and the avatar task (*Myers et al., 2016a*) with undergraduate samples which were later extended to clinical samples (*Ottenbreit, Dobson & Quigley, 2014*; *Myers et al., 2016b*). The author also focused on HA in the current study based on the combined findings of a significant positive relationship between CBAS total and subscales scores and HA (*Ottenbreit & Dobson, 2004*) and a positive relationship between HA and scores on the avatar task (*Allen, Jameson & Myers, 2017*). The first goal of the current study was to replicate the prior findings of a significant relationship between HA and the CBAS. Based on positive relationship between CBAS and HA scores it was hypothesized that HA would be strongly correlated to the CBAS total score and subscale scores. The second goal of the current study was to evaluate

how avatar scores are related to the CBAS total score and the four subscales. Based on the positive relationship between scores on the avatar task and HA scores (*Allen, Jameson & Myers, 2017*), it was hypothesized that performance on the avatar task would be related to avoidance as measured by the total CBAS score. More specifically, it was also hypothesized that scores on the avatar task would be related to behavioral avoidance subscales, but not cognitive avoidance subscales. This hypothesis came from the fact that the decision points in the scenarios in the avatar task were designed to parallel items on the AMBI which assesses behavioral inhibition. The avatar task also asks what a participant would do in particular social situation, not what the participant is thinking. Therefore, it was not designed to assess cognitive avoidance. In addition, it was hypothesized that the avatar task would have a stronger relationship with the social behavior scale than the non-social behavioral scale based on the novel social situations inherent in the party and volunteering scenarios in the avatar task.

The third goal of the current study was to assess the ability of the avatar task to differentiate to performance on the CBAS. Previously, *Allen, Jameson & Myers (2017)* reported that HA individuals (as defined by a standard cut off score) had significantly higher avatar scores than non-HA individuals. Specifically, it was hypothesized that individuals with high avatar scores should score high on the behavioral subscales, but not the cognitive avoidance scales.

METHODS

Participants

One hundred and six undergraduates (80 females and 26 males) from an introductory psychology course voluntarily participated in the study as part of a research requirement. The participants had a mean age of 19.2 years (SD = 2.7, range 18–36 years) and a mean education level of 12.9 years (SD = 1.3). The ethnicity of our sample was mainly Caucasian ($n = 58$), followed by Hispanic ($n = 18$), African-American ($n = 6$), East Asian ($n = 4$), South Asian, ($n = 2$), multi-racial ($n = 15$), and other ($n = 2$). All participants read and signed an informed consent form before participating. All procedures were approved by the Institutional Review Board at University of Northern Colorado (approval number 799609-4).

Instruments

Demographic information was collected including gender, age, years of education, and race/ethnicity through a brief questionnaire. Participants also completed the Tridimensional Personality Questionnaire (TPQ; *Cloninger, Przybeck & Svrakic, 1991*). The TPQ consists of 100 true/false iems assessing how the individual feels or behaves in various daily situations. The HA scale consists of 33 items (*Cloninger, 1986*; *Cloninger, 1987*). Individuals scoring 12 or higher on the HA scale are categorized as harm avoidant or "HA" and the remainder as non-avoidant or "non HA" based on the methodology of *Cloninger, Przybeck & Svrakic (1991)*.

Participants also completed the CBAS (*Ottenbreit & Dobson, 2004*) which is a 31-item self-report measure of avoidance. The CBAS consists of four subscales of behavioral social

(BS) avoidance ("I find that I often want to leave social gatherings."), behavioral non-social (BN) avoidance ("I find myself avoiding tasks and assignments that are really important."), cognitive social (CS) avoidance ("When I experience confusion in my relationships, I do not try to figure things out."), and cognitive non-social (CN) avoidance ("I distract myself when I start to think about my work/school performance."). Participants use a 5-point scale ranging from "not at all true for me" to "extremely true for me" to respond to each item. Scores on the four subscales are summed to create the CBAS total score which can range from 31 to 155 with higher scores indicating more avoidance.

Computer-based task

The computer-based task has been described in previous reports (*Myers et al., 2016a*; *Myers et al., 2016b*; *Allen, Jameson & Myers, 2017*). The task took about 10 min for participants to complete. On the first screen, the participant saw a selection of four male and four female avatars with a range of skin and hair colors from which he/she could choose from to represent him/her in the task. The task itself consisted of one scenario in which the avatar was attending a party full of strangers and a second scenario in which the avatar was volunteering at a charity building project. The scenarios included twenty decision points with a short text description of an event and an image showing the avatar experiencing this event. Each decision point included response options between a relatively avoidant, relatively non-avoidant, and neutral behavior (Fig. 1). All participants experienced the same sequence of events and response options regardless of their responses. At each choice point, the participant received 2 points for selecting the avoidant option, 1 for the neutral option, and 0 for the non-avoidant option. Total scores could range from 0 to 40 with higher scores indicating higher levels of avoidance. Total scores were not reported to the participants. The entire study was completed within 30 min.

Data analysis

Pearson's product moment correlations were calculated between total scores on the avatar task and the scores from HA subscale of the TPQ, the CBAS total score as well as the four CBAS subscales. A Bonferroni correction was used to protect against inflated risk of family-wise type-I error for multiple correlations. This correction resulted in the significance level for the Pearson's correlation being reduced to $.05/6 = 0.0083$. Significant differences between Pearson's correlations were calculated with a Fisher r to z transformation. A median split of the avatar scores resulted in high and low avatar groups which were compared with a t-test.

RESULTS

Computer failure resulted in loss of data for nine participants. The final sample for analysis consisted of ninety eight individuals (74 females and 24 males) with an average age of 19.3 years (SD = 2.8).

Paper and pencil inventories

Table 1 shows the mean HA scale and CBAS total scores including scores for the four CBAS subscales for all participants with separate listings for females and males. There were no

The host chats politely to you for a few moments, then excuses herself to check on something in the kitchen. You look around and realize you don't know anyone else there. You :

☐ Find someone who looks friendly, walk over, and say hi.
☒ Check out the food and drinks.
☐ Call your cousin Frank back and ask when he's coming.

Go on.

Figure 1 **Sample screen capture from the computer-based avatar task.** In the first scenario, the avatar was invited to a party where she did not know anyone there except her cousin. At this choice point the avatar has a choice between a non-inhibited responses, an intermediate response, and an inhibited response. In this case, the intermediate response was chosen.

Table 1 **Scores on the HA and CBAS inventories.**

	Total Mean (SD)	Female Mean (SD)	Male Mean (SD)	Gender effect significance level
Harm avoidance score	15.3 (8.2)	15.6 (7.3)	10.6 (6.5)	$p = 0.09$
CBAS total score	60.6 (18.7)	59.4 (17.7)	63.6 (21.1)	$p = 0.39$
Behavioral social avoidance	16.8 (7.1)	16.9 (7.1)	16.1 (7.1)	$p = 0.66$
Behavioral non-social avoidance	13.1 (4.0)	12.9 (3.7)	13.5 (5.0)	$p = 0.57$
Cognitive social avoidance	13.5 (5.3)	13.0 (5.1)	15.1 (5.5)	$p = 0.09$
Cognitive non-social avoidance	17.2 (6.3)	16.8 (6.4)	18.9 (6.0)	$p = 0.14$

significant gender differences on the HA, CBAS total score and CBAS subscales. However, there was a non-significant trend that males had higher scores on the HA and CS scales than females.

As shown in Table 2, the CBAS total score and subscales were all significantly related (all r's >0.80). These findings are similar to the levels of internal consistency reported by

Table 2 Correlation Matrix for the HA subscale scores and CBAS total and subscale scores.

Measure	1	2	3	4	5	6
1. Harm avoidance	–					
2. CBAS	0.59	–				
3. Behavioral social avoidance	0.66	0.82	–			
4. Behavioral non-social avoidance	0.57	0.80	0.61	–		
5. Cognitive social avoidance	0.22	0.81	0.50	0.48	–	
6. Cognitive non-social avoidance	0.40	0.85	0.49	0.63	0.69	–
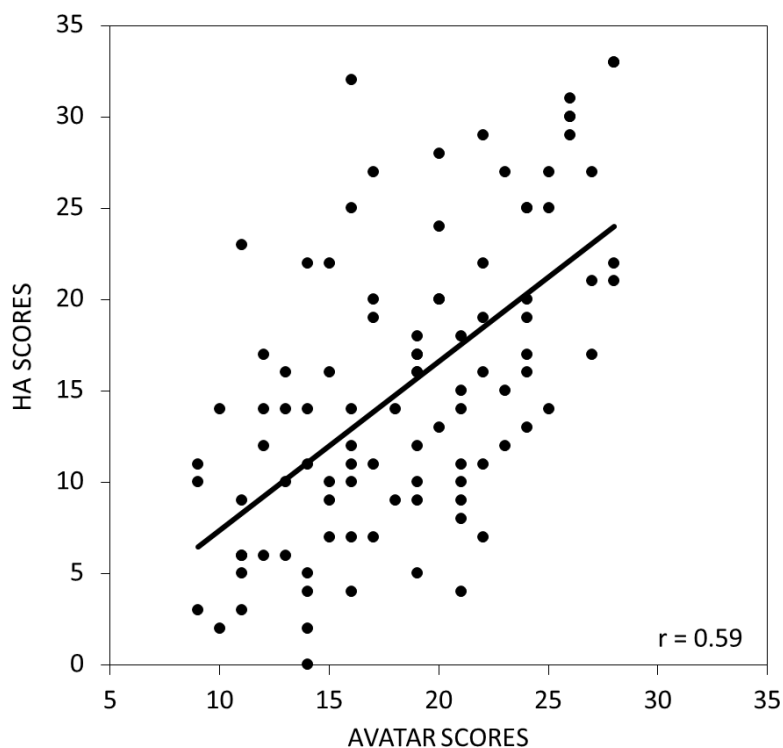
Figure 2 The relationship between the scores on avatar task and the harm avoidance (HA) subscale of the Tridimensional Personality Questionnaire. Total scores on the avatar task were strongly positively correlated with the HA subscale scores from the Tridimensional Personality Questionnaire.

Ottenbreit & Dobson (2004) for an undergraduate sample and by *Ottenbreit, Dobson & Quigley (2014)* for a sample of clinically depressed women. HA also had a significant positive relationship to the total CBAS score as well as the BS, BN, and CN subscales.

Responses on the AVATAR

The mean avatar score was 18.4 (SD = 5.3). While females (mean = 18.8, SD = 5.4) tended to have higher avatar scores than males (mean = 17.1, SD = 4.5) this difference was not significant ($p = 0.12$). As shown in Fig. 2, there was a significant positive relationship between the total AVATAR score and the HA subscale of the TPQ ($r = 0.59$, $p < 0.001$).
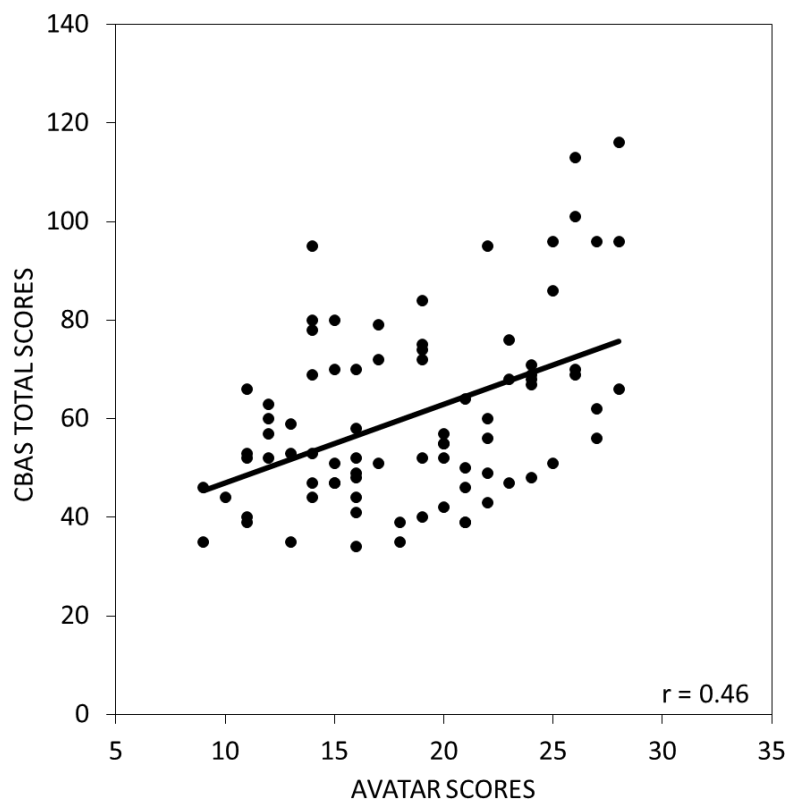
Figure 3 The relationship between scores on the avatar task and the CBAS total score. Total scores on the avatar task were strongly positively correlated with the total CBAS scores.

There was also a strong positive relationship between scores on the avatar task and the total CBAS score ($r = 0.48$, $p < 0.001$) as shown in Fig. 3. In addition, while avatar scores were significantly related to both the BS ($r = 0.70$, $p < 0.001$) and the BN ($r = 0.47$, $p < 0.001$) subscale scores as shown in Figs. 4A and 4B, the BS scores had a stronger relationship with the avatar scores than the BN scores ($z = 2.4$, $p < 0.05$). There were no significant relationships between scores on the avatar task and the Cognitive Social subscale ($r = 0.26$, $p = .010$) and between the avatar scores and the Cognitive Non-social subscale ($r = 0.20$, $p = .046$) as shown in Figs. 4C and 4D.

Using a median split of the avatar scores at a score of 18.5 resulted in two groups such that the high avatar group had significantly higher mean CBAS total scores than the low avatar group ($t(46) = -3.459$, $p < 0.001$) as shown in Fig. 5. This median split of the avatar scores was also used to analyze differences in the CBAS subscale scores. The high avatar group had significantly higher scores than the low avatar group on the BS and BN scales (both p values < 0.005), but not on the CS and CN scales ($p = 0.19$ and $p = 0.38$, respectively) as shown in Fig. 6.
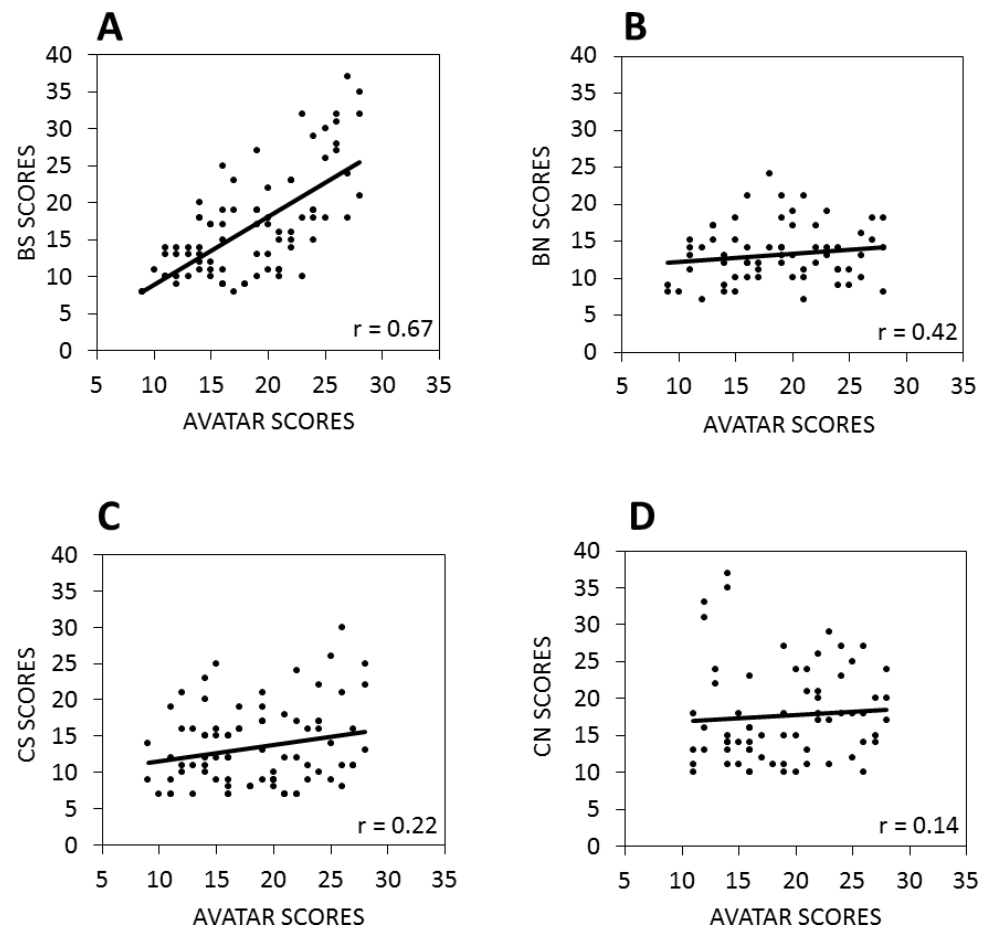
Figure 4 **The relationship between scores on the avatar task and the CBAS subscales.** Total scores on the avatar task were strongly positively correlated with (A) the behavioral social (BS) subscale and (B) the behavioral non-social (BN) subscale, but not (C) the cognitive social (CS) and (D) cognitive non-social (CN) subscales of the CBAS.

DISCUSSION

The current study investigated how a computer-based avatar task designed to assess behavioral inhibition would relate to cognitive as well as behavioral avoidance as measured by the CBAS. Previously, the avatar task was found to be related to PTSD cluster C (avoidance) symptoms (*Myers et al., 2016b*) as well as HA avoidance (*Allen, Jameson & Myers, 2017*).

The first goal of the study was to replicate the findings of *Ottenbreit & Dobson (2004)* for the relationship between harm avoidance (HA) and CBAS total scores. The current finding of a strong relationship between HA and the CBAS total score as well as varying relationships with the four subscale scores fits with the previous report of *Ottenbreit, Dobson & Quigley (2014)* in which there were correlations of 0.50 or higher between HA and the CBAS total score and the BS and BN scores while the correlations between HA and the CS and CN scores were between 0.32 and 0.38.
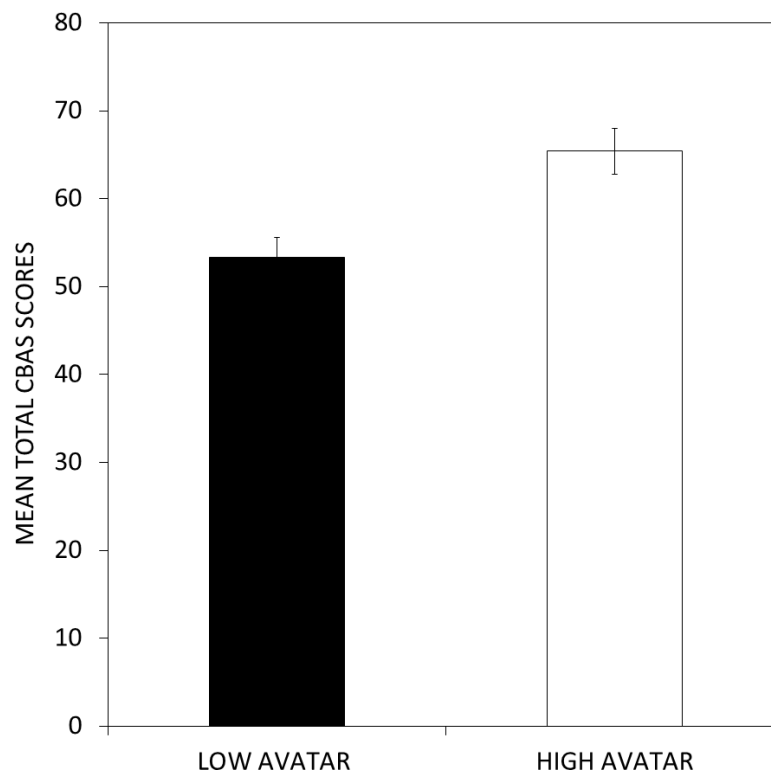
Figure 5 Differences in CBAS total scores as a function of scores on the avatar task. A median split of the avatar scores can be used to differentiate the CBAS total score. Individuals with high scores on the avatar task exhibited significantly higher CBAS total scores than individuals with low scores on the avatar task.

Based on females having higher rates of anxiety disorders than males, gender effects were examined for the HA and CBAS scores. In the current study, females tended to have higher HA than males, but this difference only approached significance. This finding is in contrast to findings of higher HA in females in a meta-analysis of thirty two studies (*Miettunen et al., 2007*) as well as in a previous study with the avatar task (*Allen, Jameson & Myers, 2017*). There were also no significant differences between males and females for the CBAS total score or any of the subscales in the current study. However, there was a non-significant trend where males tended to have higher levels of cognitive social avoidance than females. *Ottenbreit & Dobson (2004)* found males had higher total CBAS scores as well as higher scores on the BS, CS, CN subscales but not the BN subscales as compared to females. However, subsequent studies have reported no gender effect on CBAS total scores (*Moulds et al., 2007*; *Carvalho & Hopko, 2011*). Overall, the current non-significant gender effects for CBAS and HA scores are in the same direction as some previous reports. However, the non-significant gender effects in the current study may be due in part to the small sample of males ($n = 24$) which may have lacked the power to detect gender differences. Future work with the avatar task and CBAS should include more males to further explore possible gender differences.
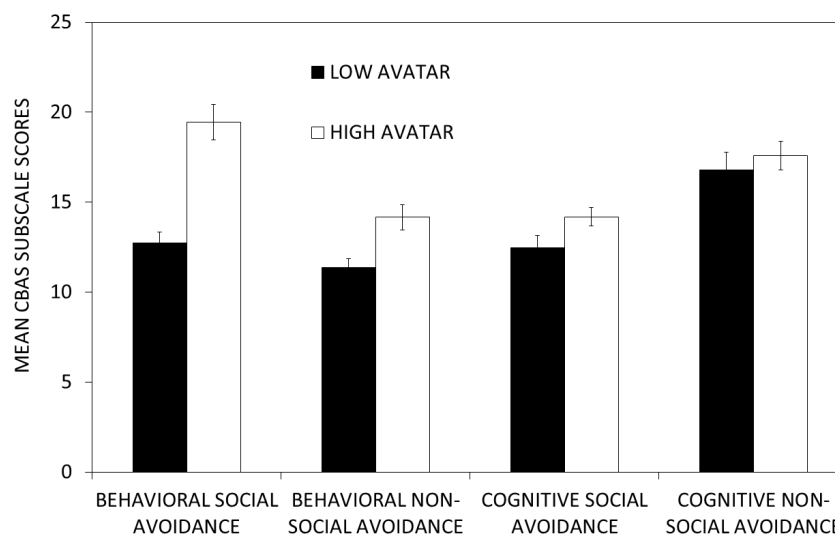
Figure 6 **Differences in the CBAS subscale scores as a function of scores on the avatar task.** A median split of the avatar scores can be used to differentiate performance on the behavioral social (BS) and behavioral non-social (BN) avoidance subscales, but not the cognitive social (CS) and cognitive non-social (CN) avoidance subscales. Individuals with high scores on the avatar task exhibited significantly higher BS and BN scores than individuals with low scores on the avatar task. There were no significant differences in CS and CN scores for individuals with high and low avatar scores.

The second goal of the current was to investigate the relationship between the avatar task and the CBAS. The mean avatar score (18.5) was close to the range of scores reported for the avatar task for samples of undergraduates (*Myers et al., 2016a*; *Allen, Jameson & Myers, 2017*) but lower than those reported for PTSD patients (*Myers et al., 2016b*). This lack of a significant gender effect for the avatar task was consistent with prior reports (*Myers et al., 2016a*; *Myers et al., 2016b*; *Allen, Jameson & Myers, 2017*).

As hypothesized, the avatar task was significantly related to the total CBAS score. This finding fits with previous reports that the avatar task is related to BI (*Myers et al., 2016a*), as well as harm avoidance (*Allen, Jameson & Myers, 2017*), as well as avoidance symptoms of PTSD (*Myers et al., 2016b*). The current work sought to further refine the relationship of the avatar task to different types of avoidance, specifically behavioral and cognitive avoidance as measured by the CBAS. Scores on the avatar task had a significant positive relationship to the BS and BN scores, but not to the CS and CN scores. This finding fits with the idea that the avatar task was designed to assess behavioral inhibition rather than cognitive avoidance. The scenarios in the avatar task asked about what the participant would do, not what he/she thinks.

Another finding from the current study was that the avatar task had a stronger relationship to behavioral social avoidance than behavioral non-social avoidance. This finding also fits with the idea that the scenarios in the avatar task involve social interactions with strangers (i.e., a party and volunteering at a construction site). In addition, BI has been linked to social inhibition (SI) in that SI in adulthood may very well be preceded by BI in childhood (*Kupper et al., 2011*).

Based on the relationship between the avatar task and HA as well as the relationship between CBAS and HA, the author included this measure of avoidance in the current analysis. The mean HA score (15.3) was higher than recently reported (mean = 12.1, *Sheynin et al., 2014*; mean = 12.8, *Sheynin et al., 2014*; mean = 12.4, *Allen, Jameson & Myers, 2017*). The current study replicated the finding of *Allen, Jameson & Myers (2017)* that HA was related to the avatar task. The current study found a stronger relationship between HA and the avatar task than previously reported (*Allen, Jameson & Myers, 2017*). Previously HA relationship was at a level of $r = 0.42$ while the current finding was $r = 0.59$.

The third goal of the current study was to investigate the ability of the avatar task to differentiate behavioral and cognitive avoidance. To be relevant for diagnosis, it is not enough that scores on the avatar task are simply related to measures of avoidance, but that the avatar scores can be used to differentiate individual's scores. A median split of the avatar scores at a score of 16.5 was used to group individuals as high and low avatar scores. Individuals who scored high on the avatar task had significantly higher scores on the CBAS task as well and the BS and BN subscales, but not the CS and CN subscales. The overall findings supported our hypothesis that performance on the avatar task differentiated behavioral avoidance but not cognitive avoidance also fit with the strength of relationships found between the avatar task and the CBAS subscales.

The differences in the relationships between performance on the avatar task and the behavioral and cognitive avoidance subscales may signify the difference between the relationship between the avatar task and PTSD and anxiety disorders as compared to depression. The CBAS was developed in the context of avoidance and depression rather than avoidance and anxiety disorders. Avoidance has been put forth as the mechanism through which sadness becomes depression (*Leventhal, 2008*). *Ottenbreit & Dobson (2004)* found that cognitive-behavioral avoidance was related to both anxiety disorders and depression and that the relationship between avoidance and depression approached the strength of the relationship between avoidance and anxiety disorders. *Blalock & Joiner (2000)* reported that cognitive avoidance coping strategies moderate the relationship between negative life events and depression in females, but not males. Experiential avoidance was associated with symptoms of depression when controlling for PTSD symptoms (*Tull et al., 2004*). *Dickson, Ciesla & Reilly (2012)* reported that cognitive avoidance was a robust predictor of rumination, worry, sadness, and anxiety while behavioral avoidance was only predictive of anxiety. *Ottenbreit & Dobson (2004)* reported that while higher levels of both behavioral and cognitive avoidance were related higher levels of depression, cognitive non-social avoidance had strongest relationship to depression. The current findings support the idea that the avatar task may be more relevant for measuring behavioral avoidance as it relates to anxiety more so than cognitive avoidance as it relates to depression.

There are several limitations concerning the sample of the current study which can be used in designing future work. As previously discussed, a limited number of males may have limited the ability to identify possible gender effects. Another limitation is the ethnic makeup of the current sample. There was a lack of ethnic diversity in that over half of our sample was Caucasian. Previous studies have reported that Asians used avoidant strategies more so than Caucasians (*Bjorck et al., 2001*; *Ottenbreit & Dobson, 2004*). Cross cultural

explorations of PTSD, anxiety disorders, and depression could be undertaken with the avatar task to further explore possible ethnic differences in avoidance with these disorders.

The current study also utilized undergraduates with no regard for clinical diagnosis of PTSD, anxiety disorders or depressive disorders. The current study parallels initial work with the CBAS (*Ottenbreit & Dobson, 2004*) and the avatar task (*Myers et al., 2016a*) that was limited to non-clinical samples. Future work can attempt to replicate the current findings with clinically depressed or anxious individuals. Just as the original finding of a relationship between scores on the avatar task and BI reported by *Myers et al. (2016a)* was extended in a study in PTSD patients (*Myers et al., 2016b*), the current study with CBAS should be replicated and extended with clinical samples. In addition the avatar task may be valuable as an assessment tool for individual's co-morbidity of PTSD and depression.

Another limitation of the current study is the time limit of 30 min to complete the avatar task as well as the paper and pencil inventories. Based on this time limit, the current study did not include the AMBI which has been consistently found to be related to the avatar or other measures of anxiety. The current study focused on the topic of the behavioral and cognitive avoidance (measured with the CBAS) and did not extend to other measures of avoidance or anxiety.

CONCLUSION AND FUTURE WORK

Future work can also compare results on the avatar task to avoidance learning tasks which have been found to be related to BI and HA. The AMBI and HA scale of the TPQ have been used to categorize individuals as avoidant prone who exhibited enhanced classical eyeblink conditioning (*Holloway et al., 2014*; *Allen, Myers & Servatius, 2014*; *Allen, Jameson & Myers, 2017*) and as well as enhanced avoidance in computer-based tasks (*Sheynin et al., 2014*). These studies should be repeated using the avatar task as a substitute for paper-and-pencil inventories such as the AMBI and TPQ to determine if avatar scores can predict performance on these learning tasks. The avatar task can also be tested with other measures of anxiety to determine how much it generalizes from behavioral avoidance. The use of the avatar task as a predictor of performance on avoidance tasks would answer the call by *Ottenbreit & Dobson (2004)* for behavioral avoidance tasks that can be related to real world scenarios like those in the avatar task.

Overall, the current study lends support for the *Myers et al. (2016a)* avatar task being an objective measure of behavioral avoidance, but not cognitive avoidance. The avatar task was also more related to behavioral social avoidance more so than behavioral non-social avoidance. Future work can also attempt to adapt the avatar task from behavioral avoidance to include cognitive avoidance by using items from the CBAS. Scenarios could be designed in which participants are asked explicitly about their thoughts rather than their actions. The current study helps to refine the extent to which this computer-based task relates to various aspects of avoidance. The ability of the avatar task to positively correlate with behavioral, but not cognitive avoidance lends support to continued work with the avatar task as a viable substitute for paper and pencil measures of avoidance as related to PTSD, anxiety disorders, and depression.

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Competing Interests

The author declares that he has no competing interests.

Author Contributions

- M. Todd Allen conceived and designed the experiments, performed the experiments, analyzed the data, contributed reagents/materials/analysis tools, prepared figures and/or tables, authored or reviewed drafts of the paper, approved the final draft.

Human Ethics

The following information was supplied relating to ethical approvals (i.e., approving body and any reference numbers):

The University of Northern Colorado Institutional Review Board granted approval to carry out the study (approval number 799609-4).

Data Availability

The raw data are provided in Supplemental File.

Supplemental Information

Supplemental information for this article can be found online at http://dx.doi.org/10.7717/peerj.5330#supplemental-information.

REFERENCES

Allen MT, Jameson MM, Myers CE. 2017. Beyond behavioral inhibition, a computer avatar task designed to assess behavioral inhibition extends to harm avoidance. *Frontiers in Psychology: Personality and Social Psychology* **8**:Article 1560 DOI 10.3389/fpsyg.2017.01560.

Allen MT, Myers CE, Servatius RJ. 2014. Avoidance prone individuals self reporting behavioral inhibition exhibit facilitated acquisition and altered extinction of conditioned eyeblinks with partial reinforcement schedules. *Frontiers in Behavioral Neuroscience* **8**:347.

American Psychiatric Association. 2000. *Diagnostic and statistical manual of mental disorders: DSM-IV-TR.* Washington, D.C.: American Psychiatric Association.

American Psychiatric Association. 2013. *Diagnostic and statistical manual of mental disorders.* 5th Edition. Washington, D.C.: American Psychiatric Publication.

Aupperle RL, Sullivan S, Melrose AJ, Paulus MP, Stein MB. 2011. A reverse translational approach to quantify approach-avoidance conflict in humans. *Behavioural Brain Research* **225(2)**:455–463 DOI 10.1016/j.bbr.2011.08.003.

Barlow DH. 2002. *Anxiety and its disorders: the nature and treatment of anxiety and panic.* 2nd edition. New York: Guilford Press.

Biederman J, Rosenbaum JF, Bolduc-Murphy EA, Faraone SV, Chaloff J, Hirshfeld DR, Kagan J. 1993. A 3-year follow-up of children with and without behavioral inhibition. *Journal of the American Academy of Child and Adolescent Psychiatry* **32(4)**:814–821 DOI 10.1097/00004583-199307000-00016.

Bjorck JP, Cuthbertson W, Thurman JW, Soon Lee Y. 2001. Ethnicity, coping, and distress among Korean Americans, Filipino Americans and Caucasian Americans. *International Journal of Social Psychiatry* **141**:421–442.

Blalock JA, Joiner TE. 2000. Interaction of cognitive avoidance coping and stress in predicting depression/anxiety. *Cognitive Therapy and Research* **24(1)**:47–65 DOI 10.1023/A:1005450908245.

Blanchard EB, Jones-Alexander J, Buckley TC, Forneris CA. 1996. Psychometric properties of the PTSD checklist (PCL). *Behaviour Research and Therapy* **34**:669–673 DOI 10.1016/0005-7967(96)00033-2.

Blascovich J, Loomis J, Beall A, Swinth K, Hoyt C, Bailenson JN. 2002. Immersive virtual environment technology as a methodological tool for social psychology. *Psychological Inquiry* **13**:103–124 DOI 10.1207/S15327965PLI1302_01.

Brown SL, Svrakic DM, Przybeck TR, Cloninger RC. 1992. The relationship of personality to mood and anxiety states: a dimensional approach. *Journal of Psychiatric Research* **26(3)**:197–211 DOI 10.1016/0022-3956(92)90023-H.

Carvalho JP, Hopko DR. 2011. Behavioral theory of depression: reinforcement as a mediating variable between avoidance and depression. *Journal of Behavior Therapy and Experimental Psychiatry* **42(2)**:154–162 DOI 10.1016/j.jbtep.2010.10.001.

Carver CS, White TL. 1994. Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment. *Journal of Personality and Social Psychology* **67**:319–333 DOI 10.1037/0022-3514.67.2.319.

Chang CM, Lee LC, Connor KM, Davidson JR, Jeffries K, Lai TJ. 2003. Posttraumatic distress and coping strategies among rescue workers after an earthquake. *The Journal of Nervous and Mental Disease* **191(6)**:391–398 DOI 10.1097/01.NMD.0000071588.73571.3D.

Charlton PFC, Thompson JA. 1996. Ways of coping with psychological distress after trauma. *British Journal of Clinical Psychology* **35(4)**:517–530 DOI 10.1111/j.2044-8260.1996.tb01208.x.

Chen CY, Lin SH, Li P, Huang WL, Lin YH. 2015. The role of the harm avoidance personality in depression and anxiety during the medical internship. *Medicine* **94(2)**:e389.

Chronis-Tuscano A, Degnan KA, Pine DS, Perez-Edgar K, Henderson HA, Diaz Y, Raggi VL, Fox NA. 2009. Stable early maternal report of behavioral inhibition predicts lifetime social anxiety disorder in adolescence. *Journal of the American Academy of Child and Adolescent Psychiatry* **48(9)**:928–935 DOI 10.1097/CHI.0b013e3181ae09df.

Clohessy S, Ehlers A. 1999. PTSD symptoms, response to intrusive memories and coping in ambulance service workers. *British Journal of Clinical Psychology* **38(3)**:251–265 DOI 10.1348/014466599162836.

Cloninger CR. 1986. A unified biosocial theory of personality and its role in the development of anxiety states. *Psychiatric Development* **3(2)**:167–226.

Cloninger C. 1987. A systematic method for clinical description and classification of personality variants: a proposal. *Archives of General Psychiatry* **44(6)**:573–588 DOI 10.1001/archpsyc.1987.01800180093014.

Cloninger CR, Przybeck TR, Svrakic DM. 1991. The tridimensional personality questionnaire: U.S. normative data. *Psychiatric Reports* **69**:1047–1057 DOI 10.2466/pr0.1991.69.3.1047.

Cloninger CR, Svrakic DM, Przybeck TR. 1993. A psychobiological model of temperament and character. *Archives of General Psychiatry* **50(12)**:975–990 DOI 10.1001/archpsyc.1993.01820240059008.

Cloninger CR, Svrakic DM, Przybeck TR. 2006. Can personality assessment predict future depression? A twelve-month follow-up of 631 subjects. *Journal of Affective Disorders* **92(1)**:35–44 DOI 10.1016/j.jad.2005.12.034.

Dickson KS, Ciesla JA, Reilly LC. 2012. Rumination, worry, cognitive avoidance, and behavioral avoidance: examination of temporal effects. *Behavior Therapy* **43(3)**:629–640 DOI 10.1016/j.beth.2011.11.002.

Ehlers A, Clark DM. 2000. A cognitive model of posttraumatic stress disorder. *Behaviour Research and Therapy* **38(4)**:319–345 DOI 10.1016/S0005-7967(99)00123-0.

Ferster C. 1973. A functional analysis of depression. *American Psychologist* **28(10)**:857–870 DOI 10.1037/h0035605.

Fincham D, Smit J, Carey P, Stein DJ, Seedat S. 2008. The relationship between behavioural inhibition, anxiety disorders, depression and CD4 counts in HIV-positive adults: a cross-sectional controlled study. *AIDS Care* **20(10)**:1279–1283 DOI 10.1080/09540120801927025.

Folkman S, Lazarus RS. 1986. Stress processes and depressive symptomatology. *Journal of Abnormal Psychology* **95(2)**:107–113 DOI 10.1037/0021-843X.95.2.107.

Freeman T, Powell M, Kimbrell T. 2008. Measuring symptom exaggeration in veterans with chronic posttraumatic stress disorder. *Psychiatry Research* **158(3)**:374–380 DOI 10.1016/j.psychres.2007.04.002.

Gil S. 2005. Pre-traumatic personality as a predictor of post-traumatic stress disorder among undergraduate students exposed to a terrorist attack: a prospective study in Israel. *Personality and Individual Differences* **39(4)**:819–827 DOI 10.1016/j.paid.2005.03.007.

Gladstone GL, Parker G. 2005. Measuring a behaviorally inhibited temperament style: Development and initial validation of new self-report measure. *Psychiatry Research* **135**:133–143 DOI 10.1016/j.psychres.2005.03.005.

Gladstone GL, Parker GB. 2006. Is behavioral inhibition a risk factor for depression? *Journal of Affective Disorders* **95(1)**:85–94 DOI 10.1016/j.jad.2006.04.015.

Han K, Kim IY, Kim JJ. 2012. Assessment of cognitive flexibility in real life using virtual reality: a comparison of healthy individuals and schizophrenia patients. *Computers in Biology and Medicine* **42(8)**:841–847 DOI 10.1016/j.compbiomed.2012.06.007.

Hirshfeld DR, Rosenbaum JF, Biederman J, Bolduc EA, Faraone SV, Snidman N, Reznick S, Kagan J. 1992. Stable behavioral inhibition and its association with anxiety disorder. *Journal of the American Academy of Child and Adolescent Psychiatry* **31**:103–111 DOI 10.1097/00004583-199201000-00016.

Holloway J, Allen MT, Myers CE, Servatius RJ. 2014. Behaviorally inhibited individuals demonstrate significantly enhanced conditioned response acquisition under non-optimal learning conditions. *Behavioural Brain Research* **261(15)**:49–55.

Hoyt CL, Blascovich J, Swinth KR. 2003. Social inhibition in immersive virtual environments. *Presence: Teleoperators & Virtual Environments* **12(2)**:183–195 DOI 10.1162/105474603321640932.

Jacobson NC, Newman MG. 2014. Avoidance mediates the relationship between anxiety and depression over a decade later. *Journal of Anxiety Disorders* **28(5)**:437–445 DOI 10.1016/j.janxdis.2014.03.007.

Kagan J, Reznick JS, Snidman N. 1987. The physiology and psychology of behavioral inhibition in children. *Child Development* **58**:1459–1473 DOI 10.2307/1130685.

Karamustafalioglu OK, Zohar J, Güveli M, Gal G, Bakim B, Fostick L, Karamustafali-oglu N, Sasson Y. 2006. Natural course of posttraumatic stress disorder: a 20-month prospective study of Turkish earthquake survivors. *International Journal of Clinical and Health Psychology* **67(5)**:882–889.

Kashdan TB, Morina N, Priebe S. 2009. Post-traumatic stress disorder, social anxiety disorder, and depression in survivors of the Kosovo War: experiential avoidance as a contributor to distress and quality of life. *Journal of Anxiety Disorders* **23(2)**:185–196 DOI 10.1016/j.janxdis.2008.06.006.

Ketterer MW, Denollet J, Goldberg AD, McCullough PA, John S, Farha AJ, Clark V, Keteyian S, Chapp J, Thayer B, Deveshwar S. 2002. The big mush: psychometric measures are confounded and non-independent in their association with age at initial diagnosis of Ischaemic Coronary Heart Disease. *Journal of cardiovascular Risk* **9(1)**:41–48.

Kupper N, Boomsma DI, De Geus EJ, Denollet J, Willemsen G. 2011. Nine-year stability of type D personality: contributions of genes and environment. *Psychosomatic Medicine* **73**:75–82 DOI 10.1097/PSY.0b013e3181fdce54.

Kupper N, Denollet J. 2014. Type D personality is associated with social anxiety in the general population. *International Journal of Behavioral Medicine* **21(3)**:496–505 DOI 10.1007/s12529-013-9350-x.

Kuyken W, Brewin CR. 1994. Intrusive memories of childhood abuse during depressive episodes. *Behaviour Research and Therapy* **32(5)**:525–528 DOI 10.1016/0005-7967(94)90140-6.

Lahat A, Hong M, Fox NA. 2011. Behavioural inhibition: is it a risk factor for anxiety? *International Review of Psychiatry* **23(3)**:248–257 DOI 10.3109/09540261.2011.590468.

Lee JH, Ku J, Cho W, Hahn WY, Kim IY, Lee SM, Kang Y, Kim DY, Yu T, Wiederhold BK, Wiederhold MD. 2003. A virtual reality system for the assessment and rehabilitation of the activities of daily living. *CyberPsychology & Behavior* **6**(4):383–388 DOI 10.1089/109493103322278763.

Leventhal AM. 2008. Sadness, depression, and avoidance behavior. *Behavior Modification* **32**(6):759–779 DOI 10.1177/0145445508317167.

Marmar CR. 1996. Characteristics of emergency services personnel related to peritraumatic dissociation during critical incident exposure. *American Journal of Psychiatry* **153**(7):94–102 DOI 10.1176/ajp.153.7.94.

Marshall RD, Turner JB, Lewis-Fernandez R, Koenan K, Neria Y, Dohrenwend BP. 2006. Symptom patterns associated with chronic PTSD in male veterans: new findings from the National Vietnam Veterans readjustment study. *The Journal of Nervous and Mental Disease* **194**:275–278 DOI 10.1097/01.nmd.0000207363.25750.56.

Miettunen J, Veijola J, Lauronen E, Kantojärvi L, Joukamaa M. 2007. Sex differences in Cloninger's temperament dimensions—a meta-analysis. *Comprehensive Psychiatry* **48**(2):161–169 DOI 10.1016/j.comppsych.2006.10.007.

Molet M, Leconte C, Rosas JM. 2006. Acquisition, extinction and temporal discrimination in human conditioned avoidance. *Behavioural Processes* **73**:199–208 DOI 10.1016/j.beproc.2006.05.009.

Morgan BE. 2006. Behavioral inhibition: a neurobiological perspective. *Current Psychiatry Reports* **8**(4):270–278 DOI 10.1007/s11920-006-0062-7.

Moulds ML, Kandris E, Starr S, Wong AC. 2007. The relationship between rumination, avoidance and depression in a non-clinical sample. *Behaviour Research and Therapy* **45**(2):251–261 DOI 10.1016/j.brat.2006.03.003.

Myers CE, Kostek JA, Ekeh B, Sanchez R, Ebanks-Williams Y, Krusznis A, Weinflash N, Servatius RJ. 2016a. Watch what I do, not what I say I do: computer-based avatars to assess behavioral inhibition, a vulnerability factor for anxiety disorders. *Computers Human Behavior* **55**:804–816 DOI 10.1016/j.chb.2015.07.067.

Myers CE, Radell ML, Shind C, Ebanks-Williams Y, Beck KD, Gilbertson MW. 2016b. Beyond symptom self-report: use of a computer "avatar" to assess post-traumatic stress disorder (PTSD) symptoms. *Stress* **19**(6):593–598 DOI 10.1080/10253890.2016.1232385.

Myers CE, VanMeenen K, McAuley JD, Beck KD, Pang KCH, Servatius RJ. 2012. Facilitated acquisition of eyeblink conditioning in veterans with high behavioral inhibition, a risk factor for post-traumatic stress disorder (PTSD). *Stress* **15**(1):31–44.

Myers CE, VanMeenen KM, Servatius RJ. 2012. Behavioral inhibition and PTSD symptoms in veterans. *Psychiatry Research* **196**(2):271–276.

North CS, Nixon SJ, Shariat S, Mallonee S, McMillen JC, Spitznagel EL, Smith EM. 1999. Psychiatric disorders among survivors of the Oklahoma City bombing. *The Journal of the American Medical Association* **282**(8):755–762 DOI 10.1001/jama.282.8.755.

O'Donnell ML, Elliott P, Lau W, Creamer M. 2007. PTSD symptom trajectories: from early to chronic response. *Behaviour Research and Therapy* **45(3)**:601–606 DOI 10.1016/j.brat.2006.03.015.

Ottenbreit ND, Dobson KS. 2004. Avoidance and depression: the construction of the cognitive–behavioral avoidance scale. *Behaviour Research and Therapy* **42(3)**:293–313 DOI 10.1016/S0005-7967(03)00140-2.

Ottenbreit ND, Dobson KS, Quigley L. 2014. A psychometric evaluation of the cognitive-behavioral avoidance scale in women with major depressive disorder. *Journal of Psychopathology and Behavioral Assessment* **36(4)**:591–599 DOI 10.1007/s10862-014-9416-3.

Park IH, Kim JJ, Jang HJ, Kim CH, Ku J, Kim IY, Kim SI, Park SH. 2009. Characteristics of social anxiety from virtual interpersonal interactions in patients with schizophrenia. *Psychiatry Interpersonal & Biological Processes* **72(1)**:79–93 DOI 10.1521/psyc.2009.72.1.79.

Park KM, Ku J, Choi SH, Jang HJ, Park JY, Kim SI, Kim JJ. 2011. A virtual reality application in role-plays of social skills training for schizophrenia: a randomized, controlled trial. *Psychiatry Research* **189(2)**:166–172 DOI 10.1016/j.psychres.2011.04.003.

Parsons TD, Rizzo AA. 2008. Affective outcomes of virtual reality exposure therapy for anxiety and specific phobias: a meta-analysis. *Journal of Behavior Therapy and Experimental Psychiatry* **39(3)**:250–261 DOI 10.1016/j.jbtep.2007.07.007.

Pérez-Edgar K, Bar-Haim Y, McDermott JM, Chronis-Tuscano A, Pine DS, Fox NA. 2010. Attention biases to threat and behavioral inhibition in early childhood shape adolescent social withdrawal. *Emotion* **10(3)**:349–357 DOI 10.1037/a0018486.

Richman H, Frueh BC. 1997. Personality and PTSD II: personality assessment of PTSD-diagnosed Vietnam veterans using the Cloninger Tridimensional Personality Questionnaire (TPQ). *Journal of Depression and Anxiety* **6(2)**:70–77 DOI 10.1002/(SICI)1520-6394(1997)6:2<70::AID-DA3>3.0.CO;2-9.

Servatius RJ, Handy JD, Doria MJ, Myers CE, Marx CE, Lipsky L, Ko N, Avcu P, Wright WG, Tsao JW. 2017. Stress-related mental health symptoms and neurocognitive function in active duty Coast Guard personnel. *Frontiers in Psychology* **8**:Article 1513 DOI 10.3389/fpsyg.2017.01513.

Sheynin J, Beck KD, Pang KC, Servatius RJ, Shikari S, Ostovich J, Myers CE. 2014. Behaviourally inhibited temperament and female sex, two vulnerability factors for anxiety disorders, facilitate conditioned avoidance (also) in humans. *Behavioural Processes* **103**:228–235 DOI 10.1016/j.beproc.2014.01.003.

Sheynin J, Shind C, Radell M, Ebanks-Williams Y, Gilbertson MW, Beck KD, Myers CE. 2017. Greater avoidance behavior in individuals with posttraumatic stress disorder symptoms. *Stress* **20(3)**:285–293 DOI 10.1080/10253890.2017.1309523.

Simeon D, Yehuda R, Cunill R, Knutelska M, Putnam FW, Smith LM. 2007. Factors associated with resilience in healthy adults. *Psychoneuroendocrinology* **32(8)**:1149–1152 DOI 10.1016/j.psyneuen.2007.08.005.

Spurrell MT, McFarlane AC. 1995. Life-events and psychiatric symptoms in a general psychiatry clinic: the role of intrusion and avoidance. *Psychology and Psychotherapy: Theory, Research and Practice* **68(4)**:333–340.

Strakowski SM, Dunayevich E, Keck PE, McElroy SL. 1995. Affective state dependence of the Tridimensional Personality Questionnaire. *Psychiatry Research* **57(3)**:209–214 DOI 10.1016/0165-1781(95)02655-G.

Suls J, Bunde J. 2005. Anger, anxiety, and depression as risk factors for cardiovascular disease: the problems and implications of overlapping affective dispositions. *Psychological Bulletin* **131(2)**:260–300 DOI 10.1037/0033-2909.131.2.260.

Svihra M, Katzman MA. 2004. Behavioural inhibition: a predictor of anxiety. *Paediatrics & Child Health* **9(8)**:547–550 DOI 10.1093/pch/9.8.547.

Svrakic DM, Przybeck TR, Cloninger CR. 1992. Mood states and personality traits. *Journal of Affective Disorders* **24(4)**:217–226 DOI 10.1016/0165-0327(92)90106-G.

Tull MT, Gratz KL. 2008. Further examination of the relationship between anxiety sensitivity and depression: the mediating role of experiential avoidance and difficulties engaging in goal-directed behavior when distressed. *Journal of Anxiety Disorders* **22(2)**:199–210.

Tull MT, Gratz KL, Salters K, Roemer L. 2004. The role of experiential avoidance in posttraumatic stress symptoms and symptoms of depression, anxiety, and somatization. *Journal of Nervous and Mental Disease* **192(11)**:754–761 DOI 10.1097/01.nmd.0000144694.30121.89.

Waller D, Beall AC, Loomis JM. 2004. Using virtual environments to assess directional knowledge. *Journal of Environmental Psychology* **24(1)**:105–116 DOI 10.1016/S0272-4944(03)00051-3.