Brief report

The relation of depression and anxiety to measures of executive functioning in a mixed psychiatric sample

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Abstract

The relationship between mood and executive functioning is of particular importance to neuropsychologists working with mixed psychiatric samples. The present study evaluated the relation of self-reported depression and anxiety to several common measures of executive functioning: the Wisconsin Card Sorting Test, the Trail Making Test, the Controlled Oral Word Association, and the Letter–Number Sequencing subtest of the Weschler Adult Intelligence Scale-III. Records from 86 adult patients evaluated in an outpatient psychiatry unit were examined. Correlations between self-reported depression or anxiety and most measures of executive functioning were small and non-significant. The variance predicted by depression or anxiety after controlling for age, gender, and IQ was minimal (typically \( \leq 3.0\% \)), even after conducting diagnostic subgroup analyses. These results suggest that impaired performance on measures of executive functioning is minimally related to self-reported depression and anxiety within mixed psychiatric settings.

Keywords: Executive functioning; Depression; Anxiety; Trail Making Test; Wisconsin Card Sorting Test

Executive functioning may be broadly defined as the ability to adaptively respond to novel situations and purposely coordinate one’s actions (Lezak, Howieson, & Loring, 2004) and is often attributed to functioning of the frontal lobe. Abilities subsumed under executive functioning include sustaining, directing, and appropriately shifting attention (including working memory); planning; inhibiting inappropriate responses; and designing, selecting, and implementing problem-solving strategies (Engle & Kane, 2004; Engle, Tuholski, Laughlin, & Conway, 1999; Lezak et al., 2004).

The relationship between mood and executive functioning has been of particular interest to neuropsychologists in recent years. A growing body of literature attests to this fact. Research to date has focused primarily on the relationship between depression and executive functioning, with relatively equivocal results. Some studies have found significant differences in executive functioning between depressed patients and non-depressed controls (e.g., Fossati, Amar, Raoux, Ergis, & Allilaire, 1999; Kindermann, Kalayam, Brown, Burdick, & Alexopoulos, 2000; Merriam, Thase, Haas, Keshavan, & Sweeney, 1999). Others have concluded that depressed patients do not manifest central executive functioning deficits (e.g., Martin, Oren, & Boone, 1991) or have failed to find group differences after controlling for
intellectual functioning (Watkins & Brown, 2002). Still others have demonstrated that individuals who are depressed with psychotic features manifest executive functioning deficits, whereas nonpsychotic depressed patients score within the average range on many neuropsychological tests (Basso & Bornstein, 1999).

By comparison to studies on depression, research on the relationship between anxiety and executive functioning is relatively sparse. There appears to be modest but mixed evidence for executive dysfunction among individuals diagnosed with obsessive-compulsive disorder, particularly on tasks associated with memory performance (for reviews see Kuelz, Hohagen, & Voderholzer, 2004; Tallis, 1997; cf. Moritz, Hübner, & Kluwe, 2004). Studies on the relationship between the other anxiety disorders (e.g., panic disorder, generalized anxiety disorder, social phobia) and executive functioning are lacking.

Because of the frequency with which measures of executive functioning are administered in neuropsychological settings, it is important to understand the effects of depression and anxiety on scores among different populations of interest. Practicing neuropsychologists are often charged with the complicated task of discerning whether deficits on measures of executive functioning are epiphenomena of a patient’s mood state or instead reflective of a broader cognitive disturbance. Because most studies to date have focused on comparisons of relatively homogeneous diagnostic groups, their conclusions may not be directly relevant to the practice of neuropsychologists who work with mixed samples. To our knowledge, no published studies have directly evaluated the unique impact of depression or anxiety on common measures of executive functioning within a mixed psychiatric sample. Accordingly, the aim of the present study was to evaluate the degree to which self-reported depression or anxiety would predict performance on tasks of executive functioning in a clinically relevant, heterogeneous psychiatric sample.

1. Method

1.1. Participants

The sample consisted of archival data extracted from 86 adult patients referred for comprehensive neuropsychological assessment who had data for all variables of interest. The neuropsychology clinic is located within an outpatient psychiatry unit of a large southeastern medical center. The primary DSM-IV diagnoses (American Psychiatric Association, 2000) of patients were determined by the referring psychiatrist as well as results of psychological testing and clinical interview. Individuals receiving a diagnosis of dementia (regardless of etiology) or having an IQ <70 were excluded from data analysis so as to minimize the influence of extreme outliers. The most common primary Axis I diagnoses of the sample were depressive disorders (n = 26), anxiety disorders (n = 19), cognitive disorder NOS (n = 11), attention-deficit/hyperactivity disorder (n = 8), bipolar disorder (n = 5), alcohol dependence (n = 3), no diagnosis (n = 3), schizophrenia (n = 2), and undifferentiated somatoform disorder (n = 2). The mean age was 36.4 years (S.D. = 14.1; range = 16–75); 56.2% of the participants were female. Of the 78 participants who disclosed their ethnicity, 59 were Caucasian, 16 were African-American, and 3 were classified as “other.” The mean IQ was 95.84 (S.D. = 16.62).

1.2. Materials and procedures

Patients were administered the following commonly-used measures of executive functioning (cf. Burgess, 2003) as part of a larger neuropsychological battery: the Wisconsin Card Sorting Test (WCST; Heaton, Chelune, Talley, Kay, & Curtiss, 1993), the Trail Making Test (TMT A and B; Reitan & Wolfson, 1985), the Controlled Oral Word Association (COWA; Benton & Hamsher, 1989), and the Letter–Number Sequencing subtest of the Weschler Adult Intelligence Scale-III (WAIS-III; Wechsler, 1997).

The Wisconsin Card Sorting Test (WCST) is a widely-used neuropsychological measure of executive functioning, particularly set-shifting, or one’s ability maintain cognitive flexibility as task demands change. Patients are instructed to select one of four target cards that best match a stimulus card in shape, color, or number. The sorting criterion changes without warning after each series of 10 consecutive correct matches, and the test ends when the patient completes all six matching categories or has seen all the stimulus cards. The version of the WCST employed in this study was the 128-card version that is hand-administered, although computerized scoring was used. The WCST score of interest was the percentage of perseverative errors made. Perseverative errors denote those occasions when the patient continues to unsuccessfully use a sorting strategy after receiving negative feedback. We did not include WCST categories completed in the present study, because these data lacked variability and were extremely skewed (as 65% of the sample completed 6/6 categories).
The Trail Making Test (TMT) is another common measure of executive functioning that includes motor speed, visual scanning and attention, and sequencing. Unlike the WCST, the TMT is timed. In Part A, the patient connects 25 randomly arranged numbers in consecutive order. In Part B, the patient connects 25 numbers and letters in consecutive order by alternating between numbers and letters. Although TMT B is typically considered a better measure of cognitive flexibility than TMT A (e.g., Arbuthnott & Frank, 2000), both parts are highly correlated with each other ($r \approx .70$) and similarly correlated with perseverative errors on the WCST (Kortte, Horner, & Windham, 2002). In view of these findings, and in consideration of the fact that the precise neuropsychological mechanisms involved in each part of the TMT have yet to be fully explicated, we included both TMT A and TMT B in the present study. Scores used from the TMT included the amount of time taken to complete each part (A and B).

The Controlled Oral Word Association (COWA), also known as the FAS, consists of three word naming trials and is a widely-used measure of verbal fluency. Over the three trials, the patient is asked to name as many words as quickly as possible that begin with the letters F, A, and S, respectively (excluding proper nouns or variations of a previously said word). One minute is allotted for the naming of words for each letter. The score of interest was the summed total of words named for the three letters.

The Letter–Number Sequencing subtest of the WAIS-III is a component of the Working Memory Index of the WAIS-III. The patient is read a mixed series of numbers and letters and then asked to repeat the sequence, naming the numbers first in ascending order followed by the letters in alphabetical order. Three sequences of combined numbers and letters are provided within each trial; the task is discontinued when the patient incorrectly repeats all three sequences within a trial. The score of interest is the number of correct sequences produced over the entire subtest.

Depression and anxiety were assessed using the Beck Depression Inventory—2nd edition (BDI; Beck, Steer, & Brown, 1996) and the State-Trait Anxiety Inventory (STAI; Spielberger, 1983), respectively. The BDI is a 21-item self-report measure on which respondents rate the severity of symptoms of various depression symptoms (affective, cognitive, and physiological) experienced over the past two weeks. The STAI is a 40-item self-report measure of general affective, cognitive, and physiological manifestations of anxiety; 20 items inquire about current symptoms (State subscale), and 20 assess more longstanding symptoms (Trait subscale). Intellectual assessment was based on the FSIQ index score from the WAIS-III.

Measures were administered in accordance with their standardized protocols. Prior to data analysis, raw scores on the WCST, TMT, and COWA were converted into norm-referenced $t$-scores as outlined in their respective manuals. Age-corrected scaled scores on Letter–Number Sequencing were converted into $t$-scores so that all criterion variables would represent a common metric. All resultant $t$-scores thus corrected for age, and some corrected also for education (WCST) and for gender, education, and race (TMT, COWA). Converting raw scores to norm-referenced $t$-scores served to control for age-related variations in performance that are not adequately captured by the presentation of raw scores alone.

### 1.3. Statistical analyses

To examine the relationship between measures of executive functioning and self-reported symptoms of depression and anxiety, we first computed Pearson correlations between the BDI and STAI subscales and the measures of executive functioning. Multiple regression analyses were then utilized to determine the amount of unique variance in each criterion variable that the BDI and STAI subscales individually predicted beyond the covariate of IQ. The following criterion variables were examined: WCST—percentage perseverative errors; TMT—part A completion time and part B completion time; COWA—total number of words generated; Letter–Number Sequencing subtest of the WAIS-III—number of sequences completed. Unique variance accounted for is expressed as point estimates of effect sizes (incremental change in $R^2$ from the IQ-only block). Because our sample size was somewhat limited in terms of detecting small effect sizes and interpreting negative results, we report 95% confidence intervals around these $R^2$ point estimates. Graf and Alf’s (1999) equations for computing asymptotic confidence limits for change in $R^2$ values were used.

### 2. Results

#### 2.1. Correlation analyses

Table 1 displays the mean scores for and Pearson correlations between the BDI, STAI subscales, and measures of executive functioning. Most correlations between self-reported depression or anxiety and the executive functioning
Table 1
Mean scores for and Pearson correlations between the BDI, STAI, and measures of executive functioning (N = 86)

<table>
<thead>
<tr>
<th></th>
<th>BDI</th>
<th>STAI-State</th>
<th>STAI-Trait</th>
<th>WCST % perseverative errors</th>
<th>TMT A</th>
<th>TMT B</th>
<th>COWA</th>
<th>Letter–Number Sequencing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean scores</td>
<td>Mean (S.D.)</td>
<td>21.20 (13.51)</td>
<td>46.71 (12.84)</td>
<td>50.99 (13.06)</td>
<td>46.08 (13.23)</td>
<td>42.49 (11.31)</td>
<td>42.70 (11.48)</td>
<td>39.62 (10.16)</td>
</tr>
<tr>
<td>Pearson correlations between measures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BDI</td>
<td>–</td>
<td>.65***</td>
<td>.81***</td>
<td>.13</td>
<td>–.14</td>
<td>–.23*</td>
<td>–.21</td>
<td>–.33**</td>
</tr>
<tr>
<td>STAI-State</td>
<td>–</td>
<td>–</td>
<td>.70***</td>
<td>.11</td>
<td>–.17</td>
<td>–.19</td>
<td>–.16</td>
<td>–.15</td>
</tr>
<tr>
<td>STAI-Trait</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>.23*</td>
<td>–.11</td>
<td>–.15</td>
<td>–.06</td>
<td>–.12</td>
</tr>
</tbody>
</table>

Note. BDI: Beck Depression Inventory-II; STAI: State-Trait Anxiety Inventory; WCST: Wisconsin Card Sorting Test; TMT: Trail Making Test (completion time in seconds); COWA: Controlled Oral Word Association. WCST, TMT, COWA, and Letter–Number Sequencing scores represent norm-referenced t-scores as described in the text.

***Correlation significant at p < .0001. **Correlation significant at p < .01. *Correlation significant at p < .05.
measures were “small” (Cohen, 1988) and non-significant (rs ranging from −.33 to .23). There were three exceptions: BDI scores were significantly correlated with TMT B (r = −.23) and Letter–Number Sequencing (r = −.33), and STAI-State scores were significantly correlated with WCST percentage perseverative errors (r = .23). Because scores on many neuropsychological tests are significantly associated with intellectual functioning, we next endeavored to ascertain the influences of depression and anxiety on executive functioning beyond the covariate of IQ.

2.2. Regression analyses

Although BDI and STAI scores were highly correlated with each other, multicollinearity among predictor variables was not of concern because our data analytic strategy evaluated the predictive utility of the BDI and both STAI scores separately. T-score criterion variables were all normally distributed.

Table 2 presents the point estimates of effect sizes ($R^2$ values) with 95% confidence intervals. The covariate of IQ accounted for a significant proportion of variance in each measure of executive functioning, and in most cases this effect was of medium to large size. By contrast, the unique variance accounted for by depression or anxiety was typically quite small and non-significant. With the exception of WCST performance, unique variance accounted for by depression or anxiety was less than 3% on all measures of executive functioning. Unique variance predicted by the BDI ranged from 0.0% (TMT A) to 4.6% (WCST percentage perseverative errors). Unique variance accounted for by the STAI-State ranged from 0.2% (Letter–Number Sequencing) to 2.3% (WCST percentage perseverative errors), while that predicted by the STAI-Trait ranged from 0.0% (COWA) to 6.9% (WCST percentage perseverative errors).

The presentation of aggregate data was dictated by our interest in exploring the relationship between negative affect and executive functioning within a mixed psychiatric sample. However, this strategy does raise the question as to whether different diagnostic subgroups exhibit different relationships between affective symptoms and performance. To examine this possibility, we conducted post-hoc analyses after separating the sample into subgroups based on each individual’s primary Axis-I diagnosis. Given the wide variability of assigned diagnoses, three subgroups were defined in order to capture the most common diagnoses and thus establish subgroups of moderate size. The three subgroups were comprised of: (a) those with a primary Axis-I diagnosis of any depressive disorder, excluding bipolar disorder (Depression subgroup; n = 26); (b) those with a primary Axis-I diagnosis of any anxiety disorder (Anxiety subgroup; n = 19); and (c) the remaining patients with neither a primary depression nor primary anxiety diagnosis (“Neither depression nor anxiety” subgroup; n = 41).

The post-hoc subgroup analyses were conducted by running each prior regression analysis using an interaction between effect-coded subgroup and each affective predictor (Subgroup × BDI, Subgroup × STAI-State, Subgroup × STAI-Trait). None of these interactions accounted for a significant proportion of unique variance in performance on any measure of executive functioning. The interaction between effect-coded subgroup and BDI accounted

Table 2

<table>
<thead>
<tr>
<th>Measure</th>
<th>Initial $R^2$ (IQ covariate)</th>
<th>$\Delta R^2$ from IQ-only block</th>
<th>BDI</th>
<th>STAI-State</th>
<th>STAI-Trait</th>
</tr>
</thead>
<tbody>
<tr>
<td>WCST % perseverative errors</td>
<td>$0.57^* (-0.038, 0.152)^a$</td>
<td>$0.046^* (-0.038, 0.130)^a$</td>
<td>$0.023 (-0.038, 0.084)$</td>
<td>$0.069^* (-0.031, 0.169)^a$</td>
<td></td>
</tr>
<tr>
<td>TMT A</td>
<td>$0.237^* (0.080, 0.394)$</td>
<td>$0.000 (N/A, N/A)^b$</td>
<td>$0.007 (-0.024, 0.038)$</td>
<td>$0.002 (-0.014, 0.018)$</td>
<td></td>
</tr>
<tr>
<td>TMT B</td>
<td>$0.188^* (0.039, 0.337)$</td>
<td>$0.011 (-0.029, 0.051)$</td>
<td>$0.015 (-0.031, 0.061)$</td>
<td>$0.009 (-0.027, 0.045)$</td>
<td></td>
</tr>
<tr>
<td>COWA</td>
<td>$0.138^* (0.035, 0.273)$</td>
<td>$0.010 (-0.029, 0.049)$</td>
<td>$0.010 (-0.029, 0.049)$</td>
<td>$0.000 (N/A, N/A)^b$</td>
<td></td>
</tr>
<tr>
<td>Letter–Number Sequencing</td>
<td>$0.365^* (0.203, 0.527)$</td>
<td>$0.024 (-0.027, 0.075)$</td>
<td>$0.002 (-0.013, 0.017)$</td>
<td>$0.002 (-0.013, 0.017)$</td>
<td></td>
</tr>
</tbody>
</table>

Note. BDI: Beck Depression Inventory-II; STAI: State-Trait Anxiety Inventory; WCST: Wisconsin Card Sorting Test; TMT: Trail Making Test (completion time in seconds); COWA: Controlled Oral Word Association. WCST, TMT, COWA, and Letter–Number Sequencing scores represent norm-referenced t-scores as described in the text.

* $R^2$ value significant at $p < .001$. ** $R^2$ value significant at $p < .05$.

a This value was statistically significant although the confidence interval includes zero; conflicting results are a function of differing methods of calculating conventional point estimates vs. asymptotic confidence intervals.

b Graf and Alf’s (1999) equations for asymptotic confidence intervals do not allow for precise calculation of confidence intervals when the point estimate is exactly 0.00.
for a median of 0.6% of the variance in performance (range 0.3–1.9%). Median variance in performance accounted for by the interaction including STAI-State scores was 2.2% (range 0.7–4.1%), while that including STAI-Trait scores was 0.8% (range 0.3–1.7%). These amounts of unique variance suggest that the prior analyses were not differentially influenced by participant diagnostic status.

3. Discussion

Discerning the influence of depression and anxiety on tasks of executive functioning is of particular importance to practicing neuropsychologists working within general psychiatric settings. Because most studies to date have focused on comparisons between specific diagnostic groups, this is the first study to evaluate this relationship utilizing multiple measures of executive functioning, a mixed psychiatric sample, and taking into account the impact of IQ. The results of this study suggest that the impact of self-reported depression or anxiety on measures of executive functioning is quite minimal within a mixed psychiatric sample. This conclusion is based on three lines of evidence: (a) small and non-significant correlations between BDI/STAI scores and the large majority of executive functioning measures; (b) $R^2$ point estimates indicating that depression and anxiety accounted for a small amount of unique variance (after controlling for IQ) in scores on most measures; and (c) confirmation of these results with post-hoc subgroup analyses.

Within our mixed psychiatric sample, the effect sizes of depression and anxiety on scores of all measures of executive functioning were generally quite small, particularly as compared to the much larger and statistically significant effects obtained using the covariate of IQ (see Cohen, 1988, for a discussion of effect size characterizations). Comparable results were obtained by Martin et al. (1991), who found no differences between major depressives’, dysthymsics’, and non-psychiatric controls’ performance on the WCST after controlling for verbal IQ. O’Jile, Schrimsher, & O’Bryant (2005) reported a thematically similar finding, in which depression and anxiety were weak predictors of verbal memory performance beyond the predicted afforded by gender, age, and IQ. Taken together, these results suggest that executive functioning deficits are likely most representative of actual cognitive disturbance rather than epiphenomena associated with symptoms of depression or anxiety. Our data also hint at the notion that any potential relationship between mood and executive functioning may be mediated by other variables such as IQ, although this hypothesis awaits further empirical verification.

Some limitations of our study are worth mentioning as they relate to the broader literature on mood and executive functioning. First, our adult sample was relatively young (mean age = 36.4 years) and high-functioning in comparison to some other studies that have reported executive functioning deficits in geriatric individuals who are depressed (e.g., Mast, Yochim, MacNeill, & Lichtenberg, 2004). We excluded individuals with dementia or mental retardation so as to provide a clearer picture of the influence of affective distress on measures of executive functioning. The results of this study thus may not generalize to geriatric or lower-functioning populations, highlighting the need for further research on the boundary conditions of executive functioning deficits as they relate to affective distress. Second is our reliance on self-report measures of depression and anxiety. The BDI and STAI are used frequently in neuropsychological evaluations and in research settings. No diagnoses were made based only on scores on these measures. The present study utilized BDI and STAI scores instead as predictor variables, because our goal was to assess the utility of self-reported depression and anxiety (as continuous variables) in predicting performance on tasks of executive functioning. Third, our study evaluated the prediction afforded by depression and anxiety separately. Future research should endeavor to elucidate the synergistic impact of comorbid depression and anxiety on executive functioning. Indeed, there is some evidence that anxiety compounds the effects of depression on memory performance (e.g., Kizilbash, Vanderploeg, & Curtiss, 2002), but further research with larger samples is needed to address this issue.

Methodological differences may help reconcile our findings to contradictory studies within the literature. Studies confirming the relationship between affective distress and executive functioning are based largely on comparisons between specific diagnostic groups (e.g., Mahurin et al., 2006; Merriam et al., 1999). That was not the major focus of the present study. Our interest was in examining the unique variance predicted by depression and anxiety within a mixed psychiatric sample, rather than simple significance testing between diagnostic groups. Nonetheless, post-hoc subgroup analyses confirmed our aggregate conclusion that depression and anxiety were minimally associated with deficits in executive functioning. Whereas the failure to find a non-significant effect of the interaction between diagnostic status and depression/anxiety might be expected given our low power for this type of comparison, more meaningful are the small amounts of variance accounted for by these relationships. As a final methodological point, because slightly
different effect-size point estimates might be obtained with a larger sample, we included 95% confidence intervals so as to indicate the range of plausible effect-size values. Unique variance accounted for by depression or anxiety remained relatively small even when considering the uppermost limits of these confidence intervals.

In summary, the current results have direct relevance to neuropsychologists practicing within general psychiatric settings, suggesting that when executive functioning deficits are observed, they may be only minimally related to self-reported depression and anxiety. This does not mean that depression and anxiety have no detrimental impact on executive functioning among some individuals (i.e., simply because an effect is termed “small” does not mean that it is entirely unimportant or does not exert some subtle influence). Instead, our results suggest that the influence of depression and anxiety are relatively minor after taking into consideration the IQ of the examinee, a trend that held across a wide variety of executive functioning measures. Clearly, continued research is needed to further clarify the boundary conditions under which executive functioning deficits may be related to depression and anxiety. In practice, the utilization of a thorough clinical interview and other neuropsychological and affective measures should be used to confirm any conceptualization regarding the presumed relationship between depression or anxiety and executive functioning or frontal lobe deficits.

References


