Test Anxiety in Relation to Measures of Cognitive and Intellectual Functioning

Carlton S. Gass1,2,*, Rosie E. Curiel1,2

1Psychology Service (116B), Veterans Affairs Medical Center, Miami, FL, USA
2Department of Psychiatry and Behavioral Sciences, University of Miami Miller School of Medicine, Miami, FL, USA

*Corresponding author at: Miami VA Healthcare System, Psychology Service (116B), 1201 NW 16th Street, Miami, FL 33125-1693, USA.
Tel.: +1-305-575-3215; fax: +1-305-575-7010
E-mail address: carlton.gass@va.gov (C.S. Gass).

Accepted 8 April 2011

Abstract

The potential impact of test anxiety on cognitive testing was examined in a sample of 300 predominantly male veteran referrals who were administered a comprehensive neuropsychological test battery. Exclusionary criteria included failure on effort testing (n = 14). Level of test anxiety was significantly related to performance on the WAIS-III Working Memory Index (r = .343, p < .001) but not to scores on the Processing Speed, Perceptual Organization, or Verbal Comprehension indexes. Test anxiety was not related to a global index of neuropsychological performance on the HRNES-R (Average Impairment Scale). Level of education had a collinear relationship with test anxiety in predicting cognitive test performance. Regression analyses revealed a more prominent role for education, indicating the possibility that test anxiety may be a reaction to, more than a cause of, deficient working memory performance. These results suggest that clinicians who use these particular tests should be reluctant to attribute poor test performance to anxiety that occurs during the testing process.

Keywords: test anxiety; Wechsler Adult Intelligence Scale; intelligence testing; neuropsychological assessment

Introduction

Intelligence tests, and neuropsychological tests in general, are purported to measure an individual’s mental abilities. Performance on these measures is used to evaluate neurobehavioral capacity. To the extent that emotional factors, such as anxiety, interfere with test performance, inferences regarding brain-based abilities are more uncertain. Previous research has suggested that performance on intelligence and other neuropsychological tests is largely independent of scores on standard self-report measures of psychological adjustment, such as the Minnesota Multiphasic Personality Inventory (MMPI-2; Calsyn, Louks, & Johnson, 1982; Gass, 1991; Heaton & Crowley, 1981; Zillmer & Perry, 1996). Unlike trait anxiety, which is commonly measured in these inventories, test anxiety reflects an individual’s reaction to the testing situation characterized by worry, intrusive thoughts, tension, and physiological arousal. Relatively few empirical studies have addressed the role of test anxiety in global measures of intelligence or neuropsychological functioning. Nevertheless, concern over the issue is so ubiquitous that clinicians are admonished to take specific steps to minimize its effects (Bennett-Levy, Klein-Boonschate, Batchelor, McCarter, & Walton, 1994).

Individuals may perceive the evaluative nature of mental abilities testing as anxiety-provoking. In fact, research suggests that test anxiety is more pronounced when the stakes are higher (Hurley & Padro, 2006). Anticipated consequences of a negative outcome in neuropsychological testing may produce anxiety and might include fears of receiving an unwanted diagnosis (e.g., neurodegenerative disease), loss of certain freedoms and roles, and a newly present or future burden on family members or other loved ones. Given the nature of such an evaluation, individuals who are particularly prone to test anxiety might experience disruptive mental intrusions or worries that can interfere with their cognitive test performance. In such cases, test results might underestimate an individual’s neurobehavioral capacity and be misinterpreted as evidence of compromised brain function.
functioning. A limited body of empirical data links anxiety with lower performance on neuropsychological tests, especially tests of learning and memory (Gass, 1996; Kizilbash, Vanderploeg, & Curtiss, 2002). Even fewer studies have examined the more specific relationship between test anxiety and performance on various cognitive tasks. Existing studies of test anxiety include the measures of attention and executive function (Gass et al., 2005), processing speed (Firetto, Walker, & Davey, 1972), reading comprehension (Minnaert, 1999), and working memory (Darke, 1988; Ikeda & Iwanga, 1996; Lee, 1999). However, to the best of our knowledge, the potential impact of test anxiety on the widely used Wechsler intelligence scales or on a comprehensive neuropsychological test battery has not been explored in a clinical sample.

The purpose of this investigation is to explore the role of test anxiety in relation to performance on four basic components of the Wechsler Adult Intelligence Scale-Third Edition (WAIS-III) that have been preserved in the WAIS-IV. These components consist of verbal comprehension, perceptual organization, working memory, and speed of information processing. In addition, we examine the relation of test anxiety to performance on a comprehensive and standardized neuropsychological test battery as reflected in a global summary score (Halstead–Russell Neuropsychological Evaluation System-Revised [HRNES-R], Average Impairment Scale [AIS]). We hypothesized that, in the neuropsychologically unimpaired group, relatively high test anxiety as reported on the Test Anxiety Profile (TAP; Oetting & Deffenbacher, 1980) would show a significant effect on the Working Memory Index (WMI) and Processing Speed Index (PSI) of the WAIS-III. In specific, we hypothesized that higher scores on the TAP would be associated with lower scores on the WMI and PSI of the WAIS-III.

Method

The sample consisted of 300 patients who were referred for a comprehensive neuropsychological evaluation to assist in diagnostic and/or functional assessment in a VA medical center. Approval for this study was obtained from the Medical Research and Development Committee of the Department of Veterans Affairs. Clinical referrals were made predominantly by staff physicians in the Psychiatry, Primary Care, or Neurology Departments throughout the medical center. Approximately 85% were outpatients, and over two thirds of the patients had multiple medical problems with comorbid psychiatric diagnoses including problems with anxiety and/or depression. As such, the sample constituted a diagnostically diverse group. Fourteen patients were subsequently excluded from this study due to evidence of incomplete effort based on unusually poor performance on the Digit Span subtest of the WAIS-III (age corrected scaled score ≤5). This measure has demonstrated moderate sensitivity and high specificity in the detection of incomplete effort (Babikian, Boone, Lu, & Arnold, 2006). In addition, we incorporated the Vocabulary minus Digit Span Index as an exclusionary criterion in which a scale score difference of five or more suggests incomplete effort (Larrabee, 2007). The remaining 286 individuals consisted of 274 men and 12 women with an average age of 59.3 (SD = 15.3). An educational background of 12.7 years (SD = 2.6) was observed. The sample included 66% Caucasian/Anglo, 19% African American, 14% Hispanic, and 1% Other.

All patients in this study were evaluated using the HRNES-R (Russell & Starkey, 1993) followed by the TAP, which measures self-reported anxiety-related feelings, physiological reactions and cognitions that occurred during testing (see the Appendix). As part of the HRNES-R battery, examinees completed the WAIS-III (Wechsler, 1997) which yields index scores on four distinctive cognitive domains that are combined to provide a Full-Scale intelligence quotient (IQ). These domains consist of the Verbal Comprehension Index (VCI), Perceptual Organization Index (POI), WMI, and PSI. The TAP consists of 12 likert-type self-report items that measure perceived anxiety in the testing situation as manifested in emotional state, physiological responses, and intrusive thoughts. Reliability and validity data presented in the manual (Oetting & Deffenbacher, 1980) appear to be acceptable.

The potential role of test anxiety was examined separately for patients classified as neuropsychologically “normal”/nondeficient versus impaired/deficient in order to control for the potentially confounding effect of brain dysfunction severity and location on the analysis of the relation between self-reported test anxiety and intelligence test performance. “Deficient” performance was determined based on objective evidence of neuropsychological impairment as operationally defined using the empirically established cutoff score of 96 on the AIS. The AIS is a global neuropsychological index consisting of 10 neuropsychological tests that are representative of diverse neurobehavioral domains measured by the HRNES-R. The HRNES-R battery of tests and the AIS have received a substantial amount of validation support (Russell, 1995, 2004; Russell & Starkey, 1993).

Using the AIS cutoff score of 96, 156 patients performed within the normal range. Their average age was 60.9 (SD = 5.7) and education was 13.2 (SD = 2.6). Their Full-Scale IQ on the WAIS-III was 103.6 (SD = 9.6), Verbal IQ was 104.5 (SD = 10.6), and Performance IQ was 101.6 (SD = 10.9). The neuropsychologically deficient/impaired sample (AIS ≤ 96) consisted of 130 patients who had an average age of 57.3 (SD = 15) and education of 12.1 (SD = 2.6). Their Full-Scale IQ on the WAIS-III was 86.8 (SD = 10.5), Verbal IQ was 90 (SD = 10.9), and Performance IQ was 85 (SD = 9.7). As classified by degree of estimated impairment using the AIS, 2.3% were moderately impaired, 31.5% were mildly impaired, and 66.2% were very mildly impaired.
Pearson’s correlation coefficients were calculated for each group initially to determine the relation between TAP scores and performance on the four WAIS-III scores. To reduce the likelihood of a Type I error, the Holm–Bonferroni method (Holm, 1979) was used for assessing statistical significance. As a further step, we considered the possibility that the relation of test anxiety to level of cognitive performance might not be linear. For example, it is reasonable to speculate that any adverse effects of anxiety only occur when anxiety reaches a high level. Furthermore, in accordance with the Yerkes–Dodson law, a moderate degree of anxiety might contribute to better performance than a low level of anxiety. In order to explore these possibilities, each of the two subsamples were divided into three groups of approximately equal size based on their scores on the TAP: “Low” (lower third), “Moderate” (middle third), and “High” (upper third).

Results

Pearson’s correlation coefficients were calculated for the “normal” and “impaired/deficient” patient samples initially to determine the relation between TAP scores and performance on the four WAIS-III scores. Within the neuropsychologically normal sample (AIS > 95), TAP scores were unrelated to age, but significantly associated with level of education ($r = -0.216, p < .01$). In order to reduce the likelihood of a Type I error, the Holm-Bonferroni correction was applied for assessing statistical significance in examining the five cognitive test scores. In regard to the hypothesized relationship between test anxiety and working memory, TAP scores were significantly related to scores on the WAIS-III WMI, $r = -0.343, p < .001$ (Table 1). However, when the effect of education was statistically removed, this correlation dropped to $-0.284, p < .001$. Although still supportive of our first hypothesis, the unanticipated collinear effect of education was substantial. Counter to our second hypothesis, the relationship of test anxiety (TAP) to processing speed (PSI) scores failed to attain statistical significance ($r = -0.176, p = .028$). In regard to other cognitive test scores, TAP scores were not significantly related to performance on the AIS or to scores on the WAIS-III VCI or POI. Furthermore, in the 130 patients who attained AIS scores that fell within the impaired range (AIS < 96), level of test anxiety (TAP) was not significantly related to age, education, or scores on any of the cognitive measures.

As an additional planned step, we considered the possibility that the relation of test anxiety to level of cognitive performance might not be linear. For example, it is reasonable to speculate that any adverse effects of anxiety are trivial at lower to medium levels and only occur when anxiety reaches a high level. Also, in accordance with the Yerkes–Dodson law, a moderate degree of anxiety might actually contribute to an efficient arousal level and better performance than a low level of anxiety. In order to explore these possibilities, the normal and impaired cognitive performance samples were separately divided into three groups of approximately equal size based on their scores on the TAP: “Low Anxiety” (lower third), “Moderate Anxiety” (middle third), and “High Anxiety” (upper third).

In the neuropsychologically normal sample, the three groups were labeled Low (18–37, $n = 50$), Moderate (38–43, $n = 49$), and High Anxiety (44–81, $n = 57$). In the deficient sample, three groups were similarly arranged based on their TAP scores: Low (15–41, $n = 40$), Moderate (42–48, $n = 44$), and High (49–79, $n = 42$). Level of education differed across the three normal groups, $F(2, 153) = 6.74, p < .01$, but not across the deficient groups, $F(2, 127) = 0.03, n.s.$ Therefore, one-way ANCOVA with education as a covariate was used to evaluate intergroup differences across the neuropsychologically normal groups (Tables 2 and 3). Consistent with the correlational findings, reported level of test anxiety was related only to performance on

<table>
<thead>
<tr>
<th>Table 1. Pearson product-moment correlation coefficients in the analysis of Test Anxiety Profile Scores, Demographic Data, and Neuropsychological Scores</th>
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</thead>
<tbody>
<tr>
<td><strong>Test Anxiety Profile</strong></td>
</tr>
<tr>
<td><strong>Neuropsychologically Normal ($n = 156$)</strong></td>
</tr>
<tr>
<td><strong>Neuropsychologically Deficient ($n = 130$)</strong></td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Education</td>
</tr>
<tr>
<td>AIS</td>
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<tr>
<td>VCI</td>
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<td>POI</td>
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<td>WMI</td>
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<td>PSI</td>
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</table>

*Notes: AIS = Average Impairment Scale; VCI = Verbal Comprehension Index; POI = Perceptual Organization Index; WMI = Working Memory Index; PSI = Processing Speed Index.

*p < .01.

**p < .001.

***p < .05.
the WMI of the WAIS-III, $F(2, 153) = 5.15, p < .01$. No significant intergroup differences emerged in scores on the AIS, VCI, POI, or PSI. Similarly, no intergroup differences were found on any of the cognitive measures as a function of test anxiety (TAP scores) in the deficient/impaired sample.

The collinearity of education and test anxiety in predicting cognitive test performance was unexpected. In order to address the relative contributions of these two factors, hierarchical regression analyses were performed for each of the cognitive measures. The results, shown in Table 4, reveal that education was generally more powerful than level of test anxiety in predicting scores on the WAIS-III and the AIS. In relation to working memory performance, test anxiety accounted for 5.2% of unique variance and had an additional 6.6% of shared variance with level of education. Education alone accounted for 12.8% of the variance. Test anxiety was not a significant predictor of performance ($p > .05$) on any of the other four cognitive measures.

### Table 2. Test performance as classified by level of anxiety on the TAP of Non-Deficient Group

<table>
<thead>
<tr>
<th></th>
<th>Low TAP ($n = 50$)</th>
<th>Moderate TAP ($n = 49$)</th>
<th>High TAP ($n = 57$)</th>
<th>$F$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>AIS</td>
<td>100.8</td>
<td>3.05</td>
<td>99.4</td>
<td>2.47</td>
</tr>
<tr>
<td>VCI</td>
<td>109.8</td>
<td>13.1</td>
<td>107.6</td>
<td>13.4</td>
</tr>
<tr>
<td>POI</td>
<td>106.1</td>
<td>15.1</td>
<td>104.6</td>
<td>11.3</td>
</tr>
<tr>
<td>WMI</td>
<td>108.2</td>
<td>12.2</td>
<td>100.3</td>
<td>14.0</td>
</tr>
<tr>
<td>PSI</td>
<td>99.1</td>
<td>12.7</td>
<td>96.4</td>
<td>10.9</td>
</tr>
</tbody>
</table>

Notes: $df = 2, 153$. Education used as covariate. TAP = Test Anxiety Profile; AIS = Average Impairment Scale; VCI = Verbal Comprehension Index; POI = Perceptual Organization index; WMI = Working Memory Index; PSI = Processing Speed Index.

**$p < .01$.**

### Table 3. Test performance as classified by level of anxiety on the TAP of Neuropsychologically Deficient Group

<table>
<thead>
<tr>
<th></th>
<th>Low TAP ($n = 40$)</th>
<th>Moderate TAP ($n = 44$)</th>
<th>High TAP ($n = 57$)</th>
<th>$F$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>AIS</td>
<td>90.6</td>
<td>4.2</td>
<td>91.7</td>
<td>3.8</td>
</tr>
<tr>
<td>VCI</td>
<td>91.3</td>
<td>13.2</td>
<td>91.0</td>
<td>11.5</td>
</tr>
<tr>
<td>POI</td>
<td>86.5</td>
<td>11.0</td>
<td>87.9</td>
<td>10.4</td>
</tr>
<tr>
<td>WMI</td>
<td>86.1</td>
<td>12.5</td>
<td>87.3</td>
<td>12.6</td>
</tr>
<tr>
<td>PSI</td>
<td>80.6</td>
<td>10.7</td>
<td>80.9</td>
<td>9.1</td>
</tr>
</tbody>
</table>

Notes: $df = 2, 127$. TAP = Test Anxiety Profile; AIS = Average Impairment Scale; VCI = Verbal Comprehension Index; POI = Perceptual Organization index; WMI = Working Memory Index; PSI = Processing Speed Index. All $p > .05$. **$p < .01$.**

The potential impact of test anxiety on neuropsychological and intelligence test performance is an important issue that has received relatively limited research attention. These findings support the view that test anxiety generally has a limited impact on well-validated measures of intelligence and neuropsychological functioning. Degree of test anxiety as measured by the TAP was not significantly related to three of the four major components comprising the Wechsler Intelligence Test, namely processing speed, verbal comprehension, and perceptual organization. Although the clinical lore regarding adverse effects of anxiety is commonly invoked as a cause for poor performance on the subtests comprising these domains, the present data offer no such support. The data conflict with the widespread notion that performance on tasks such as Coding or Block Design, for example, must be affected by anxiety inasmuch as these subtests require sustained attention and concentration for their successful completion. However, attention and concentration are basic requirements in performance on virtually all intellectual and cognitive tasks, though the tasks themselves primarily tap other mental resources that are largely independent of working memory capacity.

Neuropsychological test performance as reflected in a global summary score (AIS) derived using a comprehensive battery (HRNES-R) was also not significantly related to level of test anxiety. This finding is consistent with previous studies that have suggested that performance on the Halstead–Reitan and Halstead–Russell batteries is largely resilient to the effects of emotional factors (Gass, 1991, 2009; Reitan & Wolfson, 1997; Russell, 1994, 1995, 2004). In general, substantial evidence suggests that in the absence of poor effort or incomplete engagement with the testing process, clinicians should be very reluctant to attribute poor performance on these particular test batteries to emotional factors such as anxiety and depression. In
contrast, the potential impact of emotional factors on performance on other cognitive tests and briefer batteries might be significant. For example, anxiety, fearfulness, and depression as measured by the MMPI-2 appear to be strongly related to some widely used measures of executive and memory functions (Gass, 1996, 2009; Gass, Ansley, & Boyette, 1994; Ross, Putnam, Gass, Bailey, & Adams, 2003).

Regarding our first hypothesis, it appears that test anxiety may generally exert a negative impact on performance on the Working Memory subtests of the WAIS-III, which include Digit Span, Arithmetic, and Letter-Number Sequencing. However, contrary to our second hypothesis, level of self-reported test anxiety was not significantly related to processing speed performance. Collectively, the working memory subtests examine elements of attention, concentration, and mental manipulation. The positive finding of a relationship between anxiety level and working memory is consistent with the notion that test anxiety is associated with intrusive thoughts that are a source of distraction. To the extent that it exists, the degree of impact appears to be generally small, as TAP scores accounted for less than 12% of the variance in working memory scores. The use of level of education as a covariate (Table 2) provided results based on an assumed independence of test anxiety and level of education in the general population. This assumption might be unwarranted.

However, it should not be assumed that these correlational data provide conclusive evidence of a causal relation in which anxiety interferes with working memory. An equally viable conclusion, which is seldom considered in this line of research,
that poorer working memory performance causes an increase in test anxiety. This conclusion is consistent with the fact that the examinees who had a higher level of formal educational background performed better and were less anxious than their counterparts who had fewer years of schooling. Furthermore, regression analyses revealed that test anxiety was not a significant factor in measures other than working memory and that education was over twice as important as test anxiety in predicting working memory performance on the WAIS-III.

Current findings suggest a potentially confounding relationship between educational background (possibly intelligence) and level of test anxiety. Level of formal education was much more influential than test anxiety. One’s fundamental ability level, which can be estimated on the basis of prior education, must be considered in evaluating the role of test anxiety in cognitive performance. Comparative failure or deficiency on cognitive tasks might be attributable to lower education or intellectual disadvantage rather than to higher test anxiety. For example, poorer performance on Block Design and Picture Arrangement might be a consequence of lower perceptual organizational ability and secondarily contribute to higher anxiety in testing (Hopko, Crittendon, Grant, & Wilson, 2005). Test anxiety is likely exacerbated, if not precipitated, by perceived failures during the testing process. It follows that less capable examinees commonly experience more anxiety than examinees who have a higher level of ability. This interpretation is consistent with the skills deficit model of test anxiety proposed by Birnbaum and Pinku (1997) and supported by research that links test anxiety with skill level more than with a disruption of test performance (Musch & Broder, 1999).

Although this study sheds some light on the role of test anxiety in cognitive testing, it has several limitations. The major limitation of this and previous studies of test anxiety is in its operational definition of test anxiety. Although self-report is generally the best way of acquiring assessment information about emotional status (Nunnally, 1978), future investigations of test anxiety would ideally incorporate one or more additional measures to more fully represent the construct. For example, studies could include a validated physiological measure of state anxiety during the testing process. The present findings do not apply to individuals who are so anxious that they cannot undergo valid testing. The present study excluded all patients who were deemed “untestable” if they were unable to become engaged in the testing process due to conditions such as a lack of cooperation or serious adverse affects of physical pain or emotional discomfort. Excluded cases therefore might have included highly anxious individuals. The sample in this study consisted of predominately male veterans who were able to complete a lengthy neuropsychological test battery. It is not known how well these results would generalize to other samples, including women, younger individuals, and examinees who are unable to complete a comprehensive battery of tests.

The inclusion of formal measures of effort is important in evaluating the cognitive effects of test anxiety and other emotional factors, inasmuch as incomplete effort, like acquired impairment, introduces a confounding variable that can obscure an analysis of the relationship of interest. The validity of cognitive performance cannot be fully established in the absence of effort measurement (Green, 2007). The use of embedded measures of effort in the present study was an improvement on prior test anxiety studies but could be improved upon through the inclusion of more recently designed measures that have superior psychometric characteristics, such as the Medical Symptom Validity Test (Green, 2005).

Conflict of Interest

None declared.

Acknowledgement

Gratitude is expressed to Martha Pham for assistance in data collection.

Appendix

TEST ANXIETY SCALE

NAME_____ DATE_____

People have different feelings and thoughts when they take tests. It is important to know how you felt and what thoughts you had during the testing you completed. Read each item below and answer by checking the answer that best applies to you. Give only one answer per item.

1. During the testing I usually felt
   _ extremely calm (1)
   _ very calm (2)
_ calm (3)
_ in between (4)
_ a little jittery (5)
_ very jittery (6)
_ extremely jittery (7)

2. During the testing my fingers were
_ extremely stiff (7)
_ very stiff (6)
_ a little stiff (5)
_ in between (4)
_ relaxed (3)
_ very relaxed (2)
_ extremely relaxed (1)

3. During the testing I felt
_ extremely helpless (7)
_ very helpless (6)
_ a little helpless (5)
_ in between (4)
_ secure (3)
_ very secure (2)
_ extremely secure (1)

4. During the testing my breathing was
_ extremely loose (1)
_ very loose (2)
_ loose (3)
_ in between (4)
_ a little tight (5)
_ very tight (6)
_ extremely tight (7)

5. During the testing I was
_ extremely worried (7)
_ very worried (6)
_ a little worried (5)
_ in between (4)
_ carefree (3)
_ very carefree (2)
_ extremely carefree (1)

6. During the testing my ideas were
_ extremely clear (1)
_ very clear (2)
_ clear (3)
_ in between (4)
_ a little confused (5)
_ very confused (6)
_ extremely confused (7)

7. During the testing I felt
_ extremely unsure (7)
_ very unsure (6)
_ a little unsure (5)
_ in between (4)
_ somewhat sure (confident) (3)
8. The testing situation seemed to me to be
_ extremely safe (1)
_ very safe (2)
_ safe (3)
_ in between (4)
_ a little dangerous (5)
_ very dangerous (6)
_ extremely dangerous (7)

9. As far as preparation for testing, I mostly felt
_ extremely unready (7)
_ very unready (6)
_ unready (5)
_ in between (4)
_ ready (3)
_ very ready (2)
_ extremely ready (1)

10. During testing my thoughts were
_ extremely jumbled (7)
_ very jumbled (6)
_ a little jumbled (5)
_ in between (4)
_ a little easy (3)
_ very easy (2)
_ extremely easy (1)

11. During testing my mind was
_ working extremely well (1)
_ working very well (2)
_ working okay (3)
_ in between (4)
_ a little blank (5)
_ very blank (6)
_ extremely blank (7)

12. While taking these tests, I generally felt
_ extremely uncomfortable (7)
_ very uncomfortable (6)
_ a little uncomfortable (5)
_ in between (4)
_ comfortable (3)
_ very comfortable (2)
_ extremely comfortable (1)

References


