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The association of psychological, cognitive, and functional variables with self-reported executive functioning in a sample of non-demented community-dwelling older adults

Erica P. Meltzer^{1,2}, Ashu Kapoor^{3,4}, Joshua Fogel⁵, Milushka M. Elbulok-Charcape², Robert M. Roth⁶, Mindy J. Katz⁴, Richard B. Lipton⁴, Laura A. Rabin^{1,2,4,6}

¹Department of Psychology, Queens College of the City University of New York, Queens, NY

²Department of Psychology, Brooklyn College and the Graduate Center of the City University of New York, New York, NY

³Department of Psychology, Ferkauf Graduate School of Psychology, Yeshiva University, Bronx, NY

⁴Department of Neurology, Albert Einstein College of Medicine, Bronx, New York

⁵Department of Business Management, Brooklyn College of the City University of New York, Brooklyn, NY

⁶Department of Psychiatry, Geisel School of Medicine at Dartmouth College, Lebanon, New Hampshire

Abstract

Subjective executive functioning (EF) measures provide valuable information about real-world difficulties, although it is unclear what variables actually associate with subjective EF scores. We investigated subjective EF in 245 non-demented, community-dwelling older adults (aged 70 and above) from the Einstein Aging Study. Partial correlational analyses controlling for age were performed between the nine Behavior Rating Inventory of Executive Function—Adult version (BRIEF-A) clinical scales and objective EF tests, self-reported mood and personality, and informant-reported activities of daily living. The significance level was set at $p < .006$ for all analyses (two-tailed). Most notably, higher worry/oversensitivity, physiological anxiety, and fear of aging were significantly associated with increased EF difficulties on all nine BRIEF-A scales. Additionally, increased EF difficulties on five or more BRIEF-A scales were significantly associated with lower conscientiousness, higher neuroticism, and higher depressive symptom scores. The only objective neuropsychological test that significantly correlated with increased EF difficulties (on four BRIEF-A scales) was a measure of practical judgment. Overall, results indicate that interpretation of subjective EF scores must account for self-report of mood and personality. Moreover, the BRIEF-A only minimally taps objective EF as measured by performance-based measures. We discuss the theoretical and practical implications of these findings.

Keywords

self-report; executive function; anxiety; depression; personality; older adults

Introduction

Executive functions, which are involved in planning, task coordination, impulse control, and attentional control, are thought to change over the life course (Diamond, 2013). Although accurate measurement of executive functioning (EF) is critical during cognitive evaluations of older adults and other clinical and nonclinical populations, executive processes are inherently complex and difficult to assess (Miyake et al., 2000). Subjective measures of EF such as the Behavior Rating Inventory of Executive Function—Adult version (BRIEF-A; Roth, Isquith, & Gioia, 2005) may offer insight into real-world difficulties, particularly those that are not obvious on objective tests (Anderson, Anderson, Northram, Jacobs, & Mikiewicz, 2002; Isquith, Roth, & Gioia, 2013; Løvstad et al., 2012; Payne, Hyman, Shores, & North, 2011). However, subjective report measures are vulnerable to biases related to order, scale, and halo-effects (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003), their strong relation to psychological factors such as depression, anxiety, and personality (Balash et al., 2013; Merema, Speelman, Foster, & Kaczmarek, 2013), and often show small to modest correlations with objective measures purported to measure the same construct (Bromley, 2007; Johnco, Wuthrich, & Rapee, 2014; Mahone et al., 2002; Schiehser et al., 2011). Thus, neuropsychologists may be left to speculate about the processes that subjective EF measures actually relate to, and further, the information that can be reasonably inferred from patients' self-reports of executive dysfunction.

The limited scholarly literature reports mixed findings with regard to correlations between the BRIEF-A and objective-based measures of EF (Roth, Isquith, & Gioia, 2014). One study found no significant relationship between BRIEF-A self- or informant-report scores and EF test scores in a sample of non-demented older adults that included individuals with amnesic mild cognitive impairment, significant cognitive complaints despite intact neuropsychological functioning, and healthy controls (Rabin et al., 2006). Another study found a weak relationship between the BRIEF-A and objective-based measures of EF in adults with lesions to the orbitofrontal cortex (Løvstad et al., 2012). Specifically, higher scores on the Digit Span subtest of the Wechsler Adult Intelligence Scale—Third Edition, a measure of auditory attention/working memory, were associated with lower self-reported difficulties on the BRIEF-A Metacognitive Index and Global Executive Composite. A third study found several significant associations between the BRIEF-A and objective-based measures of EF in adults with moderate-to-severe traumatic brain injury (García-Molina, Tormos, Bernabeu, Junqué, & Roig-Rovira, 2012). Specifically, poorer scores on the Trail Making Test-B, Stroop Color Word Interference Test, Controlled Oral Word Association Test, and Letter-Number Sequencing Test were associated with greater informant-reported difficulties on several BRIEF-A clinical scales. It is important to note that most of the literature on subjective measurement of EF relates to the original child/adolescent version of the BRIEF (Gioia, Isquith, Guy, & Kenworthy, 2000), which also has inconsistent associations with objective-based EF measures (Byerley & Donders, 2013; Faridi

et al., 2014; MacAllister et al., 2012; Mangeot, Armstrong, Colvin, Yeates, & Taylor, 2002; McAuley, Chen, Goos, Schachar, & Crosbie, 2010; Parrish et al., 2007; Vriezen & Pigott, 2002). In addition, when results have revealed a relationship between performance-based EF measures and the BRIEF, the objective-based measures tend not to be correlated with their respective BRIEF clinical scales (Toplak, Bucciarelli, Jain, & Tannock, 2009).

The BRIEF-A is associated with self-reported emotional functioning and personality. A series of validation studies of the BRIEF-A reported correlations with depression and anxiety in adult and older adult samples (Roth et al., 2005). In another study, greater report of EF problems on the BRIEF-A was associated with greater self-reported depressive symptoms in non-demented older adults (Rabin et al., 2006). Løvstad and colleagues (2012) further found that self-reported EF difficulties (as measured by the BRIEF-A's Global Executive Composite) positively correlated with the Global Severity Index of the Symptom Checklist 90 revised, a measure of emotional distress, in adults with lesions to the orbitofrontal cortex. Also, in a sample of adults with major depression, there was a modest relationship between BRIEF-A Global Executive Composite change scores and clinical interview-based depression rating scale change scores over the course of a medication treatment trial (Madhoo et al., 2014). While to our knowledge, no study has investigated the relation of BRIEF-A scores to personality traits, recent research in a relatively high-performing (largely student) sample found that self-report of executive problems were associated with higher neuroticism and lower conscientiousness (Buchanan, 2015). The subjective EF measures used in this study were the online questionnaire Webexec (Buchanan et al., 2010) and the paper-and-pencil self-report DEX scale from the Behavioral Assessment of the Dysexecutive Syndrome battery (Wilson et al., 1996).

There is little research on the relationship between the BRIEF-A and measures of activities of daily living. To our knowledge, only one study exists and this study found a significant association between informant-reported EF difficulties on the BRIEF-A and activity of daily living problems on the Patient Competency Rating Scale in moderate-to-severe traumatic brain injury (García-Molina et al., 2012). The paucity of work is surprising in light of evidence from the child literature that parent ratings on the BRIEF correlate with scores on measures of adaptive functioning (Gilotty, Kenworthy, Sirian, Black, & Wagner, 2002; Mangeot et al., 2002). Also, a study that examined the BRIEF-A in relation to demographic variables in a normative sample found that gender, education, and race/ethnicity each generally accounted for less than 2% of variance in BRIEF-A scores, whereas age accounted for a more sizable percentage of the variance (Roth et al., 2005). In another study, no significant correlations were observed between self- or informant-reported BRIEF-A scales and age, gender, or education in older adults (Rabin et al., 2006).

Overall, prior research reports inconsistent associations between the BRIEF-A and objective-based measures of EF, and has minimally examined relationships with relevant variables such as mood, personality, and activities of daily living. The current study expands prior research by examining several variables that may be associated with self-reported EF on the BRIEF-A in a sample of non-demented, community-dwelling older adults. These included standardized performance-based EF test scores, self-report inventories (state depression, state anxiety, trait conscientiousness, and trait neuroticism), and informant-reported instrumental activities

of daily living. Controlling for age, we predicted that higher subjective EF difficulties would be associated with higher depressive and anxiety symptoms, lower conscientiousness and higher neuroticism, and decreased independence in activities of daily living. We did not make specific predictions about which EF test scores might associate with specific BRIEF-A clinical scales.

Methods

Participants and procedure

Participants were a subset of individuals from the Einstein Aging Study (EAS), a community-based longitudinal study of individuals aged 70 and older residing in the Bronx, NY (Lipton et al., 2003; Katz et al., 2012). Participants were recruited through systematic sampling from Medicare or voter registration lists for Bronx County. Exclusion criteria included severe audiovisual disturbance or medical or psychiatric conditions that could interfere with the ability to complete the study; non-English-speaking, being institutionalized, or non-ambulatory status; and a diagnosis of dementia from a consensus case conference (see Katz et al. 2012 for details). No participant had dementia and approximately 21% of participants had a diagnosis of mild cognitive impairment (MCI), suggesting a preclinical dementia condition (Petersen et al., 2001; Winblad et al., 2004). More specifically, approximately 6% had a diagnosis of amnesic MCI and 15% had a diagnosis of non-amnesic MCI (for details about classification see Rabin, Chi, et al., 2014; Rabin, Wang, Katz, & Lipton, 2014). The remaining participants were cognitively intact across neuropsychological domains, although a subset (approximately 32% of participants) presented with important self-reported and/or informant-reported complaints about their memory and other aspects of cognition (classified as subjective cognitive decline, SCD). To assess subjective cognitive complaints, we used items validated in previous research (Rabin et al., 2012) to derive scores that were the proportion of positive responses. Sample items included: “Do you have difficulty remembering things that happened recently?” “Do you forget conversations that occurred a few days or hours earlier?” Subsequently, we generated an optimal cut point from a receiver operating characteristic analysis, stratified by young-old (age 70–79) and old-old (age 80 and above) groups, which used a robust EAS sample and was based on the cross-sectional association between the self or informant complaint and MCI (Rabin, Wang, Katz, & Lipton, 2014). Also, the subjective report measures used to characterize participants’ level of cognitive complaints did not include the primary outcome measure under study (i.e., BRIEF-A).

We obtained ethical approval to conduct the study and all participants provided informed consent according to procedures approved by the Institutional Committee for the Protection of Human Subjects. Participants were assessed on two occasions, separated by approximately two weeks. During the first visit (i.e., Day 1), participants completed a traditional neuropsychological battery, a neurological examination, and physical measures (e.g., blood pressure, grip strength, see Katz et al., 2012). During the second visit (i.e., Day 2), participants completed additional neuropsychological measures and the self-report questionnaires described below.

Materials

Objective executive functioning measures.—Study-relevant Day 1 measures included the Digit Symbol subtest of the Wechsler Adult Intelligence Scale–Revised (WAIS-R; Wechsler, 1981), FAS Letter Fluency (Spreen & Strauss, 1998), Trail Making Test Part B (TMT Part B; Reitan, 1958), and the Golden Stroop (Stroop, 1935). Study-relevant measures administered on Day 2 included Letter-Number Sequencing (LNS) of the Wechsler Adult Intelligence Scale—Fourth Edition (WAIS-IV; Wechsler, 2008), the Tower Test of the Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan, Kramer, 2001), Test of Practical Judgment (TOP-J; Rabin et al., 2007), and the Memory for Intentions Screening Test-A (MIST-A; Raskin, 2009; Raskin, Buckheit, & Sherrod, 2010).

The Digit Symbol task measures visuomotor speed and efficiency and requires sustained attention and persistence. Participants were provided with a printed key of number-symbol pairs and instructed to fill in blank squares with the symbol paired to the number as shown in the key. Scores were the number of squares filled in correctly in 90 seconds and range from 0 to 93. Letter Fluency measures verbal initiation and retrieval skills. Participants spontaneously produced words beginning with the letters F—A—S across three 1-minute trials, and scores were the total number of correct words. The TMT Part B is a measure of set-shifting and cognitive flexibility. Participants drew lines to connect 25 encircled numbers and letters in alternating order as fast as possible. Scores for the TMT-B were seconds to task completion, with the maximum being 300 seconds. The Golden Stroop task measures cognitive processing speed and inhibitory control. We analyzed the Color-Word Interference trial, wherein incongruent ink-colored items (e.g., RED printed in green ink) were presented, and participants were instructed to name the color of the ink that the words were printed in. The Color-Word score is the number of items completed in 45 seconds.

LNS measures auditory attention and working memory.—Participants listened to number-letter strings and were asked to recall the numbers first in ascending order and then the letters in alphabetical order. Scores were the total number of correct items and ranged from 0 to 30. The Tower Test measures spatial planning and problem-solving. Participants moved five disks across three pegs to build target towers in the fewest number of moves possible. We analyzed the total achievement score, which is based on how many towers were correctly completed in the allotted time and how many moves were made to complete them. Scores ranged from 0 to 30. The TOP-J is an open-ended measure that evaluates judgment related to safety, medical, social/ethical, and financial issues. Participants listened to brief scenarios about everyday problems and reported aloud their proposed solutions. Responses to each of 15-items were scored on a 4-point scale and total raw scores ranged from 0 to 45. The MIST-A is a measure of prospective memory, consisting of eight tasks (four time-based and four event-based tasks with delay intervals of either 2 minutes or 15 minutes). Performance on the MIST is thought to rely upon both episodic memory and executive functioning systems. MIST total scores ranged from 0 to 48.

Self-report mood and personality measures.—The short form of the Geriatric Depression Scale (GDS; Yesavage et al., 1982), and Adult Manifest Anxiety Scale–Elderly (AMAS-E; Reynolds, Richmond, & Lowe, 2003) were administered on Day 2. The GDS is a

15-item (yes/no) self-report scale used to identify emotional and psychological aspects of depression in the elderly; scores ranged from 0 to 15 with higher scores indicating greater depressive symptoms. Previous analysis of the GDS reported an internal consistency-reliability of 0.80 (Marc, Raue, & Bruce, 2008). Cronbach's alpha for the current sample was acceptable ($\alpha=0.72$).

The AMAS-E is a 44-item (yes/no) self-report measure of anxiety developed for use in the elderly population, with overall scores ranging from 0 to 44 and higher scores indicating greater anxiety symptoms. The AMAS-E has three clinical scales (Worry/Oversensitivity, Physiological Anxiety, and Fear of Aging). The Worry/Oversensitivity scale consists of 23 items, such as "I worry a lot of the time." The Physiological Anxiety scale is a measure of somatic response to anxiety/stress and consists of 7 items, such as "I become tired easily." The Fear of Aging scale consists of 7 items, including "I worry about becoming senile." An alpha coefficient of 0.91 was previously reported for the total anxiety score (Lowe & Reynolds, 2006). Cronbach alpha values for the current sample were acceptable (Worry/Oversensitivity $\alpha=0.89$; Physiological Anxiety $\alpha=0.67$; and Fear of Aging $\alpha=0.79$).

The 50-item International Personality Item Pool (IPIP; Goldberg, 2000; Gow, Whiteman, Pattie, & Deary, 2005) was administered on Day 1. The IPIP contains 10 sentence fragments for each of the Big-Five personality factors: Extraversion, Agreeableness, Conscientiousness, Openness, and Neuroticism. Positively keyed items are scored on a 5-point scale ("very inaccurate=1" to "very accurate=5"), and negatively keyed items are scored in reverse ("very inaccurate=5" to very accurate=1"). Items for each subscale are then summed (scores range from 10–50). For the purpose of this study, only the conscientiousness and neuroticism dimensions were used because of their known association with self-reported cognition. Neuroticism refers to an individual's stress reactivity or emotional responsiveness to challenge and tendency toward negative mood states. Conscientiousness taps into an individual's tendency to be task oriented, persistent, hard working, dependable, careful, organized, and able to demonstrate self-control. The 50-item IPIP has been shown to have both high correlations with other personality inventories as well as high internal consistency (Gow, Whiteman, Pattie, & Deary, 2005). Cronbach alpha values for the current sample were acceptable (Neuroticism $\alpha=0.66$; Conscientiousness $\alpha=0.70$).

Informant-reported activities of daily living measure.—The Lawton-Brody Instrumental Activities of Daily Living Scale (IADL; Lawton & Brody, 1969), a widely used scale with elderly populations (Vittengl, White, McGovern, & Morton, 2006), was completed on Day 1 and is an informant-report measure of independent living skills in 8 functional domains. Total scores ranged from 0 (low function, dependent) to 8 (high function, independent), with separate scoring systems for male and female participants. Cronbach alpha for the current study was acceptable ($\alpha=0.74$).

Primary outcome measure: BRIEF-A (self-report version).—The BRIEF-A was completed on Day 2. The BRIEF-A is a self-administered paper-and-pencil questionnaire that assesses everyday emotional, behavioral, and metacognitive aspects of EF in adults (ages 18–90). It contains 75-items that yield an overall score, the Global Executive Composite,

which is derived from two index scores--Behavioral Regulation Index (BRI) and Metacognitive Index (MI). The BRI is comprised of four clinical scales: Inhibit, Shift, Emotional Control, and Self-Monitor. The MI is comprised of five clinical scales: Initiate, Working Memory, Plan/Organize, Task Monitor, and Organization of Materials. The BRIEF-A also has three validity scales (Negativity, Infrequency, and Inconsistency). For the current study, we analyzed average raw scores for the BRIEF-A clinical scales. The BRIEF-A has demonstrated sensitivity to EF strengths and deficits in various clinical populations, including attention-deficit/hyperactivity disorder, traumatic brain injury, seizure disorders, multiple sclerosis, Alzheimer's disease, and mild cognitive impairment (Rabin et al., 2006; Roth et al., 2005). For additional description of the BRIEF-A's psychometric properties and clinical utility, see Roth et al., 2005. The three validity scales were examined and no participants had elevations of concern. In addition, we examined reliability of the BRIEF-A clinical scales and all internal consistency Cronbach alpha values were acceptable (Inhibit α =0.64; Shift α =0.71; Emotional Control α =0.83; Self-Monitor α =0.77; Initiate α =0.74; Working Memory α =0.81; Plan/Organize α =0.83; Task Monitor α =0.71; Organization α =0.79).

Statistical analyses

Descriptive statistics were calculated for all variables. GDS scores were logarithmic transformed to eliminate positive skewness. This approach included adding the value of 1 to all GDS scores because many individuals had scores of 0, which precludes a logarithmic transformation. Partial correlations controlling for age were conducted in the complete sample to examine associations between each of the nine BRIEF-A clinical scales and the executive function tests of Digit Symbol, Letter Fluency, TMT Part B, Golden Stroop, LNS, Tower Test, TOP-J, and MIST-A; and the affective, personality, and functional measures of the GDS, AMAS-E (Worry/Oversensitivity, Physiological Anxiety, and Fear of Aging), IPIP (Conscientiousness and Neuroticism), and Lawton-Brody IADL Scale. We controlled for age because age accounted for sizeable variance in BRIEF-A scores in a normative sample of adults (Roth et al., 2005). Specifically, in a normative sample, adults from 18 to 39 years of age reported greater difficulties than adults 40 to 90 years of age. We also explored correlations between the BRIEF-A and gender and education even though previous research has failed to show a meaningful relation between the BRIEF-A and these variables. Finally, for exploratory purposes, we re-ran the partial correlations in two participant subgroups—MCI and SCD.

The sample sizes employed for each individual correlational analysis varied slightly depending on the number of participants who completed the relevant measures. Due to the multiple correlational analyses and to protect from type I error, a Bonferroni correction was employed ($\alpha_{\text{original}} = .05$ divided by 9, that is, the number of BRIEF-A clinical scales), and the significance level was set at $p < .006$ for all analyses (two-tailed). IBM SPSS Statistics Version 22 was used for all analyses.

Results

Descriptive Statistics

Table 1 displays the descriptive statistics for the complete sample. The sample had an average age of more than 80 years and almost 15 years of education. More than two-thirds of the sample was female. Mean raw scores for all performance-based measures of EF and BRIEF-A clinical scales were within the normal range. In addition, participants typically endorsed minimal depressive symptoms on the GDS, an average number of anxiety symptoms on the AMAS-E clinical scales, average levels of neuroticism and conscientiousness, and relative independence in instrumental activities of daily living on the Lawton-Brody IADL scale.

Partial correlations between study variables and BRIEF-A clinical scores

Table 2 shows the partial correlational analyses for each of the nine BRIEF-A EF clinical scales, adjusting for age in the complete sample. Lower scores on the TOP-J were significantly associated with greater difficulties on the BRIEF-A Emotional Control, Self-Monitor, Working Memory, and Plan/Organize scales. No significant associations were observed between the BRIEF-A and other objective EF measures.

Higher scores on the GDS were significantly associated with greater self-reported difficulty on seven of nine BRIEF-A clinical scales of Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Task Monitor, and Organization of Materials scales. Only Inhibit and Self-Monitor did not have any significant associations. Higher scores on all three AMAS-E subscales of Worry/Oversensitivity, Physiological Anxiety, and Fear of Aging scale were significantly associated with greater EF problems on all nine BRIEF-A clinical scales.

Higher scores on the IPIP Conscientiousness subscale were significantly associated with lower EF difficulties on the BRIEF-A Initiate, Working Memory, Plan/Organize, Task Monitor, and Organization of Materials scales. Higher scores on the IPIP Neuroticism subscale were significantly associated with greater self-reported difficulties on seven of nine BRIEF-A clinical scales of Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, and Task Monitor. Only Self-Monitor and Organization of Materials did not have any significant associations. The Lawton-Brody IADL scale was not significantly associated with any of the BRIEF-A clinical scales.

In exploratory analyses, we examined associations between the BRIEF-A clinical scales and gender and education. Gender was not significantly associated with any BRIEF-A scores. Lower education showed a statistically significant weak association with higher self-reported difficulties on the BRIEF-A Working Memory ($r = -0.198$, $p = .002$) and Plan/Organize ($r = -0.255$, $p < .001$) scales.

In exploratory analyses, we examined associations between the BRIEF-A clinical scales and all other variables by participant subgroup (i.e., SCD and MCI). For the SCD subgroup ($n = 79$), the overall pattern of findings remained the same, though somewhat attenuated likely due to reduced statistical power. Specifically, the following 12 of 50 correlations were

no longer statistically significant including 4 of 4 BRIEF-A correlations with the TOP-J, 7 of 27 BRIEF-A correlations with the AMAS-E subscales of Worry/Oversensitivity, Physiological Anxiety, Fear of Aging, and 1 of 9 BRIEF-A correlations with IPIP neuroticism (see Table 2). For the MCI group ($n=51$), the significant findings were attenuated likely due to reduced statistical power. Specifically, 35 of the 50 correlations were no longer statistically significant—only 15 AMAS-E subscale comparisons from Worry/Oversensitivity, Physiological Anxiety, Fear of Aging retained their statistically significant association with the BRIEF-A (see Table 2).

Discussion

Executive dysfunction can affect many aspects of older adults' daily lives including employment, the ability to pursue vocational activities, quality of relationships, and the ability to manage finances, prescription medications, and other everyday tasks. Despite the frequent use of the BRIEF-A in clinical practice (Rabin, Paoillo, & Barr, in press), the literature is mixed on which neuropsychological and other variables are associated with BRIEF-A scores, leading to questions about its utility in neuropsychological assessments. In a community-dwelling sample of non-demented older adults, self-reported EF problems were most consistently associated with anxiety symptoms followed by depressive symptoms and aspects of personality. In addition, the only objective neuropsychological test to correlate with the BRIEF-A was the Test of Practical Judgment (TOP-J). Lastly, informant-reported instrumental activities of daily living were not associated with BRIEF-A scores. Notably, we controlled for age in each of these analyses.

Prior studies have reported an association between increased depression and greater self-reported EF difficulties with the BRIEF-A (Løvstad et al., 2012; Madhoo et al., 2014; Rabin et al., 2006; Roth et al., 2005). Thus, not surprisingly, higher depression scores on the GDS were associated with increased EF difficulties on seven of nine BRIEF-A scales in our sample. Older adults with subsyndromal depressive symptoms may be prone to misinterpreting normal cognitive lapses as reflecting cognitive decline and/or they may magnify actual lapses while filtering out instances of cognitive success. Such misinterpretations could lead to increased reports of cognitive difficulties (even when cognition is not impaired relative to peers) and also impact quality of life (Blazer & Hybels, 2005; Ferguson, 2006).

To our knowledge, only one prior study reported a relationship between higher anxiety and increased self-reported EF difficulties on the BRIEF-A (Roth et al., 2005). In our study, anxiety emerged as the strongest correlate of self-reported EF difficulties with higher scores on the AMAS-E Worry/Oversensitivity, Physiological Anxiety, and Fear of Aging scales associated with greater executive problems on all nine BRIEF-A clinical scales. Elevated anxiety in older adults may reflect awareness of objective EF difficulties and/or heightened vigilance for signs of impairment, which could then compound the EF problems. Individuals with significant cognitive complaints, for example, may be anxious that they are experiencing the first signs of dementia (and in some cases they would be correct given the emerging evidence on subjective cognitive decline as a precursor to dementia) (Jessen et al., 2014). A pre-post anxiety treatment could be informative, especially if treatment reduces

anxiety about EF in some individuals who actually deteriorate over time despite continued intact performance on objective measures such as neuropsychological tests or neuroimaging markers. Overall, our findings suggest that anxiety should be taken into consideration when interpreting BRIEF-A scores in older adults. Treatment of anxiety may reduce older adults' perceptions of EF difficulties and alter negative self-evaluative beliefs about cognition more generally. Future research might investigate which specific anxiety symptoms exert the strongest influence on cognitive self-report, as well as the magnitude of this effect. Such efforts should attempt to distinguish between affective states, enduring traits, and psychosocial stressors, each of which may affect cognitive self-appraisal but lead to different interventional approaches.

Lower conscientiousness was related to increased self-reported EF difficulties on five BRIEF-A clinical scales, suggesting that older adults who perceive more EF difficulties tend to view themselves as less conscientious. Individuals with EF difficulties may experience the types of problems associated with low conscientiousness such as lack of preparation, poor attention to details, failure to stick to or carry out plans, and failure to complete chores in a timely fashion. In addition, the construct of conscientiousness shares features with EF such as effortful control and self-regulation and may overlap somewhat (Williams et al., 2009). Moreover, conscientiousness and EF may rely upon the same neural substrates (e.g., the lateral prefrontal cortex, a region involved in planning and voluntary control of behavior) (DeYoung et al., 2010). Thus, it is not surprising that these variables were associated in the current study. We also found that higher neuroticism was related to increased self-reported EF difficulties on seven BRIEF-A clinical scales. This finding is consistent with previous research indicating that those who score high in neuroticism are also likely to report problems with various aspects of health and cognition (e.g., Bruce, Bruce, Hancock, & Lynch, 2010; Jang, Mortimer, Haley, & Graves, 2002; Jorm et al., 1993; Rosmalen, Neeleman, Gans, & de Jonge, 2007). BRIEF-A scores may reflect in part the tendency of less emotionally stable individuals to magnify negative cognitive experiences and report more problems in general.

Instrumental activities of daily living, as assessed using the Lawton-Brody IADL scale, were not associated with subjective ratings of EFs. However, because our participants were community-dwelling and generally healthy, there may have been too little variability in ADL scores to identify such a relationship. Future research examining subjective ratings of EF in populations having identified difficulty with ADLs would be informative. Exploratory analyses examining demographic variables revealed that gender was not significantly associated with BRIEF-A scores, which is consistent with prior research (Roth et al., 2005; Rabin et al., 2006). Lower education was weakly associated with higher self-reported EF difficulties on only two BRIEF-A clinical scales. This is consistent with some research that found that education influences the age-related decline in EF, with low education exacerbating age effects and high education related to more successful aging (Van der Elst et al. 2006; Grigsby et al. 2002). However, this pattern does not occur in all studies of EF as others found that education is a poor predictor of EF performance in older adults (Manly et al. 2005; Hashimoto et al. 2006).

Consistent with much prior research on the BRIEF, the BRIEF-A essentially did not correlate with objective EF measures, including tests of processing speed, working memory, verbal fluency, set-shifting, cognitive inhibition, and planning. Some write that objective EF measures assess basic foundational cognitive abilities whereas rating scales such as the BRIEF assesses the application of these basic skills in daily life (McAuley et al., 2010). The BRIEF-A may have relatively strong ecological validity because it was designed to tap the complex and multidimensional nature of executive dysfunction as experienced in daily life. Objective measures, by contrast, typically capture an individual's best performance under optimal conditions in a laboratory setting (Burgess, 1997; Byrley & Donders, 2013; Chaytor & Schmitter-Edgecombe, 2003; Goldberg & Podell, 2000; Isquith, Roth, & Gioia, 2013; Sbordone, 2000; Payne et al., 2011). The aforementioned explanations for the minimal association between objective and subjective EF measures, however, may be oversimplifications. Objective measures are not devoid of ecological validity. Some objective tests predict important outcomes in children in adolescents (Biederman et al., 2004; Gathercole & Pickering, 2000; McAuley et al., 2010; McClelland et al., 2007). Regardless of the reason for low convergent validity, subjective rating scales should not serve as a proxy for objective measures (Toplak et al., 2009). Rather, the different measures could be used for different purposes. For example, subjective measures could be used to gain insight into everyday cognitive failures and to guide intervention planning. Even in older adults with subjective EF dysfunction in the context of objectively normal cognition (like many of the current participants), there could be an opportunity to intervene with training in external or internal strategy use (see Randolph and Chaytor, 2013). Such interventions may subtly improve EF and importantly also build confidence and promote a perception of better cognitive functioning. In psychotherapy contexts, information gained from self-reports of EF may provide useful information about patients' potential ability to engage with treatment strategies such as cognitive restructuring. Further, the BRIEF-A, can typically be completed quickly (10–15 minutes) and is thus an efficient way to gather useful information in a therapy context.

The BRIEF-A Emotional Control, Self-Monitor, Working Memory, and Plan/Organize scales were associated with greater difficulty on the TOP-J, suggesting that the TOP-J may be tapping into executive problems as experienced in everyday life in older adults, though not robustly. Individuals with decision-making problems may have difficulty with multiple aspects of EF, such as self-monitoring, impulse control, emotion regulation, working memory, planning, and organization. Similar to the BRIEF-A, which asks individuals to reflect on their cognitive processes and behaviors in everyday life, the TOP-J requires participants to use executive functions to solve problems that arise in everyday life. The TOP-J therefore also may offer greater ecological validity than other performance-based measures of EF.

There are several limitations to the present study. First, an alternative explanation for observed correlations between the affective and personality variables and BRIEF-A scores might relate to item similarity between the measures (several IPIP and AMAS-E items are very similar to BRIEF-A items). A way to address this possibility would be to replicate the study using measures of mood and personality that do not rely on self-report. Second, our participants were relatively cognitively healthy, as evidenced by mean raw scores falling in

the normal range for the BRIEF-A, objective EF measures, mood measures, and the ADL scale. Observed patterns may not be maintained in clinical samples with greater variability in cognition and functional abilities. Future research should assess whether informant-ratings of EF are more reflective of neuropsychological performance than self-report ratings. Third, we would have liked to conduct our correlational analyses by participant subgroup, but we lacked sufficient statistical power. Nonetheless, our exploratory analyses in the SCD subgroup suggests an overall similar pattern of findings and future research with larger sample sizes should confirm these results. Finally, the cross-sectional design of our study precludes inferences about the sequence of events or causality. We cannot rule out the possibility that anxiety symptoms reflect distress associated with declining EF.

Conclusions

In a sample of community-dwelling older adults, the most robust correlate of subjective EF problems was self-reported anxiety followed by depression, conscientiousness, and neuroticism. These findings highlight the important need to consider the effects of mood and personality in interpreting BRIEF-A scores and to investigate pathways through which depression, anxiety and personality influence subjective cognition. Additionally, the BRIEF-A may tap aspects of objective EF related to judgment and problem solving in real-world situations. Overall, the BRIEF-A may best be utilized in conjunction with objective measures (and evaluation of mood) to allow for a broad perspective on individuals' EF.

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Table 1:

Descriptivestatistics for the sample of 245 non-demented older adults

<i>Variables</i>	<i>M (SD) or % (n)</i>
Demographics	
Age (years)	80.82 (5.48)
Gender (% female)	69.00% (169)
Education (years)	14.47 (3.47)
Performance-based executive function tests	
WAIS-R Digit Symbol, total raw score	39.77 (18.50)
FAS Letter Fluency, total raw score	37.38 (14.24)
Trail Making Test, Part B, time in seconds	118.64 (51.71)
Golden Stroop, Color-Word trial, total raw score	41.14 (8.09)
WAIS-IV Letter-Number Sequencing, total raw score	14.53 (4.14)
D-KEFS Tower Test, total achievement score	12.07 (5.23)
Test of Practical Judgment, total raw score	33.98 (5.08)
Memory for Intentions Screening Test-A, total raw score	26.13 (11.46)
BRIEF-A clinical scales (average raw score)	
Inhibit	1.37 (0.28)
Shift	1.59 (0.36)
Emotional Control	1.44 (0.34)
Self-Monitor	1.50 (0.37)
Initiate	1.52 (0.35)
Working Memory	1.56 (0.37)
Plan Organize	1.51 (0.36)
Task Monitor	1.65 (0.36)
Organization of Materials	1.49 (0.36)
Subjective measures of mood, personality, and activities of daily living	
Geriatric Depression Scale short form, total raw score	1.56 (1.98)
Adult Manifest Anxiety Scale-Elderly	
Worry/Oversensitivity, total raw score	6.06 (5.37)
Physiological Anxiety, total raw score	2.37 (1.88)
Fear of Aging, total raw score	3.10 (2.29)
International Personality Item Pool	
Conscientiousness, total raw score	37.12 (6.42)
Neuroticism, total raw score	21.18 (5.96)
Lawton-Brody IADL Scale, total raw score	6.81 (1.49)

Note. WAIS-R: Wechsler Adult Intelligence Scale–Revised, WAIS-IV: Wechsler Adult Intelligence Scale–Fourth Edition; D-KEFS: Delis-Kaplan Executive Function System; Lawton-Brody IADL Scale: Lawton-Brody Instrumental Activities of Daily Living Scale.

Table 2:

Partial correlations for the BRIEF-A clinical scales controlling for age

Variables	Inhibit	Shift	Emotional Control	Self-Monitor	Initiate	Working Memory	Plan/ Organize	Task Monitor	Organization of Materials
Performance-based EF tests									
Digit Symbol	-0.004	-0.074	-0.023	-0.005	-0.054	-0.101	-0.069	0.002	-0.049
Letter Fluency	-0.034	-0.009	-0.031	-0.049	-0.023	-0.142	-0.105	-0.026	-0.077
Trail Making Test, Part B	-0.081	-0.013	-0.012	-0.073	-0.017	0.011	0.069	-0.031	0.156
Golden Stroop, Color-Word	0.022	-0.002	-0.013	0.053	-0.081	-0.102	-0.129	-0.031	-0.117
Letter-Number Sequencing	-0.037	-0.030	-0.104	-0.056	-0.059	-0.138	-0.164	-0.062	-0.020
Tower Test	0.060	-0.047	-0.024	0.036	0.061	-0.057	-0.042	0.035	0.033
TOP-J	-0.175	-0.105	-0.187 [*]	-0.187 [*]	-0.147	-0.238 [*]	-0.189 [*]	-0.092	-0.008
MIST-A	-0.077	-0.077	-0.098	-0.088	-0.015	-0.134	-0.139	-0.049	-0.036
Subjective measures									
GDS	0.153	0.293 [*]	0.180 [*]	0.040	0.367 [*]	0.296 [*]	0.294 [*]	0.258 [*]	0.205 [*]
AMAS-E									
Worry/Oversensitivity	0.458 [*]	0.524 [*]	0.587 [*]	0.423 [*]	0.359 [*]	0.478 [*]	0.446 [*]	0.442 [*]	0.257 [*]
Physiological Anxiety	0.338 [*]	0.491 [*]	0.464 [*]	0.290 [*]	0.567 [*]	0.571 [*]	0.592 [*]	0.533 [*]	0.476 [*]
Fear of Aging	0.270 [*]	0.378 [*]	0.362 [*]	0.278 [*]	0.253 [*]	0.354 [*]	0.338 [*]	0.370 [*]	0.253 [*]
IPIP									
Conscientiousness	-0.165	-0.218	-0.105	-0.145	-0.552 [*]	-0.446 [*]	-0.581 [*]	-0.479 [*]	-0.512 [*]
Neuroticism	0.240 [*]	0.345 [*]	0.405 [*]	0.132	0.269 [*]	0.301 [*]	0.336 [*]	0.250 [*]	0.147
Lawton-Brody IADL	-0.066	0.059	0.085	-0.018	-0.108	0.017	0.040	0.030	0.099

^{*} $p < .006$

Note: EF: executive functioning; Digit Symbol: Digit Symbol subtest of the Wechsler Adult Intelligence Scale-Revised; Letter Fluency: Letter-Number Sequencing; Letter Number Sequencing subtest of the Wechsler Adult Intelligence Scale-Fourth Edition; Tower Test: Tower Test of the Delis-Kaplan Executive Function System; TOP-J: Test of Practical Judgment; MIST-A: Memory for Intentions Screening Test-A; GDS: short form of the Geriatric Depression Scale; AMAS-E: Adult Manifest Anxiety Scale-Elderly; Lawton-Brody IADL Scale: Lawton-Brody Instrumental Activities of Daily Living Scale. As some respondents opted to skip certain tests or items, sample sizes vary slightly across the variables presented above.

^a Indicates that the correlation remained statistically significant when analyses were conducted in the SCD subgroup.

Indicates that the correlation remained statistically significant when analyses were conducted in the MCI subgroup.
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