Depressive Symptoms Are More Strongly Related to Executive Functioning and Episodic Memory Among African American compared with Non-Hispanic White Older Adults

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Abstract

We examined whether the reserve capacity model can be extended to cognitive outcomes among older African Americans. Two hundred and ninety-two non-Hispanic Whites and 37 African Americans over age 54 participated in the normative study for the NIH Toolbox for the Assessment of Neurological and Behavioral Function. Multiple-group path analysis showed that associations between depressive symptoms and cognition differed by race, independent of age, education, reading level, income, health, and recruitment site. Depressive symptoms were associated with slowed processing speed among Whites and worse task-switching, inhibition, and episodic memory among African Americans. African Americans may be more vulnerable to negative effects of depression on cognition than non-Hispanic Whites. Further research is needed to explicate the psychological and neurobiological underpinnings of this greater vulnerability.

Keywords: Depression; Cross-cultural/minority; Elderly/geriatrics/aging; Executive functions

Introduction

The incidence and prevalence of dementia are higher among African-American older adults compared with Whites (Demirovic et al., 2003; Tang et al., 2001). This increased risk does not appear to reflect increased genetic susceptibility to dementia-related neuropathology due to African ancestry (Schlesinger et al., 2013). Independent of race, depression has been associated with accelerated age-related cognitive decline and heightened risk of dementia (Ownby, Crocco, Acevedo, John, & Loewenstein, 2006; Zahodne, Stern, & Manly, 2014). While African-American older adults report similar or lower levels of depressive symptoms when compared with Whites (Blazer, Landerman, Hays, Simonsick, & Saunders, 1998; Ford et al., 2007; Jimenez, Alegría, Chen, Chan, & Laderman, 2010), depressive disorders are more chronic and disruptive among African Americans (Williams et al., 2007). It is unknown whether the strength of the association between depression and cognitive status differs for African-American older adults compared with Whites.

The reserve capacity model posits that individuals of lower socioeconomic status (SES) are more vulnerable to the negative health effects of depression because increased exposure to negative life events and chronic stress diminishes “reserve” (i.e., psychological resources such as self-esteem) needed to buffer these effects (Gallo & Matthews, 2003). In other words, individuals of lower SES may or may not experience depression more often than individuals of higher SES, but they experience more severe health consequences of depression when it is present. Individuals of lower SES may be exposed to a greater number of situations

that tax or degrade psychological resources, or they live in environments that interfere with the development or replenishment of these resources.

Independent of SES, African Americans are exposed to unique stressors such as racial discrimination that may similarly diminish psychological resources needed to buffer the negative health effects of depression. Indeed, perceived discrimination is an independent predictor of negative health outcomes among African Americans (Mays, Cochran, & Barnes, 2007; Ryan, Gee, & Laflamme, 2006; Seaton, Caldwell, Sellers, & Jackson, 2008). In addition, African Americans report lower self-efficacy than Whites (Gurin, Gurin, & Morrison, 1978; Shaw & Krause, 2001). The greater chronicity and functional impact of depressive disorders among African Americans (Williams et al., 2007) may reflect this disadvantage. Specifically, African Americans may be less able to buffer the negative health effects of depression due to higher levels of perceived stress and lower levels of self-efficacy. Whether the reserve capacity model can be extended to cognitive outcomes among African Americans is unknown. Even prior to dementia, depressive symptoms have been associated with worse performance in multiple cognitive domains in older adults. Cognitive domains most consistently affected by depressive symptoms include executive functioning (Baudic, Tzortzis, Barba, & Traykov, 2004) and processing speed (Christensen, Griffiths, Mackinnon, & Jacomb, 1997; Sheline et al., 2006). While the neurobiological underpinnings of these differential relationships is not fully understood, they may involve fronto-striatal disconnection (Sheline et al., 2006).

The present study sought to test the hypothesis that depressive symptoms have a stronger relationship to cognitive test performance among older African Americans, when compared with Whites, particularly in the domains of executive functioning and processing speed. A second aim of the study was to determine whether self-reported perceived stress or self-efficacy differ between older African Americans and Whites. Following the literature, we predicted that African Americans would report greater perceived stress and lower self-efficacy compared with Whites (Clark, Anderson, Clark, & Williams, 1999; Hughes & Demo, 1989).

Materials and Methods

Participants and Procedure

The 329 individuals (292 non-Hispanic White, 37 African American) in this sample were participants in the NIH Toolbox norming study (Beaumont et al., 2013). In brief, study participants were randomly selected from existing databases maintained by several market research companies following a sampling strategy defined by age, sex, and primary language (English or Spanish). There was no further stratification based on race, ethnicity, or educational attainment. However, target quotas were set relative to the U.S. population distributions of these variables. Inclusion criteria for the NIH Toolbox norming study were: first, community-dwelling and non-institutionalized; secondly, ages 3–85 years; thirdly, capable of following test instructions (English or Spanish); finally, able to give informed consent. Participants were not excluded on the basis of psychiatric or cognitive status. Participants in the NIH Toolbox norming study traveled to a research site to participate in the study and were supervised by a trained administrator. All participants included in the present study were tested in English.

Of the 487 individuals over age 54 with available data on Emotion and Cognition modules at the time of the current study, 5 were excluded for the self-reported presence of a neurological condition (dementia, seizures, multiple sclerosis, or stroke/TIA), 107 were excluded for self-reported Hispanic ethnicity, and 44 individuals were excluded for self-reported race other than African American or White. This study complied with the ethical rules for human experimentation that are stated in the Declaration of Helsinki, including approval of the local institutional review boards and informed consent. Characteristics of this community-dwelling, older adult sample are shown in Table 1. Due to a significant age difference between African Americans and Whites in this study, age-corrected cognitive and psychosocial scores are presented and compared in Table 1.

Measures

Depressive symptoms and cognitive abilities were assessed with the NIH Toolbox for the Assessment of Neurological and Behavioral Function (www.nihtoolbox.org). The NIH Toolbox is a standardized set of web-based measures developed through a contract initiated by the NIH Blueprint for Neuroscience Research (Gershon et al., 2013). It contains four modules: Motor, Sensation, Emotion, and Cognition. Emotion and Cognition modules were the focus of the present study. Both modules have been normed and validated in adults aged 18–85 (Salsman et al., 2013; Weintraub et al., 2013). The Cognition module has been shown to be sensitive to age-related differences in cognitive functioning (Weintraub et al., 2013).

Depressive symptoms. In the Emotion module, subdomains of psychosocial functioning are assessed with Likert-type items using computerized adaptive testing based on item response theory (Salsman et al., 2013). This module takes ~12–20 min to complete for ages 18–85. Reliability (Cronbach α) of the Sadness survey is 0.97, and convergent validity (correlation with the Center for

Table 1. Sample characteristics

	White (<i>n</i> = 292)	African American (<i>n</i> = 37)	<i>p</i>
Demographics			
Age	71.3 (8.8)	66.1 (7.8)	.001
Gender (% female)	53.4	61.1	.38
Education	13.7 (2.7)	14.2 (2.9)	.41
Income (% under 40,000)	34.2	54.5	.02
Health (0–7)	0.7 (0.7)	0.9 (0.8)	.04
Reading ^a	4.1 (4.6)	1.1 (7.5)	.03
Cognitive^b			
Flanker	103.0 (14.2)	99.7 (14.5)	.19
DCCS	103.6 (13.9)	99.8 (13.3)	.11
List Sorting	104.1 (15.5)	99.2 (13.9)	.08
Pattern Comparison	102.4 (15.2)	94.6 (14.4)	.004
Picture Sequence Memory	101.5 (14.4)	102.2 (16.6)	.80
Psychosocial^c			
Sadness	50.2 (8.7)	45.5 (8.7)	.003
Perceived Stress	49.5 (9.8)	48.0 (10.6)	.42
Self-efficacy	51.0 (9.8)	52.9 (7.9)	.28

Notes: DCCS = Dimensional Change Card Sort.

^aReading variables reflect unadjusted θ scores.

^bCognitive variables reflect age-corrected standard scores.

^cPsychological variables reflect age-corrected *T*-scores.

Epidemiologic Studies—Depression Scale) is 0.67 (Salsman et al., 2013). Unadjusted *T*-scores on the Sadness survey, which queries depressive symptoms over the past 7 days, were used as a predictor of cognition. Secondary analyses compared age-corrected *T*-scores on Perceived Stress and Self-Efficacy surveys. Reliability (Cronbach α) of these scales is 0.91 and 0.93, respectively (Salsman et al., 2013).

Cognition. The Cognition module comprises computerized tests of executive functions, working memory, processing speed, episodic memory, vocabulary, and reading, and it takes ~30 min to complete (Weintraub et al., 2013). Testing is conducted by a trained administrator using a dual-monitor set-up. The present study analyzed data from tests of executive functions (Flanker Inhibitory Control & Attention, Dimensional Change Card Sort, DCCS), working memory (List Sorting), processing speed (Pattern Comparison), and episodic memory (Picture Sequence Memory) due to the known sensitivity of these cognitive domains to age-related cognitive differences (e.g., Salthouse, 2010).

Specific details of the NIH Toolbox Cognition module, including extensive evaluation of its psychometric properties, are available elsewhere (Weintraub et al., 2013). In brief, the Flanker test requires participants to indicate the direction of a central arrow that is flanked by arrows pointing in the same or different direction. The DCCS test requires participants to alternately choose which of two pictures matches a central picture based on shape or color. The Pattern Comparison test requires participants to indicate whether as many pairs of pictures are the same or different in 90 s. The Picture Sequence Memory test requires participants to view a series of related scenes presented in an arbitrary order, and then to reproduce this order. Test–retest reliability of each instrument is good, with intraclass correlation coefficients ranging from 0.72 (Pattern Comparison) to 0.94 (Flanker) in adults. Convergent validity for each instrument was demonstrated through significant, large correlations with gold-standard measures, ranging from 0.48 (Flanker) to 0.69 (Picture Sequence Memory). Unadjusted standard scores on Flanker, DCCS, List Sorting, Pattern Comparison, and Picture Sequence Memory were used to index cognition in the multiple-group model.

Covariates

The model controlled for age, education, reading level, income, health, and recruitment site. Years of education was measured via self-report. Reading level was measured with the NIH Toolbox Oral Reading Recognition Test (unadjusted theta scores). Income was dichotomized such that values of 0 correspond to 2010 total household income (before taxes) less than \$40,000 and values of 1 correspond to 2010 total household income (before taxes) of \$40,000 or more. To index overall health, one point was assigned for the self-reported presence of each of the following conditions: hypertension, peripheral vascular disease, other heart problem, diabetes, thyroid problems, joint problems, and breathing problems. These points were summed

to create an index of illness burden with a minimum value of 0 and a maximum value of 7. Recruitment site was measured with dichotomous dummy variables for the ten possible sites, located across the United States.

Statistical Analysis

Descriptive statistics were computed using SPSS version 19 (IBM Corp., Armonk, NY). Group differences were evaluated with independent *t*-tests (for continuous variables) or χ^2 tests (for categorical variables) in SPSS. Multiple-group path analysis was conducted in Mplus version 7 (Muthén & Muthén, Los Angeles, CA). Due to the large difference in sample size across the two racial groups, separate analyses were run in the whole group and in a subset of 74 participants (37 African American and 37 non-Hispanic White) who could be matched on age, sex, and education. For clarity, results focus on those obtained in the matched group, but substantive differences between results are noted where applicable.

In the multiple-group path analysis, all parameters in the model, including structural relations between variables, were estimated separately in each group (i.e., African Americans and Whites). Each cognitive outcome was regressed onto the measure of depressive symptoms (NIH Toolbox Sadness) as well as covariates. Cognitive scores were allowed to correlate with one another. Covariates and depressive symptoms were also allowed to correlate with one another.

First, all structural relations (e.g., covariances, regression paths) in the model were forced to equivalence across groups (*fixed model*). Note that means, intercepts, variances, and residual variances were not forced to equivalence in any models. Next, the specific parameters of interest (i.e., regression paths between depressive symptoms and cognitive scores) were freely estimated across groups (*free model*). If the difference in chi-square values between the fixed and free models exceeded its critical value, it was concluded that the associations between depressive symptoms and the cognitive scores were significantly different in the two groups. This conclusion would be supported by smaller values of Akaike Information Criterion (AIC) and sample-size adjusted Bayesian Information Criterion (BIC). Fit of the final model was also evaluated with the following commonly used criteria: root-mean-square error of approximation (RMSEA) < 0.05, Confirmatory Fit Index (CFI) > 0.95.

Results

Group Differences

As shown in Table 1, African Americans were younger, reported more chronic health conditions, obtained lower reading scores, and were more likely to have a 2010 household income (before taxes) less than \$40,000 when compared with the non-Hispanic Whites. African Americans also reported fewer depressive symptoms and scored lower on Pattern Comparison, a test of processing speed. African Americans and Whites did not differ on perceived general stress or general self-efficacy.

Matched groups of African Americans and Whites did not differ in age, education, reading level, health status, income, perceived general stress, or general self-efficacy. African Americans reported fewer depressive symptoms ($p = .001$) and obtained lower age-corrected scores on the processing speed test ($p = .049$).

Multiple-Group Path Analysis

Difference testing. In the whole group ($n = 329$), allowing regression paths between depressive symptoms and cognitive scores to vary across groups resulted in significantly better model fit ($\Delta\chi^2(5) = 16.72; p < .01; \Delta AIC = 6.72; \Delta BIC = 3.60$). The final, free model fit well: RMSEA = 0.04 (90% confidence interval = 0.02–0.06); CFI = 0.94. Freeing these regression paths also resulted in better model fit in the subset of matched groups ($n = 74$) ($\Delta\chi^2(5) = 14.66; \Delta AIC = 4.66; \Delta BIC = 8.90$), though overall model fit was lower in this small sample (RMSEA = 0.09 [90% confidence interval = 0.05–0.12]; CFI = 0.71).

Associations involving cognition. In the matched-groups path analysis, DCCS was positively associated with Flanker ($p < .001$), Pattern Comparison ($p = .001$), and Picture Sequence Memory ($p = .007$). Flanker was also positively associated with Pattern Comparison ($p = .001$) and Picture Sequence Memory ($p = .036$). Pattern Comparison and Picture Sequence Memory were not associated with one another. List Sorting was not independently associated with any other cognitive tests.

As shown in Table 2, Age was negatively associated with all cognitive variables except Picture Sequence Memory. Reading level was positively associated with List Sorting ($p = .011$) and Picture Sequence Memory ($p < .001$). Education was positively associated with DCCS ($p = .004$). Income was not independently associated with any cognitive variables. Independent of age and the other predictors, the number of self-reported chronic illnesses was associated with higher scores on List Sorting ($p = .003$). Recruitment sites differed on DCCS, Flanker, and List Sorting.

Table 2. Unstandardized regression estimates and standard errors from the free model

	DCCS	Flanker	List Sorting	Pattern Comparison	Picture Sequence Memory
White					
Sadness	−0.03 (0.17)	0.13 (0.14)	−0.03 (0.19)	−0.17 (0.20)	−0.05 (0.22)
Age	−0.43 (0.13)**	−0.33 (0.12)**	−0.46 (0.14)**	−0.42 (0.15)**	−0.04 (0.18)
Education	1.12 (0.39)**	0.59 (0.37)	−0.20 (0.40)	0.36 (0.46)	−0.58 (0.50)
Reading	0.19 (0.16)	0.10 (0.16)	0.44 (0.17)*	0.04 (0.19)	0.70 (0.20)**
Income	2.38 (2.23)	2.27 (1.94)	0.75 (2.36)	−1.67 (2.47)	0.43 (3.39)
Health	0.49 (1.37)	0.28 (1.25)	4.17 (1.40)**	−0.87 (1.69)	−1.13 (1.71)
African American					
Sadness	−0.32 (0.16)*	−0.48 (0.17)**	0.18 (0.17)	−0.06 (0.19)	−0.55 (0.20)**
Age	−0.43 (0.13)**	−0.33 (0.12)**	−0.46 (0.14)**	−0.42 (0.15)**	−0.04 (0.18)
Education	1.12 (0.39)**	0.59 (0.37)	−0.20 (0.40)	0.36 (0.46)	−0.58 (0.50)
Reading	0.19 (0.16)	0.10 (0.16)	0.44 (0.17)*	0.04 (0.19)	0.70 (0.20)**
Income	2.38 (2.23)	2.27 (1.94)	0.75 (2.36)	−1.67 (2.47)	0.43 (3.39)
Health	0.49 (1.37)	0.28 (1.25)	4.17 (1.40)**	−0.87 (1.69)	−1.13 (1.71)

Notes: DCCS = Dimensional Change Card Sort. Parameter estimates for dummy-coded site variables not shown due to space.

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

Associations among the predictors. Recruitment sites differed in depressive symptoms and health, but not age, education, reading level, or income. Younger adults reported more chronic health conditions in the matched-groups sample.

Depression–cognition associations. Unstandardized regression estimates from the free model in the matched-group subsample are shown in Table 2. Note that all reported associations are independent of all other parameters in the model. In addition, it should be noted that regression paths involving the covariates (i.e., age, education, reading level, income, health, and site) were forced to equivalence across groups, even in the free model.

Among Whites, depressive symptoms were not associated with any cognitive scores. In the larger sample of Whites ($n = 292$), greater depressive symptoms were associated with lower scores on Pattern Comparison ($p = .001$). Among African Americans, greater depressive symptoms were associated with significantly lower scores on DCCS, Flanker, and Picture Sequence Memory. Specifically, each additional T-score point on the Sadness survey was associated with 0.32 fewer standard score points on task-switching, 0.48 fewer standard score points on the task of attention and inhibition, and 0.55 fewer standard score points on the task of episodic memory, independent of the covariates. The association between depressive symptoms and Picture Sequence Memory was not significant in the whole-group analysis ($p = .187$). As shown in Table 2, the magnitudes of the negative relationships between depressive symptoms and executive function were larger in African Americans.

Discussion

The main finding of this study was that higher levels of self-reported depressive symptoms were more tightly associated with poorer performance on two tests of executive function and a test of episodic memory among African Americans, when compared with Whites. This discrepancy across race was found to be independent of disparities in health, income, and reading level. African Americans reported lower levels of depressive symptoms, which is consistent with the literature (Blazer et al., 1998; Ford et al., 2007; Jimenez et al., 2010). Despite the lower overall levels of depressive symptoms and similar performance on most cognitive tasks, this study showed that African-American older adults are more susceptible to the negative effects of depression on executive functioning and episodic memory than White older adults. That African Americans in this sample did *not* report more general perceived stress or less general self-efficacy than Whites suggests that these constructs are not likely to explain greater vulnerability among African-American older adults.

While there were no group differences in Perceived Stress or Self-Efficacy surveys of the NIH Toolbox, it should be noted that these are domain-general measures that may not capture all psychosocial experiences that are unique to African Americans. For example, the Perceived Stress survey inquires about nonspecific personal difficulties and their perceived uncontrollability. It is possible that the African Americans in this sample were exposed to chronic stressors such as racial discrimination that are unmeasured in this scale and reduced their ability to buffer the negative cognitive effects of depressive symptoms. Similarly, the Self-Efficacy survey inquires about one's perceived ability to handle unexpected situations and accomplish goals. This scale may not capture other potential psychological resources (e.g., self-esteem, domain-specific self-efficacy) that could differ between African Americans and Whites. For example, it has long been suggested that omnibus measures of self-efficacy may have little relevance to the specific domain of functioning (e.g., cognition) being analyzed (Bandura, 1989). Therefore, although

this study established a stronger relationship between depressive symptoms and cognition among African-American older adults, more research is needed to thoroughly investigate whether this stronger relationship can be explained by the reserve capacity model (Gallo & Matthews, 2003).

While the reserve capacity model focuses on psychosocial moderators of the relationship between depressive symptoms and health outcomes, other factors may moderate the relationship between depressive symptoms and cognitive outcomes. For example, the ability to formulate and employ cognitive strategies may allow individuals to compensate for the negative influence of depression on cognitive test performance. While higher strategy clustering scores on verbal list learning tasks has been reported among White older adults (Gross & Rebok, 2011), it is not clear whether the use of cognitive strategies differed across racial groups in the current study.

An alternative explanation for the stronger relationship between depressive symptoms and cognition among African Americans in this study is that psychotherapy and antidepressant usage is lower among depressed African Americans, compared with Whites (González et al., 2010). While African Americans reported fewer depressive symptoms than Whites in this sample, it remains a possibility that depressed individuals were differently engaged in depression treatments that improve cognitive performance. However, it should be noted that mean age-corrected *T*-score for the depressive symptom measure was within 0.5 *SD* from 50 in both African Americans and Whites in this sample.

Another possibility is that depressive symptoms are more likely to reflect an early symptom of dementia among African Americans, while etiologies of depressive symptoms among Whites may be more varied. Depression has been linked to markers of Alzheimer's neuropathology in non-demented older adults (Lavretsky et al., 2009; Pomara et al., 2012; Sweet et al., 2004), but it is not known whether this relationship is stronger among African Americans. Of note, the negative relationship between depressive symptoms and episodic memory, a core cognitive ability affected by Alzheimer's disease, was only present among African Americans in this study. However, the finding that self-reported depressive symptoms are not higher among African-American older adults with an apolipoprotein E epsilon 4 allele (Class et al., 1997) does not support the hypothesis that depressive symptoms are more likely to reflect an early symptom of Alzheimer's disease among African Americans compared with Whites. Future brain amyloid imaging studies could help to address this question.

A limitation of this study is the small sample of African-American older adults. While the proportion of African Americans in this sample (11%) is similar to that in the U.S. population, replication of these results with a larger number of African Americans is needed. Because this study was only able to measure self-reported depressive symptoms, follow-up studies should also include a thorough clinical interview for depression. Relevant variables that were not assessed in this study include effort (Benítez, Horner, & Bachman, 2011) and IQ. Another limitation is that it was cross-sectional. The path analysis instantiated a specific hypothesis about the direction of the association between depressive symptoms and cognition based on previous longitudinal research (Zahodne et al., 2014), but it cannot be ruled out that lower cognitive scores led to depressive symptoms in this sample. Future studies should include longitudinal follow-up in order to investigate the relationship between depressive symptoms and subsequent cognitive declines and dementia incidence in racially diverse older adults.

In conclusion, the present study provides support for the hypothesis that African-American older adults are more susceptible to the negative effects of depression on executive functioning and episodic memory. The clinical relevance of this finding is that executive dysfunction is a key predictor of difficulties with activities of daily living in older adults (Vaughan & Giovanello, 2010), and episodic memory deficits are a core feature of Alzheimer's disease. Future studies should investigate whether this increased vulnerability relates to negative effects of racial discrimination on psychological resources. Additional longitudinal work is needed to determine whether depression is more indicative of dementia risk among older African Americans.

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Conflict of Interest

None declared.

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