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The Frontal Assessment Battery: Relationship with functional status indicators and caregiver burden in veterans

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THE FRONTAL ASSESSMENT BATTERY: RELATIONSHIP WITH FUNCTIONAL STATUS INDICATORS AND CAREGIVER BURDEN IN VETERANS

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The Frontal Assessment Battery: Relationship with functional status indicators and caregiver burden in veterans

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Objective: Neurocognitive screening measures reflective of functional status are needed for detection of executive dysfunction. The Frontal Assessment Battery (FAB), a measure designed to assess executive functioning at bedside, lacks sufficient research establishing its ecological validity. The purpose of the study was to evaluate the ecological validity of the FAB by examining its relationship with the Functional Status Interview (FSI), a measure of basic activities (ADL) and instrumental activities (IADL), and a measure of caregiver burden (ZBI-R). Method: Participants in the primary sample were 168 veterans with a mean age of 81.3 years (*SD* = 7.6). Prior to main analyses, principal axis factoring examined the factor structure of FSI and confirmed the existence of two subscales, ADL and IADL. Correlations were calculated to examine relationships between FAB and other measures. Results: Two FSI factors (ADL and IADL) were identified with all items having strong loadings with the expected scale (absolute values of > .40) and factors accounting for 56.4% of the variance. ADL and IADL were strongly correlated. Main findings indicated a significant relationship between FAB and ADL, which slightly increased when controlling for demographic variables. A strong significant relationship was found between FAB and IADL. FAB and caregiver burden subscales were unrelated; however, when controlling for demographic variables, a weak relationship emerged with the ZBI-R dependency burden subscale. Conclusions: This study provides initial support for the ecological validity of the FAB in a sample of United States veterans. Cultural and clinical implications are discussed.

Keywords: executive function; FAB; older adults; dementia; caregiver burden

Introduction

Recent statistics suggest that approximately 50 million individuals worldwide possess some form of dementia and almost 10 million new cases are identified each year (World Health Organization [WHO], 2017). Dementia is a broad term used to describe a syndrome of impairments in cognition, neuropsychiatric symptoms, and the inability to carry out activities of daily living (WHO, 2017). It is one of the primary sources of disability and/or dependency and leads to physical, psychological, social, and economic consequences for older adults and their families (WHO, 2017). The population of older adults, defined as individuals aged 65 and older, is expected to more than double, reaching approximately 71 million by the year 2030 (Centers for Disease Control and Prevention, 2015). By 2050, it is expected that 152 million individuals

worldwide will be living with dementia (WHO, 2017), making the appropriate identification of cognitive and functional impairments a growing public health concern (Bradford, Kunik, Schulz, Williams, & Singh, 2009). Recent research indicated a variety of features commonly observed in United States veterans, including older age, depression, post-traumatic stress, traumatic brain injury, and factors that increase vascular risk, which may be associated with cognitive impairments (United States Census Bureau, 2011; McInnes, Friesen, MacKenzie, Westwood, & Boe, 2017; Rock, Roiser, Riedel, & Blackwell, 2014; Scott et al., 2015; Veitch, Friedl, & Weiner, 2013).

Despite the frequency and serious consequences of dementia, many older adults go undiagnosed. A systematic review of dementia studies showed that as many as 5.7% of individuals aged 65 or older living in North America have undiagnosed dementia, with international studies documenting prevalence as high as 12% (Boustani et al., 2003). A diagnosis of dementia at earlier stages in the disease offers many benefits for patients and caregivers alike, including evaluation for reversible causes, pharmacological intervention, and patient participation in planning for future care (Bradford et al., 2009; Moise, Schwarzinger, & Um, 2004; Standridge, 2004). However, various barriers to the early identification of cognitive impairment and/or dementia exist.

Most prominently, comprehensive neuropsychological assessment, the 'gold standard' in identification of cognitive impairment, is intensive, time-consuming, and financially demanding (Bradford et al., 2009; Pickens, Ostwald, Murphy-Pace, & Bergstrom, 2010). Thus, screening measures have been adopted to aid primary care physicians and other front-line providers in accurately identifying patients in need of further assessment (Bradford et al., 2009). However, the success of this process is dependent on the validity of both the provider's initial identification

of symptoms and the screening measures themselves. This problem is complicated by limited research documenting ecological validity of traditional neuropsychological instruments, which were originally designed to localize impairment to specific brain regions or cognitive processes (Chaytor & Schmitter-Edgecombe, 2003; Kibby, Schmitter-Edgecombe & Long, 1998; Koerts et al., 2012). Ecological validity is a term used to refer to the "functional and predictive relationship between the patient's performance on a set of neuropsychological tests and the patient's behavior in a variety of real world settings" (Sbordone in Sbordone & Long, 1996, p. 16). Ecologically valid screening is important due to its minimization of the potential for inaccurate diagnoses and conclusions. Additionally, neuropsychological tests are more frequently being used to make decisions about decision-making capacity and treatment recommendations (Chaytor & Schmitter-Edgecombe, 2003). Invalid conclusions derived in such circumstances may lead to a variety of negative outcomes, such as premature loss of autonomy in decision-making, risks to safety, and/or delays in diagnosis (Bradford et al., 2009; Moye & Marson, 2007). Additionally, absent or delayed diagnoses may preclude exploration of potential reversible causes of dementia, access to treatments, and participation in treatment and late-life planning (Bradford et al., 2009). Additionally, from an organizational healthcare perspective, inaccurate screening may lead to inappropriate allocation of clinic resources. Given the significance of undiagnosed dementia and the need for brief instruments that accurately reflect functional impairment, the current study examined the ecological validity of a commonly used executive screening measure, the Frontal Assessment Battery.

Ecological validity of The Frontal Assessment Battery (FAB)

The Frontal Assessment Battery (FAB; Dubois, Slachevsky, Litvan, & Pillon, 2000) was recently referred to as the most popular executive functioning screening measure in use (Moreira,

Costa, Castro, Lima, & Vicente, 2017). The domain of executive function, defined as "the efficiency with which an individual applies his or her ability and knowledge in order to deal with everyday life," is commonly assessed when seeking to understand the real-world implications of cognitive impairment (Princiotta, DeVries, & Goldstein in Goldstein & Naglieri, 2014, p. 144). However, some neuropsychological assessments have found no differences in executive functioning in patients with frontal lobe lesions relative to healthy controls, despite difficulties related to functional impairments (Shallice & Burgess, 1991). Likewise, the FAB has demonstrated good psychometric properties, including predicting different dementia subtypes (e.g., Moreira et al., 2017; Hanyu et al., 2009; Larner, 2013) but lacks sufficient research exploring its ecological validity, or its ability to reflect everyday cognition. The majority of studies evaluating the relationship between FAB and I/ADL (activities of daily living or instrumental activities of daily living), commonly used measures of functional status, have been conducted abroad. Though some studies have produced variable findings (e.g., Barulli et al., 2015; Miki, Kataoka, Okamura, 2012; Royall et al., 2015), results of the majority of studies have converged, identifying significant relationships between FAB and IADL (e.g., Assis, de Paula, Assis, de Moraes, & Malloy-Diniz, 2014; Brooks, 2005; de Paula & Malloy-Diniz, 2013; König, Crispim-Junior, Covella, et al., 2015; König, Crispim-Junior, Derreumaux et al., 2015; Miki, et al., 2012; Moorhouse, Gorman, & Rockwood, 2009) and FAB and ADL (e.g, de Paula & Malloy-Diniz, 2013; Moorhouse et al., 2009; Osafune, Deguchi, & Abe, 2014).

Despite the FAB's clinical use within the United States, research examining the ecological validity of the FAB has been extremely limited within domestic samples; a single identified United States study found the FAB to be weakly related to IADLs (Alosco, 2013). This dearth of literature evaluating the FAB's ecological validity in United States samples is

problematic given the importance of establishing cultural equivalence of measures due to research suggesting neuropsychological measures may assess different constructs in different cultures (APA, 2017; Mindt, Byrd, Saez, & Manly, 2010; Luria, 1976). Additionally, no known studies have examined the FAB's ecological validity among US veterans, despite veterans' impairments on the FAB, variability in report of ADL/IADL impairments, and a variety of characteristics (i.e., older age, factors associated with increased vascular risk) and diagnoses (i.e., depression, PTSD) associated with cognitive decline within this population (Brown et al., 2017; Graver, Hajek, & Bieliauskas, 2011; McInnes et al., 2017; Rock et al., 2014; Scott et al., 2015; Singh et al., 2005; Veitch et al., 2013). Taken together, these findings suggest the need for studies evaluating the functional utility of the FAB in United States veterans.

Measuring functional status

The measurement of functional status is a common criterion variable in studies of ecological validity. According to Elsawy and Higgins (2011), functional status can be defined as "a person's ability to perform tasks that are required for daily living" (p. 49). The measurement of functional status provides a way to assess the relationship between older adults' performance on neuropsychological measures and their actual everyday experience of dysfunction. Functional status is often divided into two key domains: ADL and IADL (Elsawy & Higgins, 2011). Activities of daily living involve basic aspects of functioning, such as eating, dressing, bathing, transferring, toileting, and continence, while instrumental activities involve more complex aspects of functioning, such as housework, meal preparation, managing medications, managing finances, and using the telephone (Elsawy & Higgins, 2011).

A growing body of evidence ties functional status indicators, such as ADL and IADL, to the prediction of cognitive impairment in older adults. For instance, ADL and/or IADL have

been shown to be associated with a variety of dementia indicators, such as Mild Cognitive Impairment (Buerger et al., 2002), posthumous bio-markers of Alzheimer's Disease (Arai et al., 1995; Blennow et al., 1995; Marshall, Fairbanks, Tekin, Vinters, & Cummings, 2006; National Institute on Aging, 2015), general cognitive decline (Rajan, Hebert, Scherr, Mendes de Leon, & Evans, 2013), and executive dysfunction (Alosco et al., 2014; de Paula & Malloy-Diniz, 2013). In particular, IADLs have been found to be associated with impairments in executive function, regardless of diagnosis or cognitive status (Marshall et al., 2011). Furthermore, some research suggests functional status may be more strongly related to executive function than global cognition (Johnson, Lui, & Yaffe, 2007) suggesting ADL and IADL measures may serve as appropriate functional indicators in the validation of executive screening measures used with older adults.

Caregiver burden

Caregiver burden is often considered when evaluating the cognitive and functional status of an older adult. Caregiver burden is defined as "a multidimensional response to the negative appraisal and perceived stress resulting from taking care of an ill individual" (Kim, Chang, Rose, & Kim, 2012, p. 846). In studies of patients with executive dysfunction, greater levels of executive dysfunction were found to be correlated with greater levels of caregiver burden (Ryan et al., 2012; Stinson et al., 2014). Specifically, Stinson and colleagues demonstrated a relationship between executive function and dependency burden, a construct thought to capture the time, money, and health-related costs of caring for a loved one (Stinson et al., 2014). Recent Japanese studies found FAB scores to be correlated with caregiver burden (Hashimoto et al., 2017) and smaller volume of the left dorsal lateral prefrontal cortex, which was found to influence overall burden levels with particular impact on dependency burden (Matsuoka et al.,

2017). This body of research suggests caregiver burden is reflective of patient dependence (Gallagher et al., 2011; Miyamoto, Tachimori, & Ito, 2010) and, thus, an appropriate functional indicator in assessing the ecological validity of the FAB. However, no known studies have explored this relationship in United States veterans.

Hypotheses

H_1: The Frontal Assessment Battery (FAB) will demonstrate moderate concurrent validity (.30 or Greater per Coen, 1988) with the VA Functional Status Interview (FSI).

H_2: The Frontal Assessment Battery (FAB) will demonstrate moderate concurrent validity (.30 or Greater, per Coen, 1988) with a measure of caregiver burden, the Zarit Burden Interview-Revised (ZBI-R).

Method

Participants

Participants included 168 veterans with a mean age of 81.3 years and age range of 65-101 (*SD* = 7.6). They had completed an average of 11.7 years of education (*SD* = 3.5). The majority of participants were White (63.1%) and male (97.0%). Due to limited representation of certain racial groups, racial minority participants were collapsed into a single group, creating separate groups for White and racial minority participants. The minority group was composed of African American (35.1%), Asian (.6%), and Pacific Islander (.6%) participants. Data for race were missing for .6% of the sample. Additionally, due to missing data for one of the primary measures (the Zarit Burden Interview-Revised; some protocols were not fully completed), data from a subsample of 129 participants were used in analyses between FAB and ZBI-R subscales. Participants in the subsample were predominantly White (66.7%) and male (98.4%) with a mean age of 81.1 years and age range of 65-101 (*SD* = 7.6) and 11.8 years of education (*SD* = 3.3).

The minority group for the subsample was composed of African American, (31.0%), Asian (.8%), and Pacific Islander (.8%) participants. Data for race were missing for .8% of the subsample.

Measures

Demographics

Demographic data including age, gender, race, and years of education were obtained from clinical interview and VA records.

Executive function

The Frontal Assessment Battery (FAB; Dubois et al., 2000) is a brief bedside screening measure assessing various domains of executive-mediated cognitive and motor function. The measure is composed of eight items, scored from 0-3 and summed to obtain a total score. Items assess the following domains: Conceptualization, Mental Flexibility, Motor Programming, Sensitivity to Interference, Inhibitory Control, and Environmental Autonomy. Higher scores on each item indicate higher levels of executive functioning. In the original study (Dubois, et al., 2000), FAB was shown to have good interrater reliability ($k = 50.87$, $p < .001$) and internal consistency (Cronbach's coefficient alpha = .78). Furthermore, Dubois and colleagues demonstrated good discriminate validity (89.1% of cases correctly identified in a discriminant analysis of patients and controls) and good concurrent validity (rho = .68, $p < .01$) with the Mattis Dementia Rating Scale (MDRS; Mattis, 1976, 1988) and a modified version of the Wisconsin Card Sorting Test (MCS; See Nelson, 1976) number of categories achieved (rho = .77, $p < .001$) and perseverative errors (rho = .68, $p < .001$). A recent review article summarized psychometric properties of the FAB in studies conducted; the FAB showed Cronbach's alpha reliability (.68-.78), interrater reliability (.79-.96), and concurrent validity with a variety of

executive (.33-.94) and non-executive (.41-.71) measures (Moreira et al., 2017). In the current study, the FAB showed adequate internal consistency (Cronbach's alpha = .66).

Functional status

The 16-item VA Functional Status Interview (FSI) is a VA-developed clinician-rated measure of functional activities based on items of the Katz Activities of Daily Living scale (Katz & Akpom, 1976) and the Lawton and Brody Instrumental Activities of Daily Living scale (Lawton & Brody, 1969). The measure was developed for use in a Veterans Affairs Memory Clinic. The development of this measure was based on previous measures of two factors, ADL and IADL, referenced in the literature as standard measures of functional status (Elsawy & Higgins, 2011; Norström & Thorslund, 1991). Seven items were intended to measure ADL function (bathing, grooming, transferring, mobility, eating, dressing, toileting) and nine items were intended to measure IADL function (medication management, finances, driving, using the telephone, safety awareness, traveling, shopping, preparing meals, and completing housework). The measure was administered as part of a semi-structured interview by individuals with training in neuropsychological assessment and scored by clinicians to address issues with older adults with cognitive impairment under-reporting functional decline (Okonkwo et al., 2009; Thames et al., 2011). During administration, the examiner provided standardized prompts and follow-up questions as needed. Clinicians then used patient and informant data to assign ratings on a 3-point Likert scale (0 = 'Dependent,' 1 = 'Needs Assistance,' 2 = 'Independent'). Scores were averaged with total scores ranging from 0-2, and higher scores indicating more independent functioning.

Because the FSI was developed for in-house use, reliability and validity were not previously established in the literature. However, items were based on existing measures, the

Katz Activities of Daily Living scale (Katz & Akpom, 1976; Cronbach's alpha = .92, as reported by Khoei, Akbari, Sharifi, Fakhrzadeh, & Larijani, 2013) and the Lawton and Brody Instrumental Activities of Daily Living scale (Lawton & Brody, 1969; r = .93 as reported by Farias, Harrell, Neumann, & Houtz, 2003), which have yielded excellent internal consistency. Though the FSI was created to assess two factors, some research has divided functional items into 1-factor (Spector & Fleishman, 1998), 3-factor (Thomas, Rockwood, & McDowell, 1998; Wolinsky & Johnson, 1991; Clark, Stump, & Wolinsky, 1998), and 4-factor solutions (Fitzgerald et al., 1993). Thus, the current study included an examination of the factor structure of the FSI before exploring its relationship with the FAB.

Caregiver burden

Caregivers of evaluated patients completed the Zarit Burden Interview-Revised (ZBI-R; Zarit, Reever, Bach-Peterson, 1980). The ZBI-R is composed of 22 questions on a 5-point Likert scale ranging from 0 (*Never*) to 4 (*Nearly Always*). An item example is, "Do you feel your relative is dependent on you?" Total scores range from 0-88 with higher scores indicating greater perceived burden. A recent exploratory factor analysis conducted in a veteran sample yielded a three-factor structure: Psychosocial Burden, Dependency Burden, and Guilt (Stinson et al., 2014). According to Stinson and colleagues, the Psychosocial Burden factor was thought to relate to one's affective responses to caregiving while Dependency Burden related to the tangible costs, and Guilt represented perceived performance in this role. Scores can be obtained for these subscales in addition to the total score. The ZBI-R has been shown to have excellent Cronbach's alpha coefficient for the total score (α = .92; Hérbert, Bravo, & Préville, 2000). In the current study, the alpha coefficient for the total scale was .93 and alpha coefficients were .90, .86, and .71 for Psychosocial Burden, Dependency Burden, and Guilt, respectively. According to a meta-

analysis, significant variability was found with regard to test-retest reliability (r = .24 - .89), but this variability was attributed to the large range of time intervals across studies (e.g., a few days to five years; Bachner & O'Rourke, 2007). Validity studies of the Zarit Burden Interview (ZBI) have shown the measure correlated significantly with a single global rating of burden (r = .71; Zarit & Zarit, 1990). Stinson et al. (2014) reported that the dependency burden factor significantly correlated with neuropsychological test performance of care recipients.

Procedures

Following IRB approval, archival data from veterans who presented for evaluation at the Memphis Veterans Affairs Medical Center (VAMC) Memory Clinic between 2007-2017 were accessed. Patients were referred to the Memory Clinic via one of two means, the result of a dementia evaluation decision-tree or annual clinical reminders. Referrals that occurred via dementia decision trees satisfied the following criteria: aged 65 or older; non-rapid symptom progression (< 6 months) with motor symptoms; and demonstration of problematic behaviors, need for geriatric pharmacy review, and/or functional decline. Patients identified for referral via annual clinical reminders met the following criteria: aged 75 or older; MiniCog score < 3 (Borson, Scanlan, Brush, Vitallano, & Dokmak, 2000); and one or more dementia warning signs. All participants demonstrated at least one potential dementia symptom and report to the referring provider of functional decline.

Results

Factor analysis of Functional Status Inventory (FSI)

Prior to primary analyses, the factor structure of the FSI was examined using principal axis factoring (PAF) to identify the factors to be used in subsequent analyses. Due to the theoretically-based relationship among expected factors, an Oblique (Oblimin) rotation was

utilized (Norström & Thorslund, 1991). The Kaiser-Meyer-Oklin value was .91 and Bartlett's Test of Sphericity was statistically significant ($p < .001$), suggesting that the inter-correlation matrix was appropriate for factor analysis.

Both the scree test and parallel analysis (Horn, 1965) suggested two clear factors and a possible, but less clear, third factor. Two- and three-factor solutions were generated. The two-factor solution resulted in all items having strong loadings (absolute values of > .40) on either factor 1 or factor 2 and the factors represented the theoretically expected scales of Instrumental Activities of Daily Living (IADL, factor 1) and Activities of Daily Living (ADL, factor 2). The three-factor solution resulted in a two-item scale and poorer loadings (some item loadings of < .40) on the other two factors. The two-factor solution was retained and the factors accounted for 56.4% of the variance. The results of the exploratory factor analysis were supported by the results of previous studies identifying a two-factor model (e.g., Mack & Patterson, 2006; Norström & Thorslund, 1991) and the well-known theoretical conceptualization of functional status.

As shown in Table 1, factor 1, which was named IADL, contained nine items assessing complex activities of daily functioning. Factor 2, which was named ADL, contained seven items assessing basic activities of daily functioning. The ADL and IADL factors strongly correlated ($r_s = .64$, $p < .01$). Scale scores for IADL and ADL were created by summing item responses. Cronbach's alpha reliability coefficients were .92 and .89 for IADL and ADL scales, respectively.

Analyses of normality and group differences

Following identification of FSI factors, data were examined to assess for statistical outliers and skewness and kurtosis on the study variables. Skewness and kurtosis were within acceptable

limits (+/- 2) for all study variables. However, the scales for ADL, IADL, ZBI-R Psychosocial Burden, and ZBI-R Guilt showed some indication of non-normality on the Shapiro-Wilk test. The histogram plots of these scales confirmed that scores were not normally distributed, which was expected given the clinical nature of the sample.

Analyses using *t* tests examined if differences existed based on race (White versus racial minority participants) for scores on FAB, ZBI-R subscales, or ADL and IADL factors. Regarding FSI factors, ADL scores were found to significantly differ between White and minority participants. Regarding ZBI-R subscales, Psychosocial Burden, Dependency Burden, and to a lesser extent, Guilt scores, were found to significantly differ between White and minority participants. Specifically, lower levels for independence for ADL were endorsed by White participants and caregivers of White participants reported greater burden. IADL and FAB scores did not significantly differ by race. Results of the *t*-tests are shown in Table 2.

Correlational analyses examined associations between age, education, and study variables. Pearson's rank correlations were used for normally distributed variables, while Spearman's rho correlations were used for variables with a non-normal distribution. These analyses are displayed in Table 3. The strength of correlational analyses was interpreted using Cohen (1988) statistical guidelines. Age did not significantly correlate with ADL or IADL scores but demonstrated a significant negative correlation with FAB scores. Furthermore, age was significantly, negatively correlated with all ZBI-R subscale scores. Education did not significantly correlate with scores for ADL or IADL but showed a significant, positive correlation with FAB scores. Education showed significant positive correlations with ZBI-R Psychosocial Burden factor scores but did not correlate with Dependency Burden or Guilt subscale scores. These data are displayed in Table 3.

Assessing ecological validity of the Frontal Assessment Battery (FAB)

Correlational analyses indicated significant relationships between FAB and ADL scores (r_s = .26, p < .01) and FAB and IADL scores (r_s = .54, p < .001). Analyses indicated non-significant relationships between FAB scores and Psychosocial Burden (r_s =-.03, p >.05), Dependency Burden (r = -.17, p = .05), and Guilt (r_s = .05, p > .05).

Due to the relationships between demographic and study variables, partial-rank correlations were calculated to control for the combined effects of race, age, and education (based on Stinson et al., 2014). Partial rank correlational analyses indicated a significant relationship between FAB and ADL scores ($r_{FABADL.race.age.education}$ = .31, p < .001*)* and between FAB and IADL scores ($r_{FABIADL.race.age.education}$ = .55, p < .001). The similarities between the Spearman's rho correlations and these partial correlations controlling for demographic variables suggests demographic variables had little effect on relationships between FAB and I/ADL scores. Additionally, with regard to ZBI-R subscale scores, partial rank correlational analyses indicated FAB significantly correlated with Dependency Burden ($r_{FABDependencyBurden.race.age.education}$ = -.23, p = .01), but not with Psychosocial Burden ($r_{FABPsychosocialBurden.race.age.education}$ = -.12, p > .05) or Guilt ($r_{FABGuilt.race.age.education}$ = -.01, p > .05) subscale scores. Additionally, to determine if differences existed when controlling for demographic variables and when utilizing existing normative data from an Irish sample (Coen et al., 2016), z-scores using means and standard deviations derived from the normative data sample were calculated. Correlational analyses were then used to examine the relationship between FAB z-scores, ADL, IADL, and ZBI-R subscale scores. These data are also displayed in Table 3.

Discussion

The number of older individuals within the United States population is increasing at historical rates and older adults remain susceptible to significant disability due to dementia (Centers for disease Control and Prevention, 2015; Mather, Jacobsen, & Pollard, 2015; WHO, 2017). Current trends suggest the number of cases of dementia will continue to rise, and veterans may be more likely to possess certain characteristics (i.e., higher age, depression, PTSD, TBI) documented to be associated with cognitive impairment (McInnes et al., 2017; Rock, et al., 2014; Scott et al., 2015; United States Census Bureau, 2011; Veitch et al., 2013; WHO, 2017). Executive dysfunction is a common feature of dementia and is thought to be related to impairment and disability in daily functioning, particularly IADL (Royall et al. 2007). Although various measures of executive function exist, there is a relative dearth of literature evaluating the ecological validity of such neuropsychological screening measures (Koerts et al., 2012). In particular, the ecological validity of the FAB is under-studied within United States veteran samples, despite the aforementioned factors associated with cognitive impairment within this population. To assess the ecological validity of the Frontal Assessment Battery, the current study examined primary relationships between the Functional Status Interview with FAB total scores.

Findings partially supported hypothesis 1, indicating a significant, but weaker than expected, small correlation between FAB and ADL and a strong, significant relationship between FAB and IADL. These associations between lower scores on FAB and functional impairment, particularly IADL, are consistent with previous research suggesting neuropsychological tests are better indicators of IADL than ADL impairments (Richardson, Nadler, & Malloy, 1995). And the conceptual understanding of IADL as more sensitive to cognitive impairment than ADL (Monaci & Morris, 2012), highlighting a strength of the measure. Specifically, the FAB may

detect more subtle functional decline, leading to the potential for earlier diagnosis, planning, and intervention prior to the onset of functional dependence. Additionally, these findings are consistent with existing studies examining the links between executive function and functional abilities (Pereira, Yassuda, Oliveira, & Forlenza, 2008; Royall, Palmer, Chiodo, & Polk, 2004). Overall, the findings suggest the FAB possesses ecological validity and can serve as a useful tool in identifying individuals in need of more comprehensive neurological assessment (Jekel et al., 2015). FAB may be particularly useful as a screening measure in settings less amenable to comprehensive testing, such as primary care and inpatient units.

These findings are particularly meaningful as early identification of dementia may allow for a variety of positive outcomes, including lower medical costs; patient participation in medical, financial, legal, and healthcare decisions; and earlier psychosocial and pharmacological management of emotional and cognitive symptoms (de Vugt & Verhey, 2013; Leifer, 2003; Woods et al., 2003). Furthermore, exploration of patient needs, support, and recommendations for care provided at the time of diagnosis is associated with higher quality of life among patients (de Vugt & Verhey, 2013; Leifer, 2003). The FAB may be especially helpful in situations where information regarding functional status is unavailable due to absent or unreliable informant report.

Additionally, correlational analyses between FAB and domains of caregiver burden did not support hypothesis 2 finding small non-significant relationships between FAB and aspects of dependency burden. These findings are in contrast to previous smaller sample studies documenting a relationship between FAB and caregiver burden, particularly dependency burden (Hashimoto et al., 2017; Matsuoka et al., 2017). These findings possibly highlight cultural or

sociodemographic differences in experience and/or report of burden associated with cognitive decline. As a result, demographic analyses and cultural considerations are discussed below.

Demographic associations

In addition to primary analyses, differences based on race and associations with age and education were also explored. Regarding race, no differences in executive function existed across groups; however, White participants experienced a greater degree of clinician-rated impairment for ADL than racial minority participants. Additionally, White caregivers endorsed greater levels of psychosocial burden, dependency burden, and, to a lesser extent, guilt-related burden than racial minority caregivers. These data suggest White and racial minority participants were similarly impaired on screening measures of cognition, but caregivers of White participants experienced greater levels of burden than their minority (predominantly African American) counterparts. These findings are consistent with previous studies suggesting African American caregivers of dementia patients experience greater life satisfaction, are less depressed, and report lower levels of burden than White caregivers (Clay, Roth, Wadley, & Haley, 2008; Kosberg, Kaufman, Burgio, Leeper, & Sun, 2007). This pattern highlights the importance of considering cultural values related to caregiving when assessing levels of reported functional decline and identifying interventions for dementia patients, as minority patients and caregivers may be less likely to report decline. Alternatively, these findings may indicate that caregiver burden as measured by the ZBI-R may be more reflective of caregiver distress related to difficulties with physical or motor functioning than cognitive impairment, as ADL, more than IADL, scores have been found to relate to physical functioning (Cahna et al., 1998).

Analyses examining associations between age and study measures suggested a small correlation between age and FAB scores, consistent with previous findings in a Brazilian sample

in which FAB was found to be associated with age and education (Beato, Nitrini, Formigoni, & Caramelli, 2007). Specifically, FAB scores in our study trended downward as age increased, a finding supported by previous research indicating a decline in executive function occurs with normal aging (Fjell, Sneve, Grydeland, Storsve, & Walhovd, 2017). Additionally, small correlations were also observed between FAB and ZBI-R subscales, suggesting expression of psychosocial, dependency, and guilt-related burden was impacted by age, such that caregivers perceived more burden when veterans were younger in age, while they experienced lesser burden when veterans were older. These findings may reflect the caregiver's initial difficulty with adapting to the caregiving role as cognitive decline first emerges, particularly if a diagnosis has not been provided, as well as improved adjustment to role requirements over time (Aneshensel et al., 1995; de Vugt & Verhey, 2013).

Alternatively, the aforementioned findings may reflect a change in the caregiving role, such that spouses may be the primary caregiver at younger ages, while children or children-in-law may step into this role when the spouse is no longer available or able to provide care (Brody, 1981; Pinquart & Sörensen, 2011). Pinquart and Sörensen (2011) hypothesized spouses may experience greater vulnerability to caregiver-related burden due in part to the strength of the attachment between spouse and care recipient. Additionally, spouses provide greater frequency of care and experience a greater degree of depressive symptoms as well as financial, physical, and relational strain than younger caregivers (Pinquart & Sörensen, 2011). The current study did not assess the relationship of the caretaker to the patient; however, findings from a recent study using data derived from a similar sample of patients in the Memphis VA Memory Clinic (Stephens et al., 2018) suggested spousal caregivers experienced significantly greater burden related to the caregiving role than adult children caregivers.

Finally, preliminary analyses examining the association between education and study measures suggested a small, positive correlation between education and FAB scores, reflecting that veterans with a higher level of education maintained higher degrees of executive function. Notably, previous studies also found a relationship between education and FAB scores (Beato et al., 2007; Beato et al., 2012). In the current study, veteran level of education also showed a small, positive correlation with caregiver reported psychosocial burden, suggesting higher levels of emotional distress in caregivers of patients with higher levels of education. This finding may capture the particularly stressful adjustment to decline when care recipients previously functioned at higher levels of cognition.

Controlling for demographic variables

As there were significant correlations between some of the demographic variables and study variables, hypotheses 1 and 2 were also explored when controlling for demographic variables as performed in a recent study by Stinson and colleagues (2014). Regarding hypothesis 1, the strength of the relationship between FAB and IADL scores remained strong, while the correlation between FAB and ADL scores increased from small to moderate, .26 to .31. These findings provide further support for the use of the FAB in identifying individuals with executive and functional impairment, particularly when caregiver report is unavailable.

Though hypothesis 2 regarding the association between FAB and caregiver burden subscales was initially unsupported, a small, albeit weak, significant negative relationship emerged between FAB and dependency burden when controlling for combined demographic variables. The relationship between FAB and dependency burden observed in the current study was similar to the relationship observed between dependency burden and commonly used executive measures (Stinson et al., 2014) and FAB in Japanese samples (Hashimoto et al., 2017;

Matsuoka et al., 2017). Data suggest that when cultural and demographic factors are taken into account, FAB may provide important information about the tangible and psychological costs of caregiving for an individual with reduced executive function, and thereby, aid in identification of patients with significant functional impairment. Additionally, findings suggest that impairment on the FAB may aid in identifying caregivers in need of caregiver support, psychoeducation, and intervention. Knowledge of diagnosis, prognosis, and available resources may be particularly helpful to caregivers since taking advantage of service options early in the disease process may lessen burden and postpone nursing home placement (Gaugler, Kane, Kane, & Newcomer, 2005).

Additionally, FAB z-scores calculated using Coen et al.'s (2016) normative data stratified by age and education yielded similar relationships with ADL, IADL, and ZBI-R subscales. These findings suggest the importance of utilizing normative reference groups for the FAB on the basis of age and education. In the absence of veteran-specific normative data, our findings support the clinical use of Coen et al.'s (2016) normative data with older adult veterans. Findings suggest FAB may provide little information about caregiver burden when sociodemographic factors, such as age, race, and education, and care provider status, are not taken into account.

Taken together, these findings provide initial support for the ecological validity of the FAB in veteran samples as it relates to real-world impairments, particularly for complex tasks, often observable only outside of the testing environment. The FAB appears to possess clinical utility as a screening measure for cognitive impairment that may require additional assessment to rule out dementia and/or when caregiver report is unavailable.

Limitations and future studies

The current study had several limitations. First, the functional status measure utilized in the current study lacked validity information prior to this study as it was adapted based on previous measures of ADL/IADL function. This measure possessed several overlapping items with other well-established measures of functional status and preliminary factor analysis supported the expected theoretical structure. The disproportionate number of men in the sample limits the generalizability to female veterans, an important area of future research. Furthermore, because the sample was composed of patients identified as having cognitive and functional decline, findings may not generalize to individuals with more mild reductions in executive function. Furthermore, analyses were limited in that they compared the experience of White and primarily African American participants but were unable to provide meaningful information regarding the relationship of study variables to other racial and ethnic groups. Furthermore, because non-executive domains of cognition were not examined in this study, the potential that differences in caregiver burden, observed across racial groups, may represent impairment in non-executive cognitive domains cannot be ruled out. Additionally, information regarding the relationship of the caregiver to the patient was unavailable in our study, though data in a subsequent study found significant differences in burden across spouse and adult child caregivers.

Future researchers should seek to explore the relationship between FAB and objective measures of I/ADL in United States veterans, as well as extend this work to primary care, geriatric inpatient, and long-term care settings. Additionally, future researchers should seek to re-produce findings in samples with a greater prevalence of female participants, as well as with various ethnic and racial minority groups. Future researchers may wish to examine the discriminate validity of the FAB in predicting functionally independent and functionally

dependent groups. Finally, research should seek to create normative data for clinical use within United States veterans.

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Appendices

Table 1

Factor Loadings and Communalities based on Principle Axis Factoring with Oblimin Rotation for the Functional Status Inventory (FSI) with 2 Imposed Factors

Item	Item description	Factor 1 (IADL)	Factor 2 (ADL)	Communalities
1	Bathing	.28	**.60**	.62
2	Grooming	.19	**.65**	.59
3	Transferring	-.11	**.83**	.61
4	Mobility	-.07	**.72**	.47
5	Eating	-.05	**.73**	.51
6	Dressing	.16	**.75**	.71
7	Toileting	.11	**.59**	.43
8	Medication Management	**.81**	-.03	.63
9	Finance Management	**.91**	-.17	.69
10	Driving	**.69**	.03	.50
11	Telephone Use	**.50**	.15	.36
12	Safety Awareness	**.54**	.13	.38
13	Traveling	**.78**	.01	.63
14	Shopping	**.90**	-.06	.76
15	Cooking	**.77**	.04	.63
16	Housework	**.64**	.13	.52

Note. N=168. Factor loadings > .40 are in boldface. ADL= Activities of Daily Living, IADL = Instrumental Activities of Daily Living.

Table 2

Results of t-test and Descriptive Statistics for ADL, IADL, FAB, and ZBI-R by Race

Variable	Race						95% CI for mean difference		
	Minority			White					
	M	*SD*	*n*	*M*	*SD*	*n*		*t*	*df*
ADL	19.05	3.08	61	17.90	3.27	106	[-2.17, -.14]	-2.24*	165
IADL	18.33	5.38	61	16.96	6.03	106	[-3.21, .48]	-1.47	165
FAB	9.08	3.34	61	9.75	3.86	106	[-.46, 1.79]	1.17	140
Psy Burden	7.52	7.40	42	12.50	8.28	86	[1.99, 7.96]	3.30**	126
Dep Burden	9.36	5.79	42	13.09	6.52	86	[1.39, 6.08]	3.16**	126
Guilt	4.07	3.19	42	5.34	2.77	86	[.18, 2.35]	2.31*	126

Note. CI = confidence interval. ADL = Activities of Daily Living, IADL = Instrumental Activities of Daily Living, FAB = Frontal Assessment Battery, Psy Burden = ZBI-R Psychosocial Burden, Dep Burden = ZBI-R Dependency Burden.

Data for ADL, IADL, and FAB are from participants in the initial sample (n = 168) who provided information about race. Data for Psy Burden, Dep Burden, and Guilt are from participants in the subsample (n = 129) who provided information about race. For FAB by Race, equal variances could not be assumed ($p < .05$).

*$p < .05$. **$p < .01$.

Table 3

Correlations for Age, Education, FAB, ADL, IADL, and ZBI-R Subscales

Variable	ADL	IADL	FAB	Psy Burden	Dep Burden	Guilt
Age	.07	-.09	-.17*	-.25**	-.19*	-.21*
Education	-.07	.06	.28***	.20*	.09	.10
FAB	.26**	.54***	--	-.03	-.17	.05
$FAB_{race.age.edu}$	.31***	.55***	--	-.12	-.23*	-.01
FAB-z	.25**	.51***	--	-.10	-.23**	-.05
$FAB\text{-}z_{race}$	.28***	.52***	--	-.12	-.26**	-.07

Note: ADL = Activities of Daily Living, IADL = Instrumental Activities of Daily Living. FAB = Frontal Assessment Battery, ZBI-R Psy Burden = ZBI-R Psychosocial Burden, ZBI-R Dep Burden = ZBI-R Dependency Burden. $FAB_{race.age.edu}$ = partial rank correlations controlling for age, race, and education. FAB-z = FAB z scores calculated using Coen et al. 2016 normative reference data. $FAB\text{-}z_{race}$ = partial rank correlations with FAB z controlling for race.

The sample, n = 168, was composed of participants who completed FAB, ADL, and IADL measures. A subsample, n =129, was composed of participants who completed FAB and ZBI-R subscales. Minimal demographic data were missing for participants. Due to the non-normal distribution of study variables, Spearman's rho correlations were used for correlations of FAB and FAB-z with ADL, IADL, ZBI-R Psychosocial Burden, and ZBI-R Guilt. Pearson's rank analyses were used for correlations between FAB and FAB-z with ZBI-R Dependency Burden. Partial-rank correlations were used to control for age, race, and education with FAB, and for race with FAB-z.

*p < .05. **p < .01. ***p < .001.