The Behavioral Dyscontrol Scale—II with Non-Elderly Veterans

Robert D. Shura1,2,3,*, Jared A. Rowland1,3,4,5, Ruth E. Yoash-Gantz1,2,3

1 Mid-Atlantic Mental Illness Research Education and Clinical Centers (MIRECC), Durham, NC, USA
2 Mental Health & Behavioral Sciences Service Line, W.G. “Bill” Hefner Veterans Affairs Medical Center, Salisbury, NC, USA
3 Department of Psychiatry & Behavioral Sciences, Wake Forest School of Medicine, Winston-Salem, NC, USA
4 Research & Education Service Line, W.G. “Bill” Hefner Veterans Affairs Medical Center, Salisbury, NC, USA
5 Department of Neurobiology & Anatomy, Wake Forest School of Medicine, Winston-Salem, NC, USA

*Corresponding author at: Hefner VAMC, 11-M MH/BS, 1601 Brenner Avenue, Salisbury, NC 28144, USA. Tel.: +1-704-638-9000; fax: +1-704-638-3857
E-mail address: robert.shura2@va.gov (R.D. Shura)
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Abstract

The Behavioral Dyscontrol Scale—II (BDS-II) is a unique test of frontal lobe function. Although the test was created for use in geriatric populations, it can add useful data to assessments of non-elderly patients. The original scoring system for the BDS was characterized by a low ceiling, limiting its use with higher functioning populations. The BDS-II scoring system was created to address this issue; however, new normative data were not published. This study used a non-elderly Veteran sample to compare the psychometric properties of the BDS and BDS-II scoring systems. The BDS-II showed improved psychometric properties (reductions in skewness and kurtosis) and was significantly more reliable than the BDS. Normative data using both the total sample, as well as the subsample of healthy individuals, are provided for clinical use.

Keywords: BDS-II; BDS; Reliability; Executive functioning; Veteran; Postdeployment

Introduction

The Behavioral Dyscontrol Scale (BDS; Grigsby & Kaye, 1996) is a brief, nine-item neuropsychological measure that uses a variety of novel tasks derived from Luria’s syndrome analysis approach (Luria, 1973; e.g., the “fist-edge-palm” manual sequencing task and a go-no-go task) to measure aspects of dynamic behavioral control and alphanumeric sequencing and insight. Dynamic behavioral control and regulation are considered facets of executive functioning that encompass inhibition of automatic behaviors, detection of erroneous behaviors, and corrective action (Garavan, Ross, Murphy, Roche, & Stein, 2002). A number of measures of executive functioning are available to clinicians (see Lezak, Howieson, Bigler, & Tranel, 2012); however, subtle impairments in processes linked to dysexecutive syndromes (such as dynamic behavioral control) are difficult to measure in conditions such as acquired brain injury using standardized measures of executive functioning. The BDS addresses this issue by providing quantitative measurement of this important domain.

Acquired brain injury, such as traumatic brain injury (TBI), occurs at any age, although population-based studies have demonstrated a tri-modal age-specific incidence. Early childhood, late adolescence/early adulthood and old age have been linked with increased incidence (Bruns & Hauser, 2003). Thus, instruments such as the BDS that are designed to measure the motor organizational aspects of the dysexecutive syndrome may be useful across adulthood. The use of the BDS total score and factor scores to differentiate lesion location (frontal vs. non-frontal) and injury severity was demonstrated in a small sample of patients ranging in age from 18 to 71 (Leahy, Suchy, Sweet, & Lam, 2003). This study suggests that the BDS may be sensitive to detecting frontal injury seen in TBI across age groups; however, more research is needed to support this clinical use.

The BDS was originally designed to measure executive functioning deficits and to predict functioning in daily life within the geriatric population; therefore, the initial normative studies (Grigsby & Kaye, 1996; Grigsby, Kaye, & Robbins, 1992) included a clinical sample of elderly Veterans and a sample of participants from the San Luis Valley Health and Aging Study (SLVHAS; Shetterly, Baxter, Mason, & Hamman, 1996). Research has supported the use of the BDS with elderly patients to predict functional
independence (Grigsby, Kaye, Kowalsky, & Kramer, 2002a, 2002b; Kaye, Grigsby, Robbins, & Korzun, 1990) and to differentiate healthy controls from those with mild cognitive impairment or dementia (Belanger et al., 2005; Hall & Harvey, 2008). Additionally, the BDS has shown clinical utility with specific neurologically impaired populations, including multiple sclerosis (Grigsby, Kravcisin, Ayarbe, & Busenbark, 1993) and stroke (Grigsby et al., 2002a). Using data from the SLVHAS study, the BDS was also found to be useful in identifying those with Type II diabetes whose impaired self-regulation may lead to increased medical services (Tran, Baxter, Hamman, & Grigsby, 2013). Finally, Suchy, Blint, and Osmon (1997) found that the BDS was superior to the Mini-Mental State Exam in predicting functional independence following discharge from a rehabilitation unit. Although the BDS has demonstrated utility with older populations, few studies have examined its use with non-elderly populations.

One concern regarding the use of the BDS in younger populations is that their high level of performance is affected by a low ceiling, reducing variance among high performers and negatively skewing the performance curve. Normative data from the test manual identify the average score for healthy elderly as 14.7 and for healthy college students as 17.6 of 19 (Grigsby & Kaye, 1996), leaving little room to measure variability in younger, intact populations. To address these limitations, the BDS-II scoring system was created in which all nine items are scored from 0 to 3, rather than 0 to 2, resulting in a maximum total score of 27 (Grigsby & Kaye, 1996); however, normative data for this scoring system are not available.

Leahy and colleagues (2003) compared the BDS and BDS-II scoring systems using a sample of 49 individuals with mild-to-moderate and severe TBI from both inpatient and outpatient settings. The authors found that the BDS-II scoring system improved significant negative skewedness present in the total score. This study and a follow-up examination have also provided preliminary evidence of criterion and construct validity of the BDS in TBI patients (Suchy, Leahy, Sweet, & Lam, 2003). Another study found significant relationships between the BDS and the Stroop Color and Word Test Part C but not with the information subtest on the WAIS-R (Suchy et al., 1997), supporting the notion that the BDS is a measure of executive functioning, specifically relevant to those executive skills required to live independently.

Despite the valuable information that the BDS may add to a neuropsychological battery, the current lack of published normative data for the BDS-II scoring system reduces its clinical utility, especially in populations that may be affected by the low ceiling of the original scoring system. Thus, the primary purpose of the current study was to extend the findings of Leahy and colleagues (2003) by examining differences in psychometric properties of the BDS and BDS-II scoring systems in a larger, well-characterized, prospective sample. Second, this study aimed to provide clinically useful normative data on the BDS-II with a sample of non-elderly Veterans returning from recent conflicts in Afghanistan and Iraq.

Methods

The prospective studies from which these data were drawn were reviewed and approved by the W.G. (Bill) Hefner VA Medical Center (Hefner VAMC) Institutional Review Board. The welfare of human subjects was protected. Voluntary verbal and written informed consent was obtained prior to initiation of any study activities.

Participants

Participants included in the current analysis were part of the Mid-Atlantic Mental Illness Research, Education, and Clinical Center (MA-MIRECC) Registry, which recruits persons who have served in the U.S. Armed Forces post-September 11, 2001. The MA-MIRECC Registry includes the Structured Clinical Interview for DSM-IV Diagnosis (First, Spitzer, Gibbon, & Williams, 2002) as well as a clinician administered TBI interview and several other self-report inventories (see Dedert et al., 2009). Participants may also be invited to complete a comprehensive neuropsychological test battery. Exclusion criteria for neuropsychological testing include current substance use disorder, combat prior to 1985, psychosis, neuropsychological evaluation in the 6 months prior to participation, history of moderate or severe TBI, and non-military PTSD present prior to deployment. Of the 185 individuals who had completed neuropsychological testing at one site, one had missing BDS data (broken hand) and an additional 39 were excluded due to failure on the Word Memory Test (WMT; Green, 2005). Table 1 lists descriptive statistics for both the final sample of 145 participants and a subsample of 53 healthy control participants without psychiatric diagnosis or history of mild TBI (mTBI).

Measures

Behavioral Dyscontrol Scale/Behavioral Dyscontrol Scale-II. The BDS is a nine-item measure designed to evaluate motor behaviors requiring executive functioning. A total score ranging from 0 to 19 is derived from the nine items. Cronbach’s α was reported as adequate (α = 0.87) in the elderly samples (Grigsby & Kaye, 1996). Reliability data were not reported for the younger or the total inclusive sample. In the original scoring system, the first eight items can be scored from 0 to 2; an insight
item is scored from 0 to 3. In the BDS-II scoring system, all items are scored from 0 to 3, for a maximum total score of 27. Research supports three factors comprising the BDS total score: motor programming (items 1, 2, 5, and 6), environmental independence (items 3 and 4), and fluid intelligence (items 7, 8, and 9; Ecklund-Johnson, Miller, & Sweet, 2004; Grigsby et al., 1992; Suchy et al., 1997).

Green’s Word Memory Test. The WMT is a performance validity test that has excellent psychometric properties and has been extensively studied in the literature (see Sollman & Berry, 2011). Test failure status was defined as a score of 82.5% or lower on immediate recall, delayed recall, or consistency, based on recommendations in the test manual (Green, 2005).

Procedures

As part of the larger neuropsychological protocol, participants completed a fixed research battery consisting of several hours of neurocognitive, psychological, and personality testing administered by a master’s or doctorate level psychologist with training in neuropsychology and supervised by a board certified neuropsychologist. Tests were administered in a fixed order and in a standardized manner in accordance with the tests’ manuals. Data were collected between June 2006 and June 2013. Statistical procedures were completed using SPSS 21 and Microsoft Excel.

Results

Psychometric Properties of the Behavioral Dyscontrol Scale and Behavioral Dyscontrol Scale-II

Skewness, kurtosis, and histograms were calculated for the entire sample (see Fig. 1). Skewness and kurtosis z-scores were calculated by dividing each statistic by its standard error; z-scores greater than twice the standard error were considered significant. Both the BDS ($G_1 = -1.43, SE = 0.20, z = 7.15$) and BDS-II ($G_1 = -0.75, SE = 0.20, z = 3.75$) scoring systems were significantly negatively skewed; however, the BDS-II skewness statistic was about half of the BDS skewness statistic, demonstrating a large reduction in skewness. Similarly, significant kurtosis was observed using the BDS scoring system ($G_2 = 1.97, SE = 0.40, z = 4.93$), but not the BDS-II scoring system ($G_2 = 0.23, SE = 0.40, z = 0.58$). As a result of the significant negative skewness, the highest possible score on the BDS was < 1 SD above the mean (mean = 17.93, SD = 1.28, maximum = 19), vastly limiting the measurement of non-impaired performance. In comparison, the BDS-II scoring system resulted in much less skewness and nearly 2 SDs between the mean and the maximum score (mean = 22.68, SD = 2.77, maximum = 27), thus increasing measurable variability in performance.

Reliability Comparison

Cronbach’s $\alpha$ was computed for each scoring system and interpreted according to the recommendations listed in George and Mallery (2003). The BDS displayed “unacceptable” reliability ($\alpha = 0.49$). The BDS-II displayed improved reliability ($\alpha = 0.62$), but still only reaching the “questionable” level. The $t$ statistic for testing differences between dependent coefficients was calculated as described by Feldt (1980) and was significant ($t = -4.75, p < .05$), demonstrating a statistically significant improvement in reliability using the BDS-II scoring system.

Table 1. Sample descriptive statistics

<table>
<thead>
<tr>
<th></th>
<th>Total sample ($n = 145$)</th>
<th>Healthy control ($n = 53$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>35.15 (9.05)</td>
<td>37.40 (10.24)</td>
</tr>
<tr>
<td>Years education</td>
<td>14.04 (1.80)</td>
<td>14.32 (2.20)</td>
</tr>
<tr>
<td>Male</td>
<td>124 (85.52%)</td>
<td>43 (81.13%)</td>
</tr>
<tr>
<td>Caucasian</td>
<td>108 (74.48%)</td>
<td>39 (73.58%)</td>
</tr>
<tr>
<td>Service connected</td>
<td>83 (57.64%)</td>
<td>24 (45.28%)</td>
</tr>
<tr>
<td>mTBI</td>
<td>43 (29.66%)</td>
<td>0</td>
</tr>
<tr>
<td>Current Psych</td>
<td>75 (51.72%)</td>
<td>0</td>
</tr>
</tbody>
</table>

Notes: mTBI = number of participants reporting a history of at least one mild TBI; Current Psych = number of participants who met DSM-IV-TR criteria for any mental disorder.

*Reported as mean (standard deviation).

*Reported as number (percent).
Pearson and Spearman’s rho correlations were used to examine relationships between demographic variables and the BDS-II total score. Results of these correlations were not significant (correlation coefficients: age = −0.08, education = 0.09, ethnicity = 0.01). Thus, uncorrected data were used to calculate an overall mean and standard deviation for normative purposes (n = 145, mean = 22.68, SD = 2.77). Factor score means and reliability estimates for the total sample were as follows: motor programming (mean = 10.04, SD = 1.61, α = 0.57), environmental independence (mean = 7.27, SD = 1.29, α = 0.39), and fluid intelligence (mean = 5.37, SD = 0.85, α = 0.25). BDS-II scores were not significantly different between participants with or without current psychiatric diagnosis (t = 1.41, ns), or with or without a history of mTBI (t = 1.21, ns). A subsample of healthy control participants without history of mTBI and no current psychiatric disorder was selected to produce additional normative data. In this healthy control sample (n = 53), the BDS-II total mean was 23.43 with a standard deviation of 2.33. Factor score means and reliability estimates for the control sample were as follows: motor programming (mean = 10.57, SD = 1.23, α = 0.29 [item 1 was removed due to zero variance]), environmental independence (mean = 7.34, SD = 1.29, unable to compute α due to zero variance), and fluid intelligence (mean = 5.53, SD = 0.58, α = 0.36). Notably, the factor scores’ α were very low or not computable in the healthy sample due to a ceiling effect, low number of items, and smaller sample size.

**Discussion**

This study compared the BDS and BDS-II scoring systems with respect to total score distribution characteristics and reliability. The BDS-II showed improvement in skewness and kurtosis over the BDS. The improved normality of the distribution also raised the ceiling of the BDS-II, allowing for a greater range of measurement. In addition to improving the total score distribution properties, the BDS-II significantly improved internal reliability compared with the original scoring system. Similar effects were also seen with the factor scores. Internal reliability in the current sample was much lower than that provided in the BDS manual (Grigsby & Kaye, 1996) for the elderly sample. This effect may be due to homogeneity of the younger Veteran sample or improved performance by younger healthy individuals. However, even with an internal consistency lower than that reported for the original sample from the BDS validation study, these data show improved reliability using the BDS-II scoring system over the original scoring system. Overall, these results suggest that the BDS-II is a better scoring system than the BDS for use in non-elderly samples and extend the findings of Leahy and colleagues (2003) to the Veteran population.

In addition to comparing the BDS and BDS-II scoring systems, normative data are provided for clinical purposes. Means and standard deviations of the BDS-II total as well as the factor scores are listed for both the total sample (n = 145) and a healthy control sample (n = 53). Psychometric evaluations computed for the total sample (n = 145) were re-calculated for the healthy control sample (n = 53) and were not found to be significantly different. Additionally, the lack of significant relationships between...
performance on the BDS-II and demographic variables such as age, education, and race/ethnicity allowed for use of a single mean and standard deviation as opposed to controlling for those factors. The relationship between age and BDS performance has been equivocal in the literature. An early study did not find significant correlations between BDS performance and either age or education (Kaye et al., 1990). Grigsby and Kaye (1996) reported that there was a weak association between age and BDS scores within the younger and older samples independently; however, they reported that there appears to be a decline in BDS scores in the 60s. The authors speculate that such an effect may be due to a younger mortality for those with impaired executive functioning. Perhaps because our sample was younger than the age of BDS decline noted by the authors, age did not affect BDS performance.

This study was conducted with younger Veterans in the Mid-Atlantic region, and results may not generalize to other populations. The sample size was not adequate to completely examine the effect of demographic variables on BDS-II performance. Future research might examine the factor structure and construct validity in a younger sample. Additionally, future research might investigate cutoff scores in various populations, which would further improve the clinical utility of the BDS-II.

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Conflict of Interest

The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs, the Department of Defense, or the U.S. government.

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