

THE RELATIONSHIP BETWEEN PSYCHOMETRICALLY-DEFINED SOCIAL
ANXIETY AND WORKING MEMORY PERFORMANCE

by

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ABSTRACT

Anxiety disorders are among the most commonly diagnosed class of mental illness in the United States, and often involve abnormally high levels of stress and social fear. Despite high lifetime prevalence rates, social anxiety disorder (SAD) has remarkably low diagnosis and treatment rates.

Furthermore, while individuals with other specific psychiatric disorders tend to exhibit significant neuropsychological deficits, neuropsychological functioning in individuals with SAD remains largely untested. A majority of the few existing studies concerning neuropsychological performance in SAD samples focus on specific functions, and their limited results are highly mixed.

The primary objective of this investigation was to provide a more thorough, broad assessment of both auditory and visual working memory as related to psychometrically-defined social anxiety disorder. In addition, this study aimed to help clarify as to whether such deficits are related to the construct of social anxiety, or whether any potential deficits are better explained by generalized state and/or trait (in-the-moment) anxiety.

The implications of a deficit in the visual and/or auditory working memory domains are multifaceted. For example, such a deficit may lead to the inability to detect visual cues in social situations. The inability to process these social cues has the potential to exacerbate some SAD-related symptoms, such as fear of humiliation and judgment.

Twenty-nine college students completed both phases of this study, including an assessment of state and trait anxiety as well as social phobia and a four-part working memory battery. An analysis of the Phase II data indicates that individual scores on the four measures of

both visual and auditory working memory did not relate to trait and/or state anxiety or psychometrically-defined social anxiety. Thus, it appears that social, generalized trait, and generalized state anxiety do not relate to a neuropsychological deficit in either type of working memory in this sample population. However, we did find a statistical trend suggesting that as social anxiety increased, there was a relative decrease in visual vs. auditory working memory. This statistical trend remained after covarying for state and trait anxiety respectively. Therefore, future research in this area should examine the discrepancy in performance between the auditory and visual working memory domains as it relates to both diagnosed social phobia and psychometrically-defined social anxiety.

DEDICATION

“ In the adventure known as Life, there are those who live it vicariously, and enjoy the ride from the safety of an armchair. There are those who have a few chances to realize incredible and life changing experiences, and although they don't repeat them, they carry with them a growth and personal philosophy for the rest of their lives. And there are those for whom a taste is never enough. For whom the lust of adventure is insatiable. And if you add to that the overwhelming desire to create, and to share, then you get where I reside. Where the end of one adventure only signifies the beginning of another.”

-Les Stroud

This coursework is dedicated to Cynthia and Ivan Vaillancourt, whose tremendous efforts have afforded me the extraordinary privilege of attending and contributing to this university.

- and -

To my late grandparents: Donald Lockery, Casmir and Irene Paskowski.

To ‘Auntie’ Rose Leone and Orville Purdy.

You are all inexplicably missed.

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Go Knights!

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LIST OF ACRONYMS AND ABBREVIATIONS

SPAI-23	23- Item Social Phobia and Anxiety Inventory
STAI	State-Trait Anxiety Inventory
WMS-IV	Wechsler Memory Scale – 4 th Edition
WAIS-IV	Wechsler Adult Intelligence Scale – 4 th Edition
WM	Working Memory
SAD	Social Anxiety Disorder
BDI-II	Beck Depression Inventory—2 nd Revision
DSM-IV-TR	Diagnostic and Statistical Manual

INTRODUCTION AND RATIONALE

According to the *Diagnostic and Statistical Manual of Mental Disorders-IV-TR* (2000), both generalized and specific social anxiety disorder are characterized by the marked and interminable fear of humiliation, and may involve persistent and/or intense stress and fear, especially with regard to one's performance in social situations with unfamiliar people (American Psychiatric Association, 2000). Speaking, writing, or working in social situations may cause stress, intense fear, or anxiety, and as such social anxiety disorder (SAD; DSM IV-TR 300.23) patients may choose to avoid specific situations (Agouridas, Ekinci, Fistikci, Götentür, & A. Topçuoğlu, 2009). Perhaps more notably, lifetime frequencies for the presence of a *specific* isolated social fear far exceed the generalized subtype of social anxiety. For example, one study conducted at the University of Bremen's *Center for Rehabilitation Research* involving 1,035 adolescents (age range = 12-17 years) found that the frequency of specific social fears, such as public speaking, greatly exceeded that of generalized social anxiety disorder (Essau, Conradt, & Petermann, 1999).

Anxiety disorders are among the most commonly diagnosed class of mental illness in the United States (Seim & Spates, 2010). More specifically, social anxiety disorder is twice as common in females than in males, and has the highest lifetime prevalence (13.3%) of any anxiety-related disorder (Agouridas, et al., 2009; Kessler, 2003). Furthermore, due to an early onset and low diagnosis and treatment rates, SAD often becomes a chronic mental health issue in adults (Agouridas, et al., 2009). In addition to both general and specific fears and avoidances, individuals diagnosed with SAD may exhibit decreased job performance, lower educational achievement, and higher unemployment rates than that of healthy individuals (Agouridas, et al.,

2009). Often, patients with SAD opt to self-medicate with drugs or alcohol prior to seeking psychiatric treatment, but these behaviors only intensify the demonstration of fear and social avoidance, and may have further unknown effects on memory and cognitive performance (Adamson, Sellman, & Robertson, 2008; American Psychiatric Association, 2000).

While individuals with other specific psychiatric disorders tend to have significant neuropsychological deficits (e.g., schizophrenia and autism), the neuropsychological functioning in individuals with SAD remains unclear. Only a handful of published studies have examined any aspect of neuropsychological performance in SAD samples, and those studies tend to find different deficits. The major limitation of these studies is that each one only examined a few areas of neuropsychological functioning, rather than a more traditional broad neuropsychological battery. A recent unpublished study appears to be the first attempt at administering a comprehensive neuropsychological battery to a sample of individuals with SAD compared to a nonpsychiatric sample (Sutterby & Bedwell, unpublished). This study found no evidence of any neuropsychological deficits related to SAD, but did report an isolated potential deficit in visual working memory (Spatial Span subtest of the WMS-III) that did not quite survive a conservative statistical correction for multiple comparisons. Related to this finding, Graver and White (2007) examined performance on the same Spatial Span subtest in an SAD sample under both stress-induced and baseline conditions. While there was no difference in performance on this task between individuals with SAD and controls under baseline conditions, spatial span performance decreased significantly in only the SAD group when re-evaluated shortly following the introduction of a social stressor (Graver & White, 2007). Outside of these two reports, there does not appear to any further investigations of visual working memory performance as related to

either SAD or psychometrically-defined social anxiety. Furthermore, three studies have examined auditory (rather than visual) working memory in SAD samples and none of them have found any suggestion of auditory working memory deficit in this disorder (Cohen et al., 1996; Graver & White, 2007; Sutterby & Bedwell, unpublished). However, two of these studies (Cohen et al., 1996; Graver & White, 2007) included only one brief measure (Digit Span) to assess auditory working memory.

One reason why there are so few studies investigating neuropsychological functioning in individuals diagnosed with SAD may be due to the potentially confounding influence of general anxiety associated with performing cognitive tasks in front of the researcher. This is a factor that often complicates the administration and interpretation of these tests in individuals with any anxiety disorder, but particularly in individuals with SAD, as there is a social aspect to performing in front of another person (Agouridas, et al., 2009; Heinrichs & Hofmann, 2005). For example, one study found that both an obsessive-compulsive disorder and a panic disorder group performed more poorly on spatial attention and visual working memory tasks than did a comparison group with clinical depression, but showed no differences on other types of cognitive tasks (Purcell, Maruff, Kyrios, & Pantelis, 1998). This could also explain why the Graver & White study only found the visual working memory deficit in the SAD sample after a social stressor and not at baseline. Ostensibly, this could imply that visual working memory tasks may be particularly sensitive to the presence of high levels of general trait anxiety, which are commonly found across all anxiety disorders.

Recent research has highlighted the complex and influential role that trait anxiety and stress may have on memory and cognition—especially executive and attention-based working

memory performance. In one particular study examining the possible effects of induced social stress on implicit, explicit, and working memory performance, Luethi, Meier, and Sandi (2008) repeatedly measured salivary cortisol levels during trials of induced social stress in a group of healthy young adult men. Cortisol (hydrocortisone) is a corticosteroid hormone secreted by the adrenal cortex as a general, biological response to stress, and as such salivary cortisol levels are often used as a measure of stress in experimental trials. The results of this study further demonstrate that a rather complex relationship exists between stress and memory performance: here, stress enhanced spatial explicit memory and classical conditioning for negative stimuli, yet proved highly disruptive for working memory and implicit memory (Luethi, et al., 2008). This may come as no surprise: memory is an organic, multi-faceted process—a reflection of the spatial organization of the physical brain—and several fMRI studies (e.g., Cohen, et al., 2004; Haut, Kuwabara, Leach, & Arias, 2000) have revealed active working memory components that are highly contingent on the functions of the prefrontal and inferior temporal cortices. The disruption of activity in these cortical regions due to the neurotoxic environment generated by the presence excess cortisol in response general life stress, psychopathology, or both, may result in working memory deficits (Luethi, et al., 2008).

Considering the unclear findings regarding a potential visual working memory deficit at baseline in SAD, along with the overall insufficient assessment of both visual and auditory working memory in this population, the primary objective of this investigation was to provide a more thorough assessment of both auditory and visual working memory as related to psychometrically-defined social anxiety. The aim was to help clarify whether such deficits are

related to the construct of social anxiety and whether any potential deficits are better explained by more general state and trait anxiety.

The implications of a deficit in the visual or auditory memory domain are multifaceted. For example, such a deficit may lead to an inability to detect visual cues in social situations, such as when a conversational partner sighs or checks her watch while speaking. The inability to process these subtle cues certainly has the potential to exacerbate some SAD-related symptoms such as fear of humiliation or judgment. Likewise, impairment in the auditory working memory could result in difficulty keeping up with what others are saying during conversations, which could also exacerbate social anxiety.

Based on the few existing studies regarding working memory performance in individuals diagnosed with SAD, we hypothesized that as college students scored higher on a continuum of psychometrically-defined social anxiety, they would exhibit worse performance on tasks of visual working memory. However, we predicted that there would be no relationship between social anxiety and performance on tasks of auditory working memory. The reduction in performance on visual working memory tasks as related to increasing levels of self-reported social anxiety was expected to be best explained by an exponential curve, as we did not expect much reduction in visual working memory performance until relatively high levels of social anxiety. As some of the previous research has suggested that working memory deficits may be related more broadly to state or trait anxiety, and not specific to social anxiety, we further hypothesized that the relationship initially found between social anxiety and visual working memory would no longer be statistically significant when either state or trait general anxiety was added as a covariate.

METHOD

Participants

The first phase of this study recruited 562 students at UCF with varying levels of social anxiety through the use of the online Psychology Department “SONA” experiment management system. Participants had already registered in the SONA system database through classes at the university, per department regulation. All participants were at least 18 years of age, due to our inability to acquire parental consent prior to the online survey completion. While there were no further restrictions based on age, gender, or ethnic background, proper color vision and adequate hearing and eyesight were required qualities of all those participating in Phase II of the experiment. Of the 562 Phase I participants, 27 (4.8%) were excluded from participation in the second phase for reporting current use of prescription medication that may impair cognitive performance, 107 (19%) were excluded for a BDI-II score above 17, and 24 (4.2%) were excluded for answering more than one of the Infrequency Scale items in the wrong direction. Following recruitment efforts on the 404 (71.89%) remaining eligible participants, 29 agreed to participate in the second, in-person, phase of this study. Of the Phase II participants, approximately 47% were freshmen (first year); 16% were sophomores (second year); 26% were juniors (third year); and 11% were seniors (fourth year +). The racial distribution of this sample was 63% Caucasian, 1% Asian-Pacific Islander, 1% African American, and 35% other/mixed (incl. Hispanic). Finally, the Phase II gender distribution was approximately 72% female.

The use of an online survey (Phase I) was required to estimate each participant’s level of social anxiety, as well as their current level of depression. For the online phase of the experiment, participants received instant compensation in the form of class credit for a

Psychology course of their choice, given that is enrolled in the SONA system. The online assessment typically lasted no longer than 30 minutes per participant. During the online survey, we asked participants if they are currently prescribed a benzodiazepine, narcotic pain medication, and/or antipsychotic medication (note: we provided example drug names from each category). If a participant reported the current use of one of these medications, they were excluded from participation in the lab-based portion of the study, as these medications have the potential to decrease cognitive performance. We also asked participants if they have been diagnosed with a current mood or psychotic disorder, as these disorders can also decrease cognitive performance, particularly on memory tasks. In addition, because it has been well appreciated that chronic and/or episodic depression is associated with cognitive functional disability, any participants who scored above 17 on the included online inventory were excluded from this study, as this cut score has been found to correctly classify 92% of patients with major depressive disorder (Arnau, Meagher, Norris, & Bramson, 2001).

We contacted the qualifying participants via e-mail and requested that they return for the additional psychometric evaluation. Those who qualified for—and accepted—participation in the lab phase were required to promptly return for additional evaluation for additional credits. The psychometric measures employed thereafter are described in detail below.

Measures

Social Phobia and Anxiety Inventory (SPAI-23)

The SPAI-23 (Roberson-Nay, Strong, Nay, Beidel, & Turner, 2007) is an abbreviated, 23-item version of the original 45-item self-report social phobia inventory. The SPAI-23 is empirically derived and was developed using item response theory to assess social

psychopathology across various situations. The SPAI demonstrates an advantage relative to other social phobia inventories because of the inclusion of an agoraphobia subscale; this score can be subtracted from the SPAI social phobia subscale score to create a 'difference score,' thus allowing for differentiation between the two symptoms. The authors of the SPAI-23 cite high test-retest reliability for both the social phobia and difference scores as well as high internal validity. In addition, SPAI-23 scores are significantly correlated with self-ratings ($r = .43$) and the difference scores were similarly correlated to scores on the original SPAI-45 ($r = .94$) (Roberson-Nay, et al., 2007).

State-Trait Anxiety Inventory (STAI)

The State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) is an empirically derived, 20-item self-report anxiety inventory that serves to detect and measure episodic (state) anxiety as well as chronic (trait) anxiety. The 20 items on the current version are divided equally among state and trait anxiety, and the authors of this measure cite equitable test-retest reliability, having considered the influence of environmental effects in causing fluctuations in state anxiety scores. Measures of internal consistency have demonstrated both high median state ($r = .88$ to $.93$) and trait ($r = .92$ to $.94$) anxiety coefficients (Kabacoff, Segal, Hersen, & Van Hasselt, 1997). The validity of the STAI is asserted in several ways. For example, Spielberger et al. (1983) has demonstrated that the STAI is sensitive to the impact of psychological intervention, and also that stable trait anxiety scores are generally higher in psychiatric, rather than non-psychiatric, groups.

Beck Depression Inventory-II (BDI-II)

A.T. Beck developed the BDI in 1961 for assessing the severity of depression in adults and older children. It has since witnessed two major revisions in compliance with changing criterion for depression in the DSM-IV: once in 1971, and again in 1996. The revised version is a 21-item Likert-type questionnaire, and was derived from observing the symptoms and attitudes of clinically depressed patients (Beck, Steer, & Brown, 1996). Items on the BDI-II relate to specific domains in depression, including (but not limited to) one's sense of guilt, self-worth, sleep abnormalities, loss of appetite, loss of pleasure, and punishment. The BDI-II was validated using college students and adolescent to adult-aged psychiatric outpatients, and has demonstrated exceptional test-retest reliability, high convergent validity, and high internal consistency (Arnau, et al., 2001; Beck, et al., 1996).

Wechsler Memory Scale – IV (WMS-IV) Symbol Span Subtest

The *WMS-IV Symbol Span* task assesses the storage and manipulation of visual cues in working memory. During the task, participants are shown a series of symbols in increasing succession for five seconds. Then, participants are shown a list of possible symbols and are asked to select the symbols shown in the correct order. The authors of the *WMS-IV Symbol Span* task cite excellent test-retest reliability and internal consistencies (Wechsler, 2009).

Wechsler Memory Scale – IV (WMS-IV) Spatial Addition Subtest

The *WMS-IV Spatial Addition* task assesses the spatial storage and manipulation of visual cues in working memory, and is derived from an *n*-back paradigm. During the initial phase of the task, participants are shown a card containing a grid with either red and/or blue dots on it for five

seconds, and are instructed to remember the location of either the blue dots and ignore the red dots. During the second phase, the participant is shown another similar card with either red and/or blue dots on it for an additional five seconds, and instructed to remember the locations of the blue dots, ignoring the red ones in the same fashion as the first phase, except this time participants must spatially retain and arrange the two visual images of the cards conjointly. During the third and final phase, the participant is given a blank card and a number of blue or blank dots, and is instructed to place the blue dots wherever they previously saw blue dots and blank dots where ever blue dots appear on both cards. As with the *WMS-IV Symbol Span* subset, the authors of the *WMS-IV Spatial Addition* subset attribute its high internal consistency and test-retest reliability to its intuitive, empirically-derived design (Wechsler, 2009).

Wechsler Adult Intelligence Scale – IV (WAIS-IV) Letter-Number Sequencing Subset

Whereas the previous two WMS-IV subtests fell under a visual working memory domain, the *WAIS-IV Letter-Number Sequencing* task assesses the storage and manipulation of auditory cues in working memory. Developed by Gold et al. (1997), the *WAIS-IV Letter-Number Sequencing* task involves presenting subjects with a random list of letters and numbers, and then asking them to repeat them in a new sequence by first listing the numbers in ascending order, then the letters in alphabetical order. High performance on the *Letter-Number Sequencing* subset suggests that the participant possesses good auditory attention, concentration, and sequencing—all indicative of normal short-term auditory memory performance. With respect to reliability and validity, the *Letter Number Sequencing* subset is thought to have sufficient psychometric properties; this *WAIS-IV* subset has demonstrated high test-retest reliability ($r = .80$), and a factor analysis reveals a factor loading of .69 with the Working Memory Index (Groth-Marnat, 2009).

Wechsler Adult Intelligence Scale – IV (WAIS-IV) Digit Span Subset

The *WAIS-IV Digit Span* subset assesses auditory sequencing and executive-based attention, with a focus on immediate recall, reversibility, and sequencing numbers (“digits”) from forward to backward (Groth-Marnat, 2009). The *Digit Span* subset includes several facets, requiring the participant to recall and internally manipulate or rearrange digits in a specific sequential order and then repeat them aloud to the experimenter. High levels of anxiety or stress are thought to interfere with performance on the *Digit Span* subset, as the sequencing involved is susceptible to mistakes caused by distraction and nervousness. As with the *WAIS-IV Letter-Number Sequencing* subset, the publishers of the *WAIS-IV Digit Span* subset cite high internal validity and reliability (Groth-Marnat, 2009).

Procedure

Informed consent was obtained using an online SONA Experiment Management System, wherein participants were randomly recruited and allowed to complete the first phase of this study by submitting the SPAI-23 and BDI-II questionnaires to assess for social anxiety as well as depression and other psychopathology. Participants were instantly and automatically compensated for their contribution through class credit (participants elected to which class the credit was granted). Qualifying participants were then contacted via e-mail and asked to return for further psychometric evaluation. Those participants who agreed to return completed new paper versions of the SPAI-23 and the STAI. They were then presented with the WMS-IV Symbol Span, Spatial Addition, and the WAIS-IV Letter-Number Sequencing and Digit Span subsets, respectively. Immediately following the test phase, participants received SONA credit and were debriefed about the purpose of this study and provided with a list of referral services

should they elect to seek psychiatric treatment. At the end of the study, participants were informed about an optional research experience exit survey, which could be completed at any time during the semester.

Statistical Analysis

Scores on all instruments measuring working memory performance in both the visual and auditory domains were converted to z -scores, which were then averaged within modality in order to create the visual and auditory domain scores. The domain scores were then correlated with the SPAI score. Following inspection of these zero-order Pearson correlations, we then conducted two more sets of partial correlations. The first set covaried for general state anxiety (data generated from STAI), and the second set covaried for trait anxiety (also from STAI). Finally, a working memory discrepancy score was generated by subtracting the visual working memory domain score from the auditory working memory domain score. This discrepancy score was then correlated with the SPAI total score (zero-order correlation) and examined with the same two partial correlations described above.

RESULTS

The Phase II sample had a mean Phase II SPAI-23 score of 27.00 (SD = 9.25; Range 13 to 46). For descriptive statistics concerning the scores on each working memory test and the STAI, refer to Table 2. Examination of all measures listed in Table 2 revealed relatively normal distributions with all skewness and kurtosis values $< \pm 2.0$.

Zero-order correlations between the auditory and visual working memory domain scores with the SPAI-23 scores indicated no statistically significant relationships (see Table 3). To examine our hypothesis that this would be represented by an exponential curve, we examined various nonlinear curve fits to this relationship and none approached statistical significance (and a linear fit provided the highest correlation value). When exploring the relationship between the individual subtests and the SPAI-23 score, there was only one correlation that was a statistical trend, which was a positive correlation between the SPAI score and the Letter-Number Sequencing score from the Auditory Working Memory domain (e.g., those with more social anxiety tended to perform better on this auditory working memory subtest). The remaining correlations between the SPAI-23 scores and the other three subtests did not approach statistical significance. Partial correlations that separately covaried for state and trait anxiety also revealed no statistically significant correlations between the auditory and visual working memory domain scores and the SPAI-23 scores.

As the correlation between SPAI scores and the visual working memory domain scores was slightly negative—while the correlation between SPAI scores and auditory working memory domain scores was slightly positive—a discrepancy score was calculated by subtracting the visual working memory domain score from the auditory working memory domain score. When

parallel exploratory analyses were conducted with this discrepancy score, there was a statistical trend for a positive relationship between the SPAI total score and the discrepancy score, meaning that as social anxiety increased, there was a relative decrease in visual vs. auditory working memory (see Table 3 and Figure 1). This relationship remained after covarying for state and trait general anxiety respectively (see Table 4).

DISCUSSION

An analysis of the Phase II data indicates that neither the verbal or visual working memory domain scores were related to either psychometrically-defined social anxiety disorder, or state or trait general anxiety. In addition, when we looked at the individual subtests that comprised these domain scores, there were also no statistically significant correlations, although there was a statistical trend for increased performance on the Letter-Number Sequencing subtest of the Auditory Working Memory domain in relation to increased social anxiety.

Thus, the data supports half of our first hypothesis, in that auditory working memory scores were not related to psychometrically-defined social anxiety. The second half of our first hypothesis, which postulates a deterioration in visual working memory performance as a function of rising social anxiety index scores, is not supported by the data. This null finding does not appear to be a simple function of our relatively small sample size ($N = 29$), as the p -values did not even approach statistical significance.

However, an exploratory working memory discrepancy score, generated by subtracting visual working memory subset scores from auditory working memory subset scores, showed a statistical trend for a positive relationship with the Phase-II SPAI-23 scores. This means that there was some tendency for participants to have relatively higher auditory than visual working memory scores as the SPAI-23 score increased (see Figure 1). This relationship remained a statistical trend when covarying for state and trait anxiety respectively. Thus, there is a preliminary suggestion that increased social anxiety is related to a personal weakness in visual working memory compared to the same participant's auditory working memory score. It is

possible that with a larger sample size, this statistical trend would become statistically significant. However, this potential relationship remains unclear with the current dataset.

Although social anxiety disorder is twice as common in females than males, sex distribution was a limitation to this study. Due to the difficult nature of recruiting college-aged male students in our Psychology Department, our sex distribution was 72% female, and as such was not a representative sample of a general nonpsychiatric community population. Related to this, our reliance on college students also limits generalization to a general nonpsychiatric community population. Also, our sample size was limited, which decreased our statistical power. However, the majority of our primary analyses did not approach statistical significance, and the Phase II sample mean SPAI-23 scores accurately matched the non-clinical sample of undergraduates used in the development of the SPAI-23 (Roberson-Nay, et al., 2007), making it unlikely that we would have found our primary relationships of interest with a different sample of undergraduate participants.

While there was not enough evidence to support our original hypothesis that visual working memory performance deteriorates as a function of SPAI-23 scores, and in particular that a significant relationship between these two variables would manifest itself as SPAI-23 scores approached high levels of social anxiety, there was some preliminary suggestion that visual working memory performance decreased relative to auditory working memory performance with increased social anxiety. As such, future research in this area should examine the discrepancy in performance between the auditory and visual working memory domains as it relates to both diagnosed social phobia and psychometrically-defined social anxiety.

TABLES

Table 1: Summary of Measures and Estimated Time Allotment

<i>Measure</i>	<i>Domain</i>	<i>Approx. Time Required</i>
SPAI-23	Social Anxiety	5 Minutes
STAI	General Anxiety	5 Minutes
BDI-II	Depression	10 Minutes
WMS-IV Spatial Addition [*]	Visual WM	15 Minutes
WMS-IV Symbol Span [*]	Visual WM	15 Minutes
WAIS-IV Letter-Number Sequencing ^{**}	Auditory WM	5 Minutes
WAIS-IV Digit Span ^{**}	Auditory WM	5 Minutes

* WMS: Wechsler Memory Scale

** WAIS: Wechsler Adult Intelligence Scale

† WM: Working Memory

Table 2: Descriptive Statistics for SPAI-23, STAI, and Working Memory Domain Scores (N=29)

<i>Measure</i>	<i>Mean</i>	<i>Standard Deviation</i>	<i>Minimum</i>	<i>Maximum</i>
STAI (State) †	45.69	5.27	34.00	56.00
STAI (Trait) †	47.41	3.88	38.00	55.00
SPAI-23 (Phase II)	27.00	9.25	13.00	46.00
WMS-IV Spatial Addition*	9.14	4.02	1.00	16.00
WMS-IV Symbol Span*	21.52	5.13	10.00	36.00
WAIS-IV Letter-Number Sequencing**	19.55	2.78	15.00	25.00
WAIS-IV Digit Span †***	28.44	4.98	19.00	38.00
WAIS-IV Digit Span (F)	11.48	2.11	7.00	15.00
WAIS-IV Digit Span (B)	8.76	1.90	5.00	13.00
WAIS-IV Digit Span (S)	8.21	2.45	3.00	13.00

* WMS: Wechsler Memory Scale

** WAIS: Wechsler Adult Intelligence Scale

*** SPAI: Social Phobia Anxiety Inventory-23 (Roberson-Nay, et al., 2007)

† STAI: State-Trait Anxiety Inventory (Spielberger, et al., 1983)

‡ “Digit Span” is the total score on all three Digit Span subsets (Forward, Backward, and Sequencing)

Table 3: Pearson Correlations for the SPAI-23, STAI, and VWM / AWM Scores (N=29)

<i>Measure</i>		<i>STAI (S)</i>	<i>STAI (T)</i>	<i>SPAI Total</i>	<i>LNS</i>	<i>DS</i>	<i>SA</i>	<i>SSP</i>	<i>AWM</i>	<i>VWM</i>
STAI (State)	Pearson Correlation Sig. (2-tailed)									
STAI (Trait)	Pearson Correlation Sig. (2-tailed)	.177 .358								
SPAI Total (Phase 2)	Pearson Correlation Sig. (2-tailed)	-.147 .446	.080 .678							
WAIS-IV Letter-Number Sequencing [‡]	Pearson Correlation Sig. (2-tailed)	-.066 .735	-.207 .282	.324 .086						
WAIS-IV Digit Span [‡]	Pearson Correlation Sig. (2-tailed)	.011 .955	-.150 .438	.193 .315	.683** <.001					
WMS-IV Spatial Addition [‡]	Pearson Correlation Sig. (2-tailed)	-.006 .974	-.065 .736	-.088 .649	.417* .024	.319 .092				
WMS-IV Symbol Span [‡]	Pearson Correlation Sig. (2-tailed)	-.035 .858	-.041 .831	-.050 .798	.196 .307	.071 .713	.423* .022			
Total Auditory Working Memory [‡]	Pearson Correlation Sig. (2-tailed)	-.030 .878	-.194 .313	.282 .138	.917** <.001	.918** .000	.401* .031	.146 .450		
Total Visual Working Memory [‡]	Pearson Correlation Sig. (2-tailed)	-.024 .900	-.062 .744	-.082 .673	.364 .053	.231 .227	.844** <.001	.843** <.001	.324 .086	
Working Memory Discrepancy Score [‡]	Pearson Correlation Sig. (2-tailed)	-0.07 .973	-.122 .530	.320 .091	.521** .004	.630** <.001	-.336 .075	-.564** .001	.627** <.001	-.533** .003

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

WMS / WAIS: Wechsler Memory Scale / Wechsler Adult Intelligence Scale

AWM / VWM: Auditory Working Memory / Visual Working Memory

LNS: Letter-Number Sequencing

DS: Digit Span

SA: Spatial Addition

SSP: Symbol Span

SPAI: Social Phobia Anxiety Inventory-23 (Roberson-Nay, et al., 2007)

† STAI: State-Trait Anxiety Inventory (Spielberger, et al., 1983)

‡ These statistics are representative of the z-scores used in the data analysis

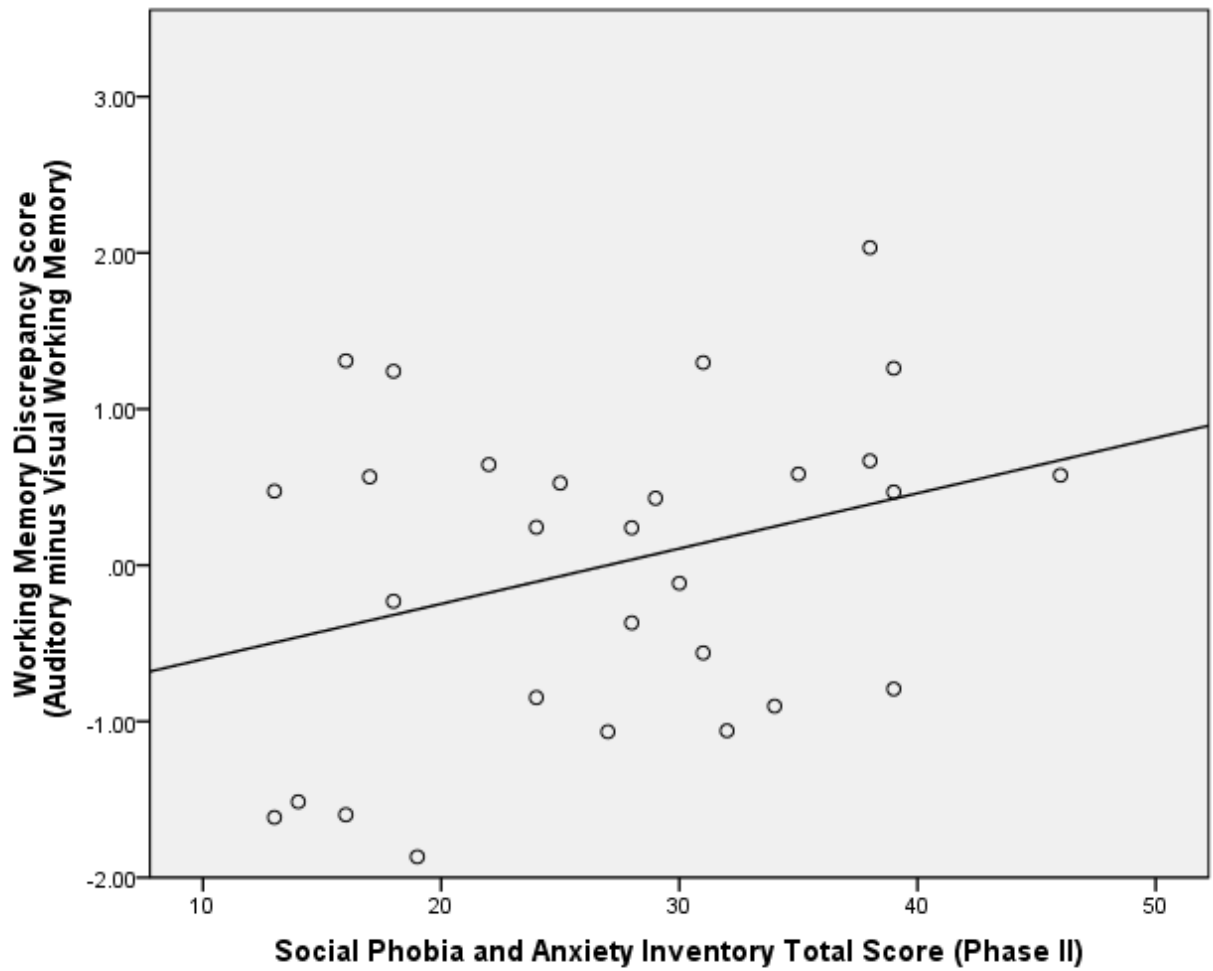
Table 4: Partial Correlations for the State-Trait Anxiety Inventory, SPAI, Auditory / Visual Working Memory Scores, and the Working Memory Discrepancy Score ($df=26$)

			<i>SPAI Total</i>	<i>Auditory WM*</i>	<i>Visual WM*</i>	<i>WM*</i> <i>Disc.</i>
<i>Covarying for STAI (State)</i>	Auditory Working Memory	Pearson Correlation Sig. (2-tailed)	.281 .148			
	Visual Working Memory	Pearson Correlation Sig. (2-tailed)	-.086 .662	.324 .093		
	Working Memory Discrepancy	Pearson Correlation Sig. (2-tailed)	.322 .095	.627 <.001	-.534 .003	
<i>Covarying for STAI (Trait)</i>	Auditory Working Memory	Pearson Correlation Sig. (2-tailed)	.305 .115			
	Visual Working Memory	Pearson Correlation Sig. (2-tailed)	-.077 .697	.319 .098		
	Working Memory Discrepancy	Pearson Correlation Sig. (2-tailed)	.333 .083	.620 <.001	-.546 .003	

* WM: Working Memory

FIGURES

Figure 1: Scatterplot of the Relationship Between the Social Phobia and Anxiety Inventory Total Score from Phase II and the Working Memory Discrepancy Score



APPENDIX A

University of Central Florida Institutional Review Board
Letter of Approval of Human Research



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

Approval of Human Research

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

To: Jeffrey S. Bedwell

Date: August 31, 2010

Dear Researcher:

On August 31, 2010, the IRB approved the following human participant research until 8/30/2011 inclusive:

Type of Review: Submission Correction for UCF Initial Review Submission Form
 Project Title: The Relationship Between Psychometrically Defined Social Anxiety and Working Memory Performance
 Investigator: Jeffrey S. Bedwell
 IRB Number: SEB-10-07069
 Funding Agency: None

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

If continuing review approval is not granted before the expiration date of 8/30/2011, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in IRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

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

On behalf of Joseph Biclitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Janice Turchin on 08/31/2010 11:54:51 AM EDT

IRB Coordinator

APPENDIX B

University of Central Florida Honors in the Major
Scholarship Award Letter



Department of Chemistry

October 28, 2010

Dear Timothy Paskowski:

Thank you for applying to the Honors in the Major (HIM) Scholarship Program. We received many excellent application packages and the choosing the award winners was a very difficult task.

I am pleased to inform you that your application was selected for an award for the Fall 2010 semester. Congratulations! Please contact the Honors College for more information regarding disbursement of the funds and associated dates.

Congratulations and good luck in your future research and studies at UCF.

Best Regards,

A handwritten signature in black ink that reads "Cherie L. Geiger".

Cherie L. Geiger, Ph.D.
Department of Chemistry

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