Published in final edited form as:
Int J Geriatr Psychiatry. 2009 September ; 24(9): 1010–1019. doi:10.1002/gps.2213.

The moderating role of personality factors in the relationship between depression and neuropsychological functioning among older adults

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SUMMARY

Objective—Depression is often associated with decreased cognitive performance among older adults. The current study focused on the association of neuropsychological functioning and personality traits in depressed and non-depressed older adults.

Methods—Data from 75 depressed and 103 non-depressed adults over the age of 60 were analyzed. All participants underwent standardized clinical assessment for depression prior to participation and completed the NEO-PI-R and a series of neuropsychological assessments.

Results—A series of multiple linear regressions were conducted to examine the relationships between personality and neuropsychological performance among depressed and non-depressed older adults. Results indicated that higher Openness to Experience was related to better performance on Parts A and B of the Trail Making Test among depressed older adults, and to better Digit Span Backward performance among all participants. Higher levels of neuroticism were related to poorer performance on Digit Span Backward, but only among depressed older adults. Depressed participants performed more poorly on the Symbol Digit Modalities Test and the Controlled Oral Word Association Test.

Conclusions—Personality characteristics, particularly Openness to Experience, modified the relationship between depression and neuropsychological functioning among older adults. Results indicate that interventions aimed at increasing one's Openness to Experience could potentially attenuate some of the neuropsychological impairments that are associated with depression.

Keywords

depression; personality; neurocognitive function

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CONFLICT OF INTEREST
None.

INTRODUCTION

Depression in older adults is a common, but not normal, part of aging (National Institute of Mental Health; NIMH, 2007). In fact, approximately 15–25% of older adults report depressive symptoms that could be considered clinically significant (Jeste *et al.*, 1999). The high prevalence rate of depression among the elderly is related to a number of factors, including medical comorbidities and sociodemographic factors (NIMH, 2008). Depression is related to a number of non-optimal outcomes among older adults, including poor physical functioning (Penninx *et al.*, 1999), decreased well-being (Ormel *et al.*, 1998), increased consumption of medical care (Koopmans and Lamers, 2001), and cognitive impairment (Arve *et al.*, 1999) The co-occurrence of depression and cognitive impairment produces a higher risk of adverse outcomes for physical health, functional status, and mortality relative to either condition alone (Mehta *et al.*, 2003), which makes cognition an important focus of diagnosis and treatment in geriatric depression.

Although most older adults with depression do not experience severe cognitive impairment, depressed individuals consistently demonstrate worse neuropsychological test performances than non-depressed individuals. Experimental studies suggest that depressed individuals are most prominently affected in the domains of executive function (Boone *et al.*, 1995; Beats *et al.*, 1996), memory (Beats *et al.*, 1996; Austin *et al.*, 1999), and processing speed (Nebes *et al.*, 2000), which is consistent with meta-analysis of the broader literature (Veiel, 1997; Zakzanis *et al.*, 1998). Executive functions have received particular attention in geriatric depression because performance in this domain is associated with lower rates of treatment remission and higher rates of depression recurrence (Kalayam and Alexopoulos, 1999; Dunkin *et al.*, 2000; Potter *et al.*, 2004). As a construct, ‘executive functions’ refers to a number of cognitive processes that are largely mediated by the prefrontal cortex, including attentional control, working memory, performance monitoring, behavioral initiation, and behavioral inhibition (Lezak *et al.*, 2004). Deficits in executive functions can contribute to a more generalized lack of cognitive flexibility associated with decreased problem-solving ability and perseverative thinking patterns.

Trait personality characteristics are also related to cognitive performance. Much of the literature exploring this relationship, however, is based on data from younger and middle-aged adults, and much of this has focused on neuroticism and extraversion (Booth *et al.*, 2006). A meta-analysis examining the relationships between personality traits and cognitive abilities found that neuroticism was negatively related to fluid and crystallized abilities (Ackerman and Heggestad, 1997). Fluid abilities reflect underlying capacity for problem solving and novel reasoning abilities, including executive function-type processes, whereas crystallized abilities generally reflect the application of previously acquired knowledge (Cavanaugh and Blanchard-Fields, 2006). This same analysis suggested that extraversion was associated with increased cognitive performance in fluid and crystallized abilities.

Fewer studies have investigated the association between cognition and other personality traits included in the ‘Big Five’ model of personality among older adults (i.e. Five-Factor Model: Openness to Experience, Conscientiousness, and Agreeableness; McCrae and John, 1992). A meta-analysis by Ackerman and Heggastad (1997) suggested that Openness to Experience was positively related to fluid and crystallized abilities, with correlations exceeding 0.30. In addition, Ashton *et al.* (2000) found that Openness, Conscientiousness, and Agreeableness were positively related to performance on a number of cognitive tests assessing crystallized and fluid abilities. Only Openness, however, remained a significant correlate of multiple cognitive tests when entered into regression models. Using data from the Seattle Longitudinal Study, Schaie *et al.* (2004) found that Openness was positively related to inductive reasoning, spatial orientation, perceptual speed, verbal memory, and verbal comprehension. Additionally,

Agreeableness was negatively related to performance on inductive reasoning and spatial orientation tasks, Extraversion was positively related to inductive reasoning, perceptual speed, numeric facility, and verbal memory, and Conscientiousness was positively related to numeric facility. These studies, however, did not assess depression, and the data were from primarily high socioeconomic status community samples.

Although there is substantial evidence supporting associations among depression and personality traits, few studies have examined these factors simultaneously, and fewer still have investigated how personality might moderate the relationship between depression and cognitive performance in older adults. Booth *et al.* (2006) investigated the relative contributions of depression and personality to cognitive performance in a sample of community-dwelling older adults. Results indicated that personality traits accounted for between 2–7% of the variance in a number of cognitive tests after controlling for age and education, with Openness being the most consistent correlate across tests. Depression, on the other hand, was not significantly related to cognitive performance after controlling for age, education, and personality characteristics. It should be noted that depression was conceptualized as a state characteristic in this study and was not defined in a clinical sample. An additional limitation in this study was that the interactions between personality and depression were not analyzed, leaving open the possibility that personality characteristics moderate the relationship between depression and cognition.

In a study examining personality as a moderator between depression and cognitive performance, van den Heuvel *et al.* (1996) found that among women, Neuroticism moderated the relationship between scores on the Mini-Mental State Exam (Folstein *et al.*, 1975) and depressive symptomatology, as well as the relationship between information processing speed (van den Heuvel et al., 1996) and depression. Among men, Neuroticism moderated the relationship between memory and depressive symptomatology. Unfortunately, other factors of the Five-Factor Model of personality were not included in this study. In addition, depression was operationalized as scores on the Centers for Epidemiological Studies Depression scale (Radloff, 1977) and did not include a clinical diagnosis (van den Heuvel *et al.*, 1996).

The present study sought to extend this previous research in three important ways. First, participants were older adults. Identifying factors associated with neuropsychological functioning is particularly important in this population given the tendency for decreased cognitive performance during late life. Second, participants included both non-depressed individuals and a clinically-defined group of older adults with Major Depressive Disorder. Including a clinically depressed group of older adults is important due to the relatively high rates of depression among older adults and the co-occurrence of cognitive deficits with late life depression (Butters *et al.*, 2004). Finally, all of the ‘Big Five’ personality traits were included in the current analyses, along with the interaction terms between these traits and depression status. Including these interactions allows for a more detailed investigation of how multiple personality dimensions might moderate the relationship between depression and cognitive ability. Understanding these interactive relationships among older adults is in order to better identify those who are most likely to experience deficits in executive function as part of their depression syndrome. The current study focused on the association of executive functions in depression with personality traits. We specifically hypothesized that: (a) lower Openness to Experience would be associated with poorer executive functioning due to the cognitive inflexibility associated with low levels of this trail, and (b) that this relationship would be particularly strong in older adults with depression based on the additional cognitive inflexibility associated with both aging and depression (Raskin, 1986).

METHODS

Participants

Data were collected from a total of 178 individuals who were at least 60 years old. Of these, 75 met the DSM-IV criteria for major depression and were currently participants from the National Institute of Mental Health Clinical Research Center (MHCRC) for the Study of Depression in Later Life, located at Duke University. On average, these individuals had a score of 15.61 (SD = 9.72) on the Montgomery-Asberg Depression Rating Scale (MADRS; Montgomery and Asberg, 1979). The remaining 103 participants were a non-depressed comparison group recruited from a volunteer registry maintained by the Center for the Study of Aging and Human Development at Duke University Medical Center. All participants underwent a standardized clinical assessment for depression during a clinical evaluation prior to participation in the study, as discussed below. Enrolled participants completed a battery of neuropsychological measures, and the current study represents a subset of individuals who also a self-report inventory of personality characteristics.

The MHCRC operates in a guideline-based treatment milieu, using an algorithm established by the Duke Affective Disorders Program rather than a standardized treatment protocol (Steffens *et al.*, 2002). Inpatients and outpatients of the Duke University Psychiatric Service presenting with clinically significant depressive symptoms or a previous diagnosis of mood disorder were screened with the Center for Epidemiologic Studies-Depression Scale (CES-D; Radloff, 1977). Eligibility was limited to patients with CES-D scores ≥16 or a diagnosis of major depression, single (incident/new case) or recurrent (prevalent cases), and was restricted to patients aged 60 years or older who could speak and write English. Please see Bosworth *et al.* (2002) for more details regarding the study exclusion criteria.

Procedure

At baseline, individuals who provided written informed consent were enrolled. A trained interviewer administered the Duke Depression Evaluation Schedule (DDES). The DDES, a composite diagnostic interview instrument based on patient self-reports, includes sections of the NIMH Diagnostic Interview Schedule (DIS; Robins *et al.*, 1981) depression assessment as well as items related to cognitive status, physical health, stress, and social support. DSM-IV major depression diagnoses were established by MHCRC geriatric psychiatrists via clinical interviews and were confirmed by responses on the DIS. Patients also received a battery of standardized clinical assessments including the Montgomery-Asberg Depression Rating Scale (MADRS; Montgomery and Asberg, 1979). Testing was administered according to standardized procedures under the supervision of a clinical neuropsychologist (GGP). Neuropsychological tests were also administered at baseline. In order to decrease participant burden and increase the likelihood of completion, participants completed the personality measure at a later date when the patient was not acutely depressed.

Independent measures

Demographics—Data were collected on a number of demographic variables, including age, sex, race, and years of education.

Revised NEO Personality Inventory (NEO PI-R)—Participants completed the 240-item NEO PI-R (Costa and McCrae, 1992). This scale measures five dimensions of personality: Openness to Experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. Participants are asked to respond to statements on a five-point Likert scale, ranging from ‘strongly disagree’ to ‘strongly agree.’ Summed scores for each domain are then converted to T-scores with norm means of 50 and norm standard deviations of 10. This measure has been

validated and used extensively with older adult samples (e.g. Costa and McCrae, 1992; Duberstein *et al*., 1999).

Dependent measures

Controlled Oral Word Association Test (COWA)—The COWA (Benton *et al.*, 1994) is a test of verbal fluency that asks participants to say as many words starting with a specified letter that they can in 60 sec. This procedure is performed with three different letters (C, F, and L). Scores indicate the total number of words the participant produced, excluding repeated words and non-eligible words as indicated in the standardized instructions.

Trail Making Test Parts A and B—The Trail Making Test (Reitan, 1992) consists of two parts. Part A requires participants to draw lines between consecutively numbered circles. This component of the test involves visual scanning, number recognition, numeric sequencing, and motor abilities. Part B of the Trail Making Test requires participants to connect a series of circles alternatively containing letters and numbers; thus it involves the additional demand of switching of cognitive sets. Scores reflect the time in seconds that the participant took to complete the task.

Symbol Digit Modalities Test (SDMT)—The SDMT (Smith, 1982) is a test of attention skills and information-processing speed that requires participants to identify nine symbols that correspond to the numbers 1–9. The participants are asked to transcribe the numbers in place of the corresponding symbols as rapidly as possible. Scores reflect the number of correct responses.

Digit Span Backward (Wechsler, 1987)—In order to assess working memory, participants were asked to repeat in reverse order an increasing number of digits that were read aloud by the examiner.

Analyses

The analyses involved two steps. The first step included calculating the descriptive statistics, examining group differences among study variables, and the bivariate correlations among study variables. Differences between the group with depression and the non-depressed group were investigated with t-tests for continuous variables and chi-square tests for categorical variables. The second step of the analysis included a series of multiple regression analyses—one for each neuropsychological measure—that included age, education, sex, depression status (depressed vs non-depressed), the five personality factors, and the five interactions between depression status and the personality factors. Prior to analyses, all variables involved in the interactions were centered around the grand mean. Due to the number of tests, we set our significance level at $p<0.01$.

RESULTS

Preliminary analyses

The groups differed on a number of demographic variables (see Table 1). Specifically, t-tests indicated that non-depressed individuals were significantly older and had significantly more years of education than the individuals with depression. With regard to personality traits, non-depressed participants had lower Neuroticism scores, higher Extraversion scores, higher Openness scores, and higher Conscientiousness scores compared to the participants with depression. The groups did not differ in terms of Agreeableness scores. On average, the two groups differed on the neuropsychological measures, with non-depressed participants outperforming the depressed participants on all of the tests.

Table 2 presents the bivariate correlations among the demographic, personality, and neuropsychological variables. The pattern of relationships between personality dimensions and scores on neurocognitive measures differed for depressed and non-depressed participants. Among those with depression, increased Openness was related to better performance on all of the measures, while the other personality traits were not related to performance on these tests. Among non-depressed participants, increased Agreeableness was related to better performance on Part A of the Trail Making Test.

Multiple regressions

To more fully investigate the relationships between personality and neuropsychological performance among depressed and non-depressed older adults, a series of multiple linear regressions were performed (Table 3). Independent variables in the models included age, sex, years of education, race (White vs African American), depression status (diagnosed *vs* non-diagnosed), Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. In addition, the five interactions of depression status and personality dimensions were tested, with only the significant interactions remaining in the final model.

With regard to part A of the Trail Making Test, both lower age and more years of education were related to better performance. In addition, depression was related to worse performance; however, this relationship was qualified by an interaction between depression between and Openness. Follow-up analyses of the simple slopes indicated that increased Openness was related to better performance on Part A of the Trail Making Test among participants with depression, but that this relationship was not significant among non-depressed participants.

As with Part A, both lower age and more years of education were related to better performance on Part B of the Trail Making Test. In addition, depression status and Openness were related to scores on this test, and these relationships were qualified by an interaction between depression status and Openness. As with Part A, follow-up tests indicated that increased Openness was related to better performance among depressed participants but not among non-depressed participants. To test whether the relationships between predictor variables and performance on Part B of the Trail Making Test could be explained by abilities common to Part A of the Trail Making Test (e.g. motor performance), we conducted follow-up tests where performance on Part A was entered into the model as a covariate. Although performance on Part A was significantly related to performance on Part B, the pattern of results concerning the other predictor variables was identical to the reported model. Thus, it can be assumed that the similar relationships among personality, depression, and performance on Parts A and B of the Trail Making Test were not merely due to shared variance between the two tests.

There were a number of significant variables associated with the SDMT. Specifically, increased age, being African American, and being diagnosed with depression were significantly related to poorer performance. More years of education, on the other hand, was related to better SDMT performance. None of the personality dimensions were significantly related to performance on this particular measure.

Performance on Digit Span Backward was worse among African Americans relative to Whites. In addition, increased Openness was related to better performance regardless of depression status. There were two significant interactions between depression status and personality on this measure. First, Neuroticism modified the relationship between depression and performance on the Digit Span Backward test in that increased Neuroticism was related to poorer performance among depressed participants but not among non-depressed participants. Second, Agreeableness modified the relationship between performance on the Digit Span Backward test and depression. Follow-up tests indicated that increased Agreeableness was related to poorer performance, but only among non-depressed participants.

Finally, only education and depression status were related to scores on the COWA, with more years of education and non-depressed status associated with higher scores on this test.

DISCUSSION

In terms of mean differences, older adults with depression performed significantly worse than non-depressed older adults on all of the neuropsychological assessments. Depressed individuals were also significantly lower in Openness to Experience, Conscientiousness, and Extraversion, but were higher in Neuroticism. The neuropsychological results are consistent with the broad body of literature that supports an association between depression and neurocognitive deficits (e.g. Lichtenberg *et al.*, 1995; Porter *et al.*, 2003; Butters *et al.*, 2004), and executive functions in particular (Boone *et al.*, 1995, Beats *et al.*, 1996; Butters *et al.*, 2004). Our neuropsychological findings are consistent with neurobiological research indicating that mood and executive functions are influenced by common brain regions (Phillips *et al.*, 2003; Ochsner and Gross, 2005), which is exacerbated by cognitive and neurobiological changes in aging (Parkin and Lawrence, 1994; Gunning-Dixon and Raz, 2000; Resnick *et al.*, 2007). In addition, there is increased brain pathology among depressed older patients compared to non-depressed older adults (e.g. Morris and Rapoport, 1990; Kramer-Ginsberg *et al.*, 1999), which might additionally contribute to executive function deficits among some depressed patients. The current results suggest, however, that characteristic personality traits among depressed individuals may also contribute to neuropsychological functioning.

The multiple regression analyses revealed a number of relationships among personality, depression, and neuropsychological functioning. As hypothesized, Openness was related to performance on a number of neuropsychological assessments. Across all individuals, increased Openness was related to better performance on the Digit Span Backward test, even after considering all of the other variables in the model. Elements associated with Openness (e.g. intellectual curiosity) might promote engaging in stimulating activities such as education pursuits and life-long learning throughout the life span. In turn, some research suggests that engaging in cognitively stimulating activities could result in improvement or at least maintenance of cognitive abilities such as working memory (Wilson *et al.*, 2002). Higher levels of Openness were also associated with better performance on both parts of the Trail Making Test, but only among depressed individuals. Raskin (1986) suggested that the interaction of age and depression results in decreased cognitive flexibility, which is captured by the Openness scale on the NEO-PI-R, along with related characteristics reflecting imagination and intellectual curiosity. Thus, increased cognitive flexibility and related characteristics associated with trait Openness could potentially attenuate the negative effect of depression on executive function tasks that involve an element of flexibility. There would also be an expectation that Openness would be associated with performance on COWA and the SDMT, but it was not. We do not have an empirical explanation for this lack of association. On the whole, studies of how personality characteristics may promote cognitive reserve in depression represent a promising direction for future research, but additional research is needed to characterize the mechanisms by which specific personality traits are related to specific neurocognitive measures.

Higher Neuroticism was related to poorer performance on the Digit Span Backwards test among depressed individuals but not among non-depressed individuals. This is consistent with previous research finding that trait Neuroticism moderated the relationship between cognitive performance and depression (van den Heuvel *et al.*, 1996). This finding is particularly important because it suggests older adults who have depression and score highly on Neuroticism might be at increased risk for cognitive deficit, at least in terms of working memory ability.

Personality factors and depression status were not significantly associated with scores on the SDMT. Finally, only depression status was related to scores on the COWA, with depressed individuals performing worse than non-depressed individuals.

Clinical implications

The current results highlight the importance of assessing both neuropsychological performance and personality in the context of late-life depression. Deficits in executive functions predict attenuated treatment response and higher rates of depression recurrence (Kalayam *et al.*, 1999; Dunkin *et al.*, 2000; Potter *et al.*, 2004), and low Openness to Experience may exacerbate these effects. Interventions aimed at increasing Openness to Experience could potentially produce effective strategies to compensate for the cognitive inflexibility associated with depression, as well as increase the chances that problem-solving therapies are effective in the treatment of depression (Alexopoulos *et al.*, 2003).

Limitations

Although this study contributes to literature examining the relationships among depression, personality, and cognitive performance, the results should be interpreted within the context of the following limitations. First, the data are correlational, thereby precluding any causal interpretations of the data (see Campbell and Stanley, 1966). Further longitudinal data are needed to in order to establish the temporal pattern of the indicated relationships. Second, the sample consisted primarily of White participants, thus reducing the generalizability of the results. Future research should investigate these relationships in more diverse samples given the differing patterns of depression and cognitive change in older adult minorities (Albert *et al.*, 1995; Brown *et al.*, 1996). Third, the current study follows a naturalistic treatment protocol and did not control for differences in use of anti-depressant medication among the depressed group; however, our findings of group differences in executive functions are consistent with numerous other studies, including medication-free studies (Boone, 1995) and clinical community-based studies with multiple psychotropic medications used among the sample (Beats *et al.*, 1996; Airaksinen *et al.*, 2004; Bierman *et al.*, 2005)

CONCLUSION AND FUTURE DIRECTIONS

This study examined the associations of depression and the ‘Big Five’ personality traits with neuropsychological performance among older adults. Consistent with most research, participants with depression scored significantly worse on the neuropsychological measures compared to non-depressed individuals. However, personality traits moderated many of these relationships, with a particularly strong relationship between executive functions and Openness to Experience. Further understanding of the complex relationships among neuropsychological performance, personality, and mood might be enhanced with correlations to neuroimaging as well as genetics.

KEY POINTS

- Personality traits moderated the relationship between depression and neurocognitive functioning.

ACKNOWLEDGEMENTS

This study was supported by National Institute of Mental Health grants P50 (MH60451), R01 (MH54846), and K24 (MH70027). BJA is supported by a post-doctoral fellowship from the VA Office of Academic Affairs. HBB is supported by an American Heart Association Established Investigator award. The views expressed in this article are those of the authors and do not necessarily represent the views of the Department of Veterans Affairs.

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Table 1

Descriptive statistics

Variable	Non-depressed (*n* = 103)		Depressed (*n* = 75)		Test of significance
	N	%	*N*	%	$X^2(df = 1)$
Demographics					
Female	72	69.9	49	65.3	0.42
White	90	87.4	71	94.7	2.67
Married	65	63.1	38	57.9	2.76
	M (Range)	*SD*	*M* (Range)	*SD*	*t*(*df* = 176)
Age	70.36 (58–73)	5.82	67.83 (60–−82)	6.19	2.79*
Years of education	15.28 (8–17)	1.97	14.07 (7–17)	2.63	3.53*
Personality					
Neuroticism	41.79 (20.46–71.00)	8.97	55.58 (29.68–91.89)	12.09	−.74*
Extraversion	50.02 (30.27–72.12)	9.57	44.34 (25.14–68.86)	10.21	3.80*
Openness	51.97 (32.56–71.51)	9.24	46.92 (22.87–76.16)	11.03	3.32*
Agreeableness	55.23 (30.21–81.60)	9.12	54.28 (37.15–77.43)	9.26	0.68
Conscientiousness	51.76 (19.27–79.94)	10.05	43.37 (16.90–68.71)	11.33	5.21*
Neuropsychological performance					
Trail making A	35.98 (15–78)	11.83	51.24 (18–220)	44.80	−3.31*
Trail making B	87.01 (31–258)	40.78	129.90 (42–301)	77.12	−4.72*
SDMT	43.96 (18–72)	9.53	37.71 (12–57)	11.21	3.98*
Backwards digit span	7.71 (3–13)	2.53	6.76 (3–12)	2.26	2.35
COWA	41.19 (23–76)	11.34	35.17 (12–63)	11.00	3.54*

Scores on the personality measures are reflected as T-scores; COWA=Controlled Oral Word Association Test; SDMT=Symbol Digit Modalities Test.

*$p<.01$.

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Table 2

Intercorrelations between predictor variables and outcome variables

Predictor variables	Neuropsychological tests				
	Trail making A	**Trail making B**	**SDMT**	**Digit span backward**	**COWA**
Non-depressed					
1. Age	0.28*	0.39**	−0.42*	−0.03	−0.11
2. Sex	−0.05	0.05	0.08	0.10	0.18
3. Education	−0.20	−0.18	0.33*	0.06	0.26*
4. Race	0.27*	0.37*	−0.48*	−0.32*	−0.27*
5. Neuroticism	−0.09	0.09	−0.06	−0.05	−0.06
6. Extraversion	0.03	−0.02	−0.07	−0.14	−0.03
7. Openness	−0.05	−0.08	0.15	0.08	0.13
8. Agreeableness	−0.26*	−0.05	−0.02	−0.19	−0.10
Depressed					
1. Age	0.25*	0.30*	−0.38*	−0.06	0.01
2.Sex	0.17	0.10	−0.05	0.08	−0.04
3. Education	−0.44*	−0.50*	0.50*	0.38*	0.52*
4. Race	0.18	0.06	−0.13	−0.14	−0.15
5. Neuroticism	−0.04	0.18	−0.08	0.13	0.06
6. Extraversion	−0.10	−0.12	0.12	0.08	0.12
7. Openness	−0.34*	−0.51*	0.45*	0.46*	0.47*
8. Agreeableness	−0.04	0.02	0.01	−0.01	−0.11

COWA = Controlled Oral Word Association Test; SDMT = Symbol Digit Modalities Test.

* $p<0.01$.

Table 3

Multiple linear regressions examining personality, depression, and neurocognitive functioning

Variable	TrailA			TrailB			SDMT			Digit			COWA		
	B	SE	β	B	SE	β	B	SE	β	B	SE	β	B	SE	β
Age	0.89	0.30	0.17*	2.90	0.64	0.28*	−0.62	0.11	−0.36*	−0.01	0.03	−0.01	−0.06	0.14	−0.04
Sex	3.15	5.00	0.05	9.70	8.50	0.07	0.60	1.42	0.03	−0.26	0.45	0.01	1.97	1.78	0.08
Education	−3.79	1.04	−0.28*	−6.07	1.95	−0.22*	1.45	0.32	0.32*	0.13	0.10	0.12	1.30	0.40	0.26*
Race	6.60	7.49	0.06	23.77	13.34	0.11	−7.17	2.25	−0.20*	−2.17	0.69	−0.25*	−4.90	2.83	−0.13
Depression Status (D)	14.70	5.19	0.23*	33.04	9.32	0.26*	−4.78	1.57	−0.22*	−0.86	0.46	−0.17	−4.18	1.16	−0.20*
Neuroticism (N)	−0.10	0.27	−0.04	1.03	0.47	0.27	−0.17	0.08	−0.16	−0.02	0.03	−0.11	−0.08	0.10	−0.09
Extraversion (E)	−0.20	0.26	−0.06	0.56	0.46	−0.10	0.08	0.08	−0.10	−0.03	0.02	−0.12	−0.02	0.10	−0.02
Openness (O)	−0.19	0.24	−0.06	−1.00	0.29	−0.19*	0.11	0.07	0.10	0.07	0.02	0.20*	0.17	0.09	0.16
Agreeableness (A)	−0.36	0.23	−0.10	0.05	0.42	0.01	−0.04	0.07	−0.04	−0.03	0.02	−0.11	−0.12	0.09	−0.10
Conscientiousness (C)	0.31	0.23	0.11	0.38	0.41	0.07	−0.03	0.07	−0.03	0.01	0.02	0.07	−0.13	0.09	−0.13
D × N										−0.10	0.03	−0.22*			
D × O	−1.04	0.33	−0.18*	−2.72	0.70	−0.26*									
R^2		0.29			0.45			0.45			0.22			0.17	
Model Fit		F (11, 166) = 6.06, p < 0.001			F (11, 158) = 11.66, p < 0.001			F (10, 165) = 13.27, p < 0.001			F (12, 135) = 3.12, p < 0.001			F (10, 167) = 3.43, p < 0.001	

COWA = Controlled Oral Word Association Test; SDMT = Symbol Digit Modalities Test.
Only significant interactions were included in the final models.

*p<0.01.