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Role of Place in Explaining Racial Heterogeneity in Cognitive Outcomes among Older Adults

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Abstract

Racially patterned disadvantage in Southern states, especially during the formative years of primary school, may contribute to enduring disparities in adult cognitive outcomes. Drawing on a lifecourse perspective, we examine whether state of school attendance affects cognitive outcomes in older adults and partially contributes to persistent racial disparities. Using data from older African American and white participants in the national Health and Retirement Study (HRS) and the New York based Washington Heights Inwood Cognitive Aging Project (WHICAP), we estimated age-and gender-adjusted multilevel models with random effects for states predicting years of education and cognitive outcomes (e.g., memory and vocabulary). We summarized the proportion of variation in outcomes attributable to state of school attendance and compared the magnitude of racial disparities across states. Among WHICAP African Americans, state of school attendance accounted for 9% of the variance in years of schooling, 6% of memory, and 12% of language. Among HRS African Americans, state of school attendance accounted for 13% of the variance in years of schooling and also contributed to variance in cognitive function (7%), memory (2%), and vocabulary (12%). Random slope models indicated state-level African American and white disparities in every Census region, with the largest racial differences in the South. State of school attendance may contribute to racial disparities in cognitive outcomes among older Americans. Despite tremendous within-state heterogeneity, state of school attendance also accounted for some variability in cognitive outcomes. Racial disparities in older Americans may reflect historical patterns of segregation and differential access to resources such as education. (*JINS*, 2015, *21*, 677–687)

Keywords: Aging, Geographical variation, Race, Cognitive functioning, Memory, Visual-spatial

INTRODUCTION

Previous research has noted a significant racial disparity in cognitive outcomes among older adults in the United States, with African Americans averaging higher rates of dementia and cognitive impairment than whites. Much of this cognitive disparity in older age has been attributed to demographic, health, and socioeconomic characteristics (Mehta et al., 2004; Morgan, Marsiske, & Whitfield, 2007; Schwartz et al., 2004; Sloan & Wang, 2005). Since cognitive performance reflects a variety of abilities and skills, neuropsychological test performance of older adults is shaped by their experiences across the lifecourse, influenced by their life history and responses to their socio-historical context. Early disadvantage associated with race may contribute to persistent racial disparities in neuropsychological outcomes among older adults (Glymour & Manly, 2008).

Researchers have linked the widespread social inequalities in the South during the 20th century to health disadvantages of African Americans nationwide and Southerners in general. Independent of adult residence, childhood residence in the South is associated with adverse health outcomes in older adults, including increased adult hypertension (Obisesan, Bargas, & Gillum, 2000), mortality due to cardiovascular disease (Fang, Madhavan, & Alderman, 1996; Greenberg & Schneider, 1992; Schneider, Greenberg, & Lu, 1997), and stroke (Howard et al., 2011). Emerging research indicates the effect of Southern residence during childhood extends to cognitive outcomes. Cognitive performance reflects a variety

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of abilities, including memory, conceptual and spatial skills, and use of language. In the standardization sample of the Wechsler Preschool and Primary Scale of Intelligence-Revised, geographic region (Northeast, Midwest, South, and West) effects on scores were small but significant (Sellers, Burns, & Guyrke, 2002) and there were several region-by-ethnicity interactions on Full Scale IQ scores. In the West and Northeast, scores of African Americans were not significantly lower than those of whites, whereas significant differences were noted in the South and Midwest.

Although African Americans are currently geographically dispersed throughout the United States, almost 90% of African Americans in the United States lived in the South in the early 20th century (Hobbs & Stoops, 2002). During the "Great Migration" (1910–1970), over six million African Americans moved from the South as a response to the economic conditions, segregation, and violence of the Jim Crow South. These migrants converged on Northern industrial cities with promising economic opportunities associated with the World Wars, such as Chicago and New York City (Lemann, 1991; Tolnay, 2003). As a result, until recently the majority of older African American adults in the United States, even those who lived in Northern states as adults, were born and raised in the South. This historic migration pattern suggests that, even in cohorts recruited in a single location, racial differences might be accounted for by differences in place of childhood residence.

Regional differences in cognitive test performance may be primarily driven by differences in the quality and quantity of schooling. Most Southern states operated *de jure* segregated schools until legally imposed desegregation in 1954. School quality differences in Southern segregated schools extended to every feature of schooling: physical infrastructure, textbooks and curriculum, teacher training and consistency, class size, hours in the school day, and mandated minimum school term lengths (Anderson, 1988; Margo, 1985, 1990). In contrast, African American from the urban areas of the North and West may also have increased test sophistication (Williams, 1998). They may have increased classroom exposure in schools to "teaching to the test," learning guessing skills, and to persevere through difficult items (Brand, 1987).

To date, few studies have examined the extent to which contextual risk factors associated with childhood residence have contributed to cognitive impairment in later life. With an aging population, the number of older people affected by cognitive decline is increasing. Since childhood is a critical period for the development of cognitive reserve (Ashendorf, Jefferson, Green, & Stern, 2009), where these individuals attended school may have important implications for older age cognitive performance. The goals of this study were to: (1) quantify the extent to which the geographic location of schooling accounts for variance in cognitive outcomes among older adults in a large, nationally representative sample as well as a smaller, community-based cohort in New York City; and to (2) determine whether the effects of state of school attendance differ by race (African American and white) and contribute to racial disparities in cognitive outcomes.

METHOD

Samples: WHICAP Participants

The Washington/Hamilton Heights-Inwood Columbia Aging Project (WHICAP) is an ongoing, longitudinal study of aging, cognitive function, and dementia among Medicare-eligible older adults residing in Northern Manhattan, New York. The current study included participants recruited in two enrollment waves, beginning in 1992 ($n = 2{,}125$) and in 1999 ($n = 2{,}183$). Participants are re-evaluated every 18 to 24 months, with similar assessments at each interval. The sampling strategies and recruitment outcomes of these two recruitment cohorts are detailed in prior publications (Manly et al., 2005; Tang et al., 2001). The current analyses were conducted using data collected in a single interview wave that began in 1999. Therefore, the cross-sectional data in the current study are from participants with complete assessments from the 4th follow-up wave of the 1992 cohort and the baseline assessment of the 1999 cohort. Our analytic sample consists of 1013 non-Hispanic African Americans and 540 non-Hispanic white WHICAP participants who were born in the United States and are English-speaking. This includes information from the baseline evaluation of the 1999–2001 enrollment cohort and the 4th follow-up wave of the 1992 enrollment cohort. Compared to the larger WHICAP sample, our analytical sample was similar in age (77 *vs*. 75) years of education (12 *vs*. 12) and the proportion who are male (67 *vs*. 70%) (Siedlecki et al., 2010).

HRS Participants

To provide a more geographically diverse sample, we also used individual-level data on education, cognitive function, and covariates from Health and Retirement Study (HRS), an ongoing national probability sample of U.S. residents born before 1948 and their spouses. Detailed documentation on HRS sample design and validation of cognitive measures is available elsewhere (Heeringa & Connor, 1995; Ofstedal, McAuley, & Herzog, 2002; Wallace & Herzog, 1995). We linked participant data from the 2000 HRS wave to state characteristics using self-reported state of school attendance. The 2000 HRS wave was the 2nd interview wave in which all the birth cohorts before 1948 were sampled and the first wave in which all respondents had been exposed to the cognitive assessments at least once before. We used cognitive assessments from the 2000 HRS wave to minimize practice effect differences that might otherwise prevail across different enrollment cohorts.

From 18,173 birth-cohort eligible sample members (born after 1949 or at least age 50 in 2000), we made the following exclusions: non-U.S. born ($n = 1683$) neither African American nor white ($n = 796$); and missing state of residence for education or went to school outside of the United States (19), for a final eligible analytic sample of 15,675 in the model with years of schooling as the outcome. Our analytical HRS sample consisted of 2362 non-Hispanic African Americans and 13,313 non-Hispanic white participants. Due to missing information on outcomes, the final analytic sample was smaller in the models with word recall (n = 14,380), vocabulary (n = 8191), or Telephone Interview for Cognitive Status (TICS) assessments (n = 8191). The Columbia University Institutional Review Board and Harvard School of Public Health Human Subjects Committee approved these analyses. All individuals discussed the study with trained research staff and provided written informed consent.

Racial and Ethnic Group Definitions: WHICAP Participants

WHICAP participants were asked to report their ethnicity and race separately. First, they were asked if they identify as Hispanic or Latino and then they were asked if they identify as American Indian/Alaska Native, Asian, Native Hawaiian or other Pacific Islander, black or African American, or white/Caucasian. Next, participants were asked whether they identified as any other race.

Racial and Ethnic Group Definitions: HRS Participants

In HRS, all respondents were asked whether they considered themselves Hispanic or Latino and, in a separate question, whether they considered themselves "primarily" white or Caucasian; black or African American; American Indian; or Asian. Reporting of multiple races was not allowed in HRS.

State of School Attendance: WHICAP Participants

In WHICAP, the following variables were assessed separately for elementary, high school, and post-high school phases of education: years completed, age or date of first year attended, location (country, state, city, rural *vs.* urban), setting (public *vs.* private), class size (one-room school or multi-room school), and estimated ethnic composition of student body and teachers). State of elementary school was used for the current analyses, and for those with no formal schooling, state of birth was used as a proxy.

State of School Attendance: HRS Participants

HRS respondents with 10 or fewer years of education were asked "In what state or country did you live most of the time you were (in grade school)?" For respondents with more than 10 years of school, the question was phrased to refer to when "in high school," and for respondents with no schooling, the phrase was "about age 10." We used state of birth as a proxy for the 4% (n = 598) of respondents missing information on state of school attendance. Approximately 83% of the respondents with information on both variables reported attending school in their state of birth.

Outcomes: WHICAP Participants

In WHICAP, total years of education was calculated as the sum of years completed in elementary, high school, and post-high school phases of education, with a minimum of 0 and a maximum of 20. In addition, participants were asked whether they were ever "left back or had to repeat a grade." Participants who obtained a General Educational Development (GED), a high school equivalency credential, were assigned the number of actual years of formal schooling. All WHICAP participants with 17 or more years of school were assigned a value of 17 for the current analyses to provide comparability with the HRS. In HRS, education was assessed as years of schooling completed, ranging from 0 to 17.

In the WHICAP sample, a neurological and physical examination was performed at the initial visit and at each follow-up. The neuropsychological evaluation included measures of learning and memory, orientation, abstract reasoning, vocabulary, and visual-spatial ability and has been previously described in detail (Manly et al., 2005; Stern et al., 1992). Perceived difficulty with memory was determined (Blessed, Tomlinson, & Roth, 1968; Gurland, Golden, Teresi, & Challop, 1984) and reading level was assessed using the Reading subtest of the Wide Range Achievement Test Version 3 (Wilkinson, 1993). Specific ability areas and tests administered include verbal list learning and memory (Buschke & Fuld, 1974), nonverbal memory (Benton, 1955, 1974), orientation (Folstein, Folstein, & McHugh, 1975), verbal reasoning (Wechsler, 1981), nonverbal reasoning (Mattis, 1988), naming (Kaplan, Goodglass, & Weintraub, 1983), letter fluency (Benton & Hamsher, 1976), category fluency (Goodglass & Kaplan, 1983), repetition (Goodglass & Kaplan, 1983), auditory comprehension (Goodglass & Kaplan, 1983), visual construction (Rosen, 1981), visual perceptual skills (Benton, 1955, 1974), and speed and executive function (D'Elia, Satz, Uchiyama, & White, 1994). Composite scores have been developed for this battery, using an exploratory factor analysis approach, with confirmatory factor analysis that tested for invariance of the factor structure across English and Spanish speaking participants in WHICAP (Siedlecki, Honig, & Stern, 2008; Siedlecki et al., 2010). This factor analysis identified factors of memory, language, processing speed, and visual-spatial ability, and the model was found to have configural and metric invariance across English-speaking and Spanish-speaking groups. Based on these findings, composite scores were created from the scores comprising these four factors. Using baseline cognitive test data for the entire cohort of WHICAP participants recruited in 1992 and 1999, Z-scores for each of the cognitive measures were created and then averaged to create a composite score for each factor.

Outcomes: HRS Participants

Total years of education were based on self-report in the HRS sample. In addition, HRS participants took repeated word list recall (Memory) and mental status (Mental Status) tests. Immediate and delayed word list recall (n = 10,694) scores were summed for a possible range from 0 to 20. General Cognitive Status was assessed with a modified TICS survey, which included serial-7 subtractions but not the immediate word recall (Brandt, Spencer, & Folstein, 1988). We omitted items for "naming scissors" (because of low correlation with other items) and second attempt at counting backward from 20 (because of apparent inconsistencies in administration) so TICS scores that measured general cognitive status ranged from 0–13. For each of these outcomes, we estimated the amount of variance explained by state of school attendance using a multilevel regression framework. We also estimated models (described below) to predict the state-average score for years of schooling and to predict the state-average cognitive score for each of the above variables.

Analysis

In the first series of analyses, we estimated linear regression models with a random-intercept for state, allowing each state of school attendance to deviate from the overall mean response by a state-specific constant. The residual in these multilevel models are decomposed into an individual and a state-level residual. Using these residuals, we estimated variance partition coefficients (VPCs) to summarize the variation in the outcomes attributable to state of school attendance. VPC is a measure of the residual correlation between the responses from two individuals from the same state; VPCs above zero suggest state level factors that influence everyone who grew up in the same state and also affect cognitive outcomes. The larger the VPC, the greater the clustering effect due to state of school attendance. We estimated race-stratified models to provide VPCs for African Americans and whites separately, and then examined disparities using race-pooled models with adjustment for race as a fixed effect. In addition, we computed empirical Bayes estimates based on the random-intercept model that included individual-level variables. Empirical Bayes estimates combine the prior means with the average estimates from the data. These estimates account for uncertainty in state specific estimates by "pulling in" the estimate toward the overall average. We aggregate and summarize the state-level empirical Bayes estimates by Census region of birth. Data use agreements concerning confidentiality preclude us from reporting the specific states of schooling or birth.

We further examined disparities in the race-pooled models with random slopes for race, initially specifying an unstructured covariance between the intercept and the slope. Both the HRS and the WHICAP random slope models indicated no statistically significant correlation between state intercepts and slopes (i.e., states in which whites, on average, obtained lower cognitive scores or fewer years of schooling, did not have systematically larger or systematically smaller racial disparities in cognitive function). For that reason, we present random slope models in both samples estimated assuming independence between the intercepts and slopes. We summarized the empirical Bayes estimates from the pooled models with random slopes for race by Census region to illustrate the heterogeneity in the predicted racial disparity in cognitive outcomes.

We conducted a series of subanalyses to help determine whether differences in patterns in the WHICAP and HRS results were due to differences between the samples. By design, the WHICAP participants consisted entirely of New York City residents, so all variability in state of school attendance was due to individuals who migrated from other states. To investigate the extent to which differences in the WHICAP and HRS models were due to the sample design, we re-estimated our models restricting the HRS sample to include the following: (1) individuals who had migrated between state of school attendance and state of residence in adulthood, (2) individuals whose states of childhood residence were represented in the WHICAP sample, and (3) individuals whose states of childhood residence were represented in the WHICAP sample and who resided in the same geographical region as their state of school attendance. We also reran all analysis on a subset of WHICAP participants who were born in a state other than New York. All analyses were race-stratified.

RESULTS

Table 1 reports the characteristics of the WHICAP and HRS participants stratified by race. In both the WHICAP and HRS samples, African American respondents differed from the white respondents on all measured sociodemographic characteristics ($p < .01$). Among the African American WHICAP respondents, the mean age was 77. Approximately 27% of the African American WHICAP respondents were male and on average they had 12 years of schooling. Among the white WHICAP respondents, the mean age was 76 with 42% male and an average of 14 years of schooling. Although all the WHICAP respondents were currently residing in New York City, their states of birth differed widely by race. African American WHICAP respondents were originally from 32 different areas (31 states plus DC) and white respondents were from 34 different areas (33 states plus DC). The African American WHICAP respondents were predominantly Southern-born (54% compared to only 4% of the white WHICAP respondents), whereas the white WHICAP respondents were predominantly from the Northeast (85% compared to 42% of the African American WHICAP respondents).

Among the African American HRS respondents, the mean age was 67 with 38% male and an average of 11 years of schooling. Among the white HRS respondents, the mean age was 68 with 30% born in the South, 44% male and an average of 13 years of schooling. Currently, respondents are geographically dispersed throughout the United States but African American respondents were originally from 43 different states and DC and white respondents were from 50 different states and DC. Approximately, 78% of the African American HRS respondents compared to 30% white HRS respondents were born in the South.

Regression Model - WHICAP Sample

Table 2 presents results from linear regression models with a random-intercept for state. It summarizes the percentage of variance explained by state of school attendance in the

Table 1. Sociodemographic characteristics by study sample and race

	WHICAP			HRS		
	African American	White	*p*-Value	African American	White	*p*-Value
N	1013	540		2362	13313	
No. of states	32	34	—	43	51	—
Age, mean (range)	77 (66, 102)	76 (66, 102)	<0.01	67 (50, 107)	68 (49,103)	<0.01
Region of birth						
Northeast, %	42	85	<0.01	10	24	<0.01
Midwest, %	3	9	<0.01	10	35	<0.01
South, %	54	4	<0.01	78	30	<0.01
West, %	<1	2	<0.01	2	11	<0.01
Male, %	27	42	<0.01	38	44	<0.01
Years of schooling, mean (*SD*)	12 (3)	14 (3)	<0.01	11 (4)	13 (3)	<0.01
Words, mean (*SD*)	—	—	—	8.6 (3.8)	10.2 (3.7)	<0.01
Cognitive, mean (*SD*)	—	—	—	9.0 (2.8)	11.2 (2.0)	<0.01
Vocabulary, mean (*SD*)	0.3 (0.6)	0.8 (0.5)	<0.01	3.9 (2.3)	5.8 (1.9)	<0.01
Memory, mean (*SD*)	0.1 (0.8)	0.6 (0.7)	<0.01	—	—	—
Speed, mean (*SD*)	0.3 (0.9)	0.8 (0.7)	<0.01	—	—	—
Visio-spatial, mean (*SD*)	0.3 (0.5)	0.7 (0.4)	<0.01	—	—	—

overall sample as well as by the race-specific and the stayer/mover-specific subsamples. Table 2 also gives the regression coefficients and the corresponding standard errors for age and race, if these were included in the model. In the pooled models, African Americans had lower average values on all the outcomes in the WHICAP sample. Conditional on age and gender, years of schooling, and cognitive outcomes were more similar for people from the same state of schooling than for people from different states. We estimate that state random effects account for 9% of the total residual variance for years of schooling, 7% in memory, 14% for language, 9% for speed, and 12% for visual-spatial outcomes in the WHICAP sample (Table 2). In the race stratified models, the proportion of the variance attributed to state of school attendance was, with the exception of speed, larger for the models restricted to whites in the WHICAP sample. However, the 95% confidence intervals (CIs) for the VPC in the race-specific models overlapped, suggesting differences in estimated VPC may be due to chance, given the sample size. For example, state of school attendance explained 30% (95% CI [12-58]) of the variance in memory for the whites compared to 6% (95% CI [2-16]) for the African Americans in the WHICAP sample. The speed outcome provided the only exception, with state of school attendance accounting for no variation for the speed outcome among whites in WHICAP. The variance explained by state of school attendance increased for all the outcomes in the models restricted to the white WHICAP respondents who were born in a state other than New York. However, the variance explained by state of school attendance only increased for education and not for the cognitive outcomes in the models restricted to the African American WHICAP respondents who were born in a state other than New York.

To further explore the geographic variation, we examined the empirical Bayes predicted average values for African American and white WHICAP participants from each state, grouped by Census region. The South had the largest range of predicted state average for education and the cognitive outcomes for both African Americans and whites (Table 3). For example, the average education for African Americans in the worst southern state was 10.1 years, whereas it was 13.0 for the best southern state. For white, the range across southern states was 12.8 to 14.1 years. For cognitive outcomes, the range of predicted state-level differences was also largest in the South (Table 3).

Regression Models: HRS Sample

Results for the overall sample of HRS participants and for each race and stayer/mover HRS subsample showed interesting differences and commonalities. In the overall sample of HRS participants, state of school attendance explained 5% of the variance in years of schooling, 3% for general cognitive status, 1% for memory, and 5% for vocabulary (Table 2). Similar VPC estimates were found for the random intercept models restricted to the HRS sample who lived in the WHICAP states and the HRS participants who lived in the same geographical region during the study as in their childhood (i.e., the "stayers") and those who moved to a different geographical region from their childhood (i.e., the "movers").

In the race-stratified analysis, the VPC estimates were consistently larger in the sample restricted to African Americans compared to whites in HRS. For example, state of school attendance explained 13% (8–21%) of the variance in completed years of schooling for African Americans compared to 5% (3–7%) for whites in HRS. State of school attendance explained 7% of variance in general cognitive status for African American respondents and only 3% of the

Table 2. Results of the multilevel linear regression models predicting schooling and cognitive measures in WHICAP and HRS by subsample

Sample	Covariate	Outcome: Education	Memory	Language	Speed	Visual-spatial
WHICAP						
	African American	−1.36 (0.19)	−0.35 (0.04)	−0.36 (0.03)	−0.30 (0.05)	−0.21 (0.03)
Pooled[a]	Age	−0.07 (0.01)	−0.04 (0.00)	−0.02 (0.00)	−0.05 (0.00)	−0.02 (0.00)
	VPC	*9 (4–19)*	*7 (3–14)*	*14 (7–24)*	*9 (4–18)*	*12 (6–21)*
African Americans	Age	−0.07 (0.02)	−0.04 (0.00)	−0.02 (0.00)	−0.05 (0.01)	−0.02 (0.00)
	VPC	*9 (4–22)*	*6 (2–16)*	*12 (6–25)*	*8 (3–18)*	*9 (4–19)*
Whites	Age	−0.07 (0.02)	−0.04 (0.00)	−0.03 (0.00)	−0.05 (−0.01)	−0.02 (0.00)
	VPC	*7 (0–57)*	*30 (12–58)*	*29 (12–55)*	*0 (0–0)*	*26 (9–54)*
WHICAP, restricted to movers						
	African American	−2.16 (0.38)	−0.40 (0.08)	−0.44 (0.06)	−0.43 (0.11)	−0.33 (0.05)
Pooled[a]	Age	−0.07 (0.02)	−0.03 (0.00)	−0.02 (0.00)	−0.05 (0.01)	−0.02 (0.00)
	VPC	*5 (2–14)*	*5 (2–13)*	*11 (5–20)*	*7 (3–17)*	*8 (4–16)*
African Americans	Age	−0.06 (0.03)	−0.02 (0.00)	−0.03 (0.01)	−0.05 (0.01)	−0.02 (0.00)
	VPC	*8 (2–21)*	*6 (2–16)*	*11 (5–24)*	*7 (2–19)*	*8 (3–18)*
Whites	Age	−0.18 (0.05)	−0.04 (0.01)	−0.04 (0.01)	−0.07 (0.01)	−0.03 (0.01)
	VPC	*16 (2–65)*	*31 (11–62)*	*35 (15–62)*	*7 (0–95)*	*45 (24–68)*

Sample	Covariate	Outcome: Education	Memory	Vocabulary	Cognitive
HRS					
	African American	−1.44 (0.07)	−1.66 (0.08)	−1.52 (0.07)	−1.87 (0.07)
Pooled[a]	Age	−0.06 (0.00)	−0.15 (0.00)	−0.02 (0.01)	−0.02 (0.01)
	VPC	*5 (3–8)*	*1 (1–2)*	*5 (3–8)*	*3 (2–5)*
African Americans	Age	−0.12 (0.01)	−0.16 (0.01)	0.00 (0.02)	−0.03 (0.02)
	VPC	*13 (8–21)*	*2 (1–6)*	*12 (6–21)*	*7 (3–15)*
Whites	Age	−0.05 (0.00)	−0.16	−0.03	−0.02 (0.01)
	VPC	*5 (3–7)*	*1 (1–2)*	*5 (3–8)*	*3 (1–5)*
HRS, restricted to residents with the states of school attendance as WHICAP states					
	African American	−1.44 (0.07)	−1.67 (0.09)	−1.52 (0.07)	−1.87 (0.08)
Pooled[a]	Age	−0.07 (0.00)	−0.15 (0.00)	−0.02 (0.01)	−0.02 (0.01)
	VPC	*6 (4–19)*	*1 (1–2)*	*5 (3–8)*	*3 (2–6)*
African Americans	Age	−0.12 (0.01)	−0.16 (0.01)	0.00 (0.02)	−0.03 (0.02)
	VPC	*13 (8–22)*	*2 (1–6)*	*12 (6–22)*	*7 (3–15)*
Whites	Age	−0.05 (0.00)	−0.15 (0.00)	−0.02 (0.01)	−0.02 (0.01)
	VPC	*5 (3–8)*	*1 (1–2)*	*5 (3–8)*	*3 (2–5)*
HRS, restricted to respondents who stayed in their states of school attendance					
	African American	−1.38 (0.12)	−1.68 (0.11)	−1.51 (0.09)	−2.03 (0.10)
Pooled[a]	Age	−0.06 (0.00)	−0.15 (0.00)	−0.02 (0.01)	−0.02 (0.01)
	VPC	*6 (3–9)*	*2 (1–3)*	*7 (4–12)*	*4 (2–7)*
African Americans	Age	−0.13 (0.01)	−0.16 (0.01)	−0.03 (0.02)	−0.04 (0.03)
	VPC	*14 (8–25)*	*2 (1–7)*	*20 (10–35)*	*8 (3–20)*
Whites	Age	−0.05 (0.00)	−0.15 (0.00)	−0.02 (0.01)	−0.02 (0.01)
	VPC	*5 (3–9)*	*2 (1–3)*	*7 (4–12)*	*4 (2–7)*
HRS, restricted to respondents who moved from their state of school attendance					
	African American	−1.74 (0.11)	−1.87 (0.13)	−1.77 (0.10)	−1.81 (0.11)
Pooled[a]	Age	−0.07 (0.00)	−0.15 (0.00)	−0.02 (0.01)	−0.03 (0.01)
	VPC	*5 (3–7)*	*1 (0–2)*	*3 (1–5)*	*3 (1–5)*
African Americans	Age	−0.11 (0.01)	−0.15 (0.01)	0.03 (0.03)	−0.01 (0.03)
	VPC	*14 (7–24)*	*4 (2–11)*	*5 (1–19)*	*11 (4–29)*
Whites	Age	−0.06 (0.00)	−0.15 (0.01)	−0.03 (0.01)	−0.03 (0.01)
	VPC	*3 (2–5)*	*0 (0–2)*	*3 (1–5)*	*2 (1–4)*

[a]Race is included as a covariate in the pooled models. Gender and linear and quadratic terms for age were included in all models.

Table 3. Range of predicted state-level average outcomes by race, census region and study sample

Sample	No. states	Education	Memory	Language	Speed	Visual-spatial
WHICAP African Americans[a]						
Northeast	5	10.8–12.7	0.4–1.0	0.4–0.6	0.4–0.8	0.4–0.6
Midwest	8	11.1–13.1	0.3–1.0	0.3–0.6	0.5–0.6	0.3–0.4
South	17	10.1–13.0	−0.1–1.1	0.0–0.5	0.1–0.6	0.1–0.4
West	2	11.8–12.5	0.6–1.0	0.3–0.5	0.4–0.4	0.3–0.4
WHICAP whites[b]						
Northeast	8	13.7–14.3	0.3–0.5	0.7–1.0	0.9[b]	0.6–0.8
Midwest	6	13.4–14.8	0.2–0.5	0.7–1.0	0.9[b]	0.6–0.8
South	15	12.8–14.1	0.0–0.4	0.2–1.0	0.9[b]	0.2–0.9
West	5	13.7–14.3	0.3–0.4	0.8–1.0	0.9[b]	0.6–0.7
Sample	No. States	Education	Memory	Vocabulary	Cognitive	
HRS African Americans[c]						
Northeast	9	11.5–12.7	9.0–9.8	4.4–5.8	9.4–10.4	
Midwest	12	11.5–13.2	9.0–9.5	4.7–5.4	9.4–10.4	
South	17	9.2–12.6	8.2–9.4	3.3–5.3	8.4–10.3	
West	13	10.8–12.8	8.9–9.2	4.4–5.4	9.3–10.4	
HRS whites						
Northeast	9	12.1–13.1	10.6–11.4	5.9–6.2	11.3–11.8	
Midwest	12	12.2–13.2	10.5–11.3	5.8–6.3	11.4–11.7	
South	17	11.4–13.3	10.3–11.4	5.0–6.3	10.6–11.6	
West	13	12.3–13.3	10.8–11.4	6.9–6.7	11.1–11.6	

[a]The number of states represented in the speed in the WHICAP sample was smaller than for the other outcomes (7 in the NE, 6 in the Midwest, 9 in the South, and 4 in the West for the white subsample; and 5 in the NE, 6 in the Midwest, 16 in the South, and 1 in the West for the African American subsample).
[b]The state of school attendance accounted for no variation for the speed outcome among whites in WHICAP.
[c]The number of states represented in the general cognitive status outcome in the HRS African Americans sample was smaller than for the other outcomes (5 in the NE, 9 in the Midwest, 17 in the South, and 8 in the West).

variance for whites. The same pattern of larger VPC for the models with the African American sample was noted in the models restricted to HRS respondents from WHICAP states and for HRS respondents who were movers and stayers.

When the HRS sample was restricted to respondents who lived in states with WHICAP representation, the percentage of variance explained by geography was similar to the estimate obtained from the whole HRS sample (e.g., 5% in the full HRS sample for education *vs.* 6% in the HRS sample restricted to WHICAP state representation). While the variance explained by state of school attendance was similar for the HRS respondents who moved compared to those who stayed for most outcomes, there was one notable exception. Conditional on age and gender, vocabulary was more correlated within childhood state of residence for African Americans in the HRS sample who stayed compared to those who moved (20% with 95% CI [10-35% *vs.* 5%] with 95% CI [1-19%]).

The empirical Bayes estimates for average cognitive outcomes in each state varied substantially, indicating state level influences, across all Census regions, the range of state-level estimates for African Americans was larger than the range for whites in the HRS samples (Table 3). In the HRS African American sample, the empirical Bayes estimate of state-average general cognitive score for those who attended school in the South ranged from 8.4–10.3 compared to a range of 10.6–11.6 for whites in the Southern states.

Random Slope Models

Results from the random slope models indicated racial disparities in education and cognitive outcomes prevailed in nearly every state for both the WHICAP and the HRS sample (Figure 1). In WHICAP, there was substantial variation in the magnitude of disparities in years of education across states (from less than 1 year to over 3 years), but little variation in the magnitude of disparities in Language, Speed, or Visual-spatial scores across states. In HRS, there were large between-state differences in the magnitude of racial disparities in education and all three cognitive outcomes (Figure 1).

DISCUSSION

Our study used two cohorts of older African American and white adults to assess the role of state of school attendance in explaining variation in older age cognitive function. We examined three domains of cognitive functions (i.e., general cognitive status, memory, and vocabulary) in the HRS sample and four domains (i.e., memory, language, processing speed, and visual-spatial ability) in the WHICAP sample. We found a sizable proportion of the variability in different domains of late-life cognitive function was associated with state of school attendance among African Africans. The estimated role of state of school attendance in cognitive

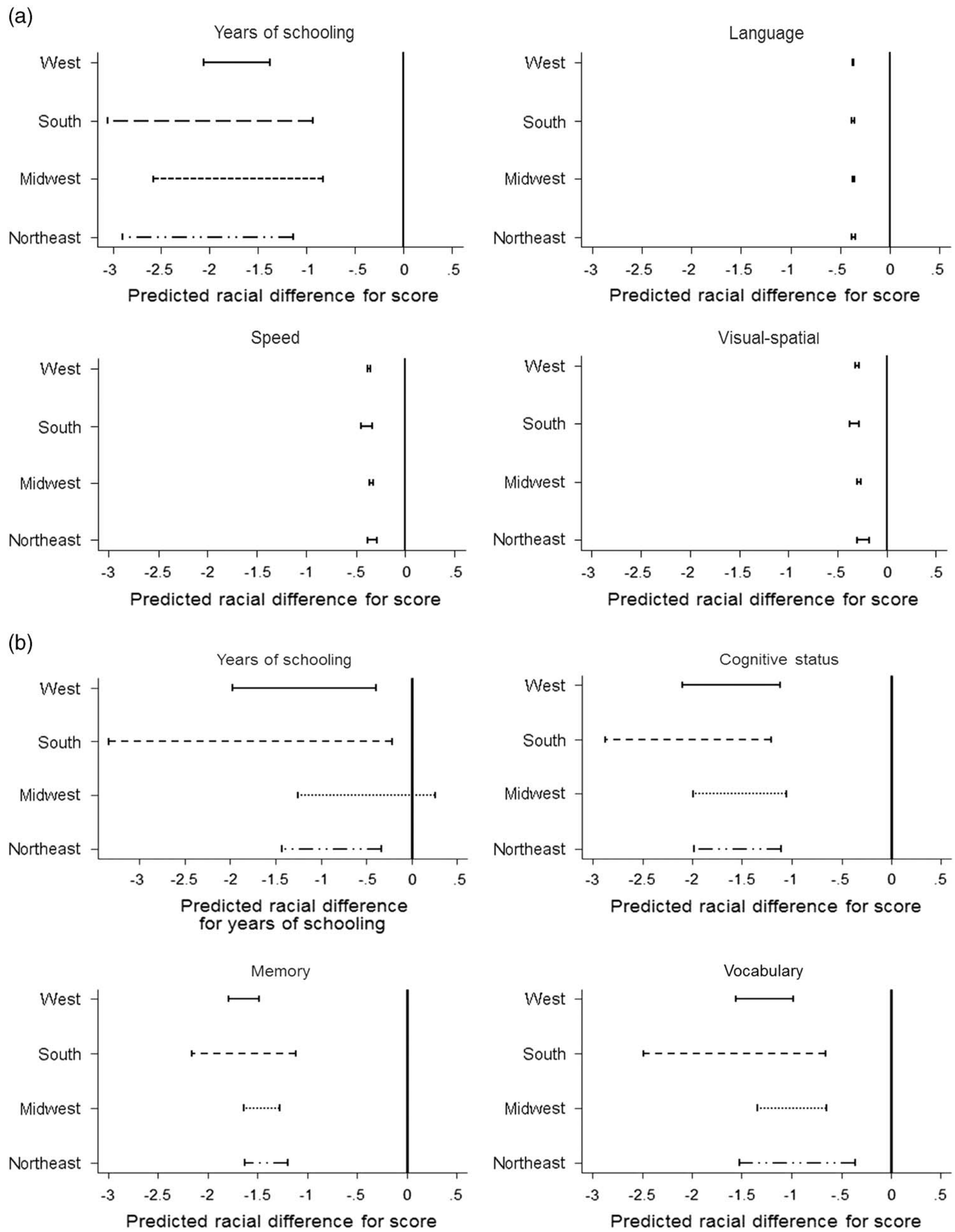

Fig. 1. Range of predicted state-level African American-white difference in years of schooling and cognitive outcomes by Census region and study sample[e]. [e]Solid line depicts the predicted racial difference for the states in the West, the dashed lines for the states in the South, the dotted lines for the states in the Midwest and the lines with the dots and dashes are for the states in the Northeast. **A:** WHICAP sample. **B:** HRS sample.

outcome for older white adults was less consistent, smaller than for African American adults in the HRS cohort and larger in the WHICAP cohort. For both datasets and across cognitive outcomes, individuals who resided in Southern states in childhood averaged the worst cognitive outcomes. The gap in test performance between African Americans and whites also varied significantly by state of school attendance, with some states having much larger disparities than others. These results suggest historical and area-level characteristics (e.g., segregation policies) of childhood residence may be associated with years of completed education and late-life cognitive outcomes, particularly for African Americans.

According to our results, state of childhood residence explained 2–12% of the variance in our HRS sample and 0–45% in the models using the WHICAP sample depending on measure and the subpopulation. In general, we do not expect very high percentages of variance in a complex outcome such as cognition to be explained by state of childhood residence. Nonetheless, the percentages of variance explained by these minimal measures strongly indicates the importance of contextual variables that prevailed in childhood in shaping old age cognitive outcomes and African American-white disparities. As a point of comparison, we calculated the Level-1 R^2 (Snijders & Bosker, 1994), the total amount of explained variance, in models with only age as a covariate. In our models, the range of explained variance by state of childhood residence is similar to the variance explained by age, a well-known contributor to cognitive measures in older ages (Appendix Table 1). For language, R-squared for the age-adjusted model was 11% in the pooled WHICAP sample (Appendix Table 1) compared to the 14% variance explained by state of childhood residence in the pooled WHICAP sample (Table 2).

Differences in the results from the WHICAP and the HRS sample may reflect sample compositional and selection effects. Results from the sensitivity analyses in which the HRS sample was restricted to respondents who moved to a census region different from their region of birth were similar to the results using the entire HRS sample and differed from the results in the WHICAP sample. This suggests restricted range in childhood and current residence underlies the differential impact of childhood residence on cognitive function by race in the WHICAP versus the HRS sample. The larger VPC from the models with the WHICAP sample compared to estimates from the HRS sample may reflect the difference between using a geographically localized sample and a geographically dispersed sample.

WHICAP is a geographically localized community-based study sample. In WHICAP, everyone was either born in New York or else migrated to New York, and the cohort was drawn only from neighborhoods within Northern Manhattan. In contrast, HRS is a geographically dispersed, national analytical sample and thus has a broader range of childhood and current residential experiences than WHICAP. The white WHICAP respondents differed from the African American WHICAP respondents and from the white HRS sample in several sociodemographic characteristics. For example, only 4% of the white WHICAP respondents were from the South compared to 34% of the African American WHICAP respondents and 30% of the white HRS sample. More research is needed to identify the characteristics of the white WHICAP sample that distinguishes them from the African American WHICAP sample and the white HRS sample and whether such characteristics may contribute to the differences noted.

The subsample with the largest percentage of variance explained by state of childhood residence was the African Americans in the HRS cohort. The likely explanation for these differences is that: (1) the variability in the states (and thus educational opportunities and experiences) where African Americans were born in HRS has a much greater impact among African Americans than among whites, and (2) African Americans born in the South in HRS are more likely to currently live in the South than among WHICAP participants (where currently none live in the South), and continued residence in the South has a greater impact on educational experiences among African Americans than among whites.

We hypothesize local educational experiences may be an important mechanism driving the regional racial disparities in cognitive measures that we find in our study. The educational experience differed dramatically for African American and white children in much of the United States in the first half of the 20th century. State of school attendance is a crude proxy for experiences that were substantially heterogeneous within states and smaller geographical areas (i.e., counties, districts). Before *Brown vs. Board of Education* in 1954, schools in the South were racially segregated with African American schools on average receiving fewer resources (e.g., shorter school term length, higher pupil-teacher ratio) than schools for white students (Card & Krueger, 1992a, 1992b). Given the higher percentage of older African American adults in our study who report a Southern state of birth or state of school attendance, it is highly probable that many of the African American adults in our study had an educational experience of lower quality than their white peers. Improvements in various school quality indicators after *Brown vs. Board of Education* have been shown to be associated with improvements in adult health and socioeconomic outcomes (Frisvold & Golberstein, 2010; Johnson, 2011). Recently, self-reported educational quality has been shown to explain a significant amount of variation in the neurocognitive performance of a community-based sample of African Americans and non-Hispanic white Americans (Sayegh, Arentoft, Thaler, Dean, & Thames, 2014). Similarly, in a small sample of older African Americans and whites raised in Alabama, county-level measures of school quality predicted cognitive test performance (Crowe et al., 2013). These results suggest school quality is one plausible mechanism that may account for the variation due to state of school attendance and its differences according to racial group. Historical racial differences in school quality and the educational experience may have systematically disadvantaged African Americans.

Geography may contribute to inequality of opportunity both in the short- and long-term. Other state-level policies that differed by race due to *de jure* segregation (e.g., socioeconomic opportunity) may have also contributed to the patterns we report. These differences associated with state of childhood residence may have long-term effects *via* multiple pathways. For example, African Americans from the South and from areas with lower per-capita income may be more likely to have low socioeconomic trajectories with respect to income and occupation, which may in turn contribute to poor cognitive outcomes in later life. Further research is needed to examine the interplay between state-level contextual conditions in childhood and individual-level characteristics throughout the lifecourse leading to poor cognitive health in later life.

This study has several limitations. Although state of school attendance largely coincides with states where children attended school, it does entail some misclassification (Card & Krueger, 1992b). In addition, there may be selection bias due to survival, frequently a concern in studies of racial disparities in older adults. African Americans have higher mortality rates than whites throughout most of their life course, except at older ages when a racial mortality crossover occurs such that the oldest African Americans have lower mortality risk than whites of the same age (Corti et al., 1999; Johnson, 2000; Yao & Robert, 2011). Since African Americans are more likely to die at younger ages, surviving elderly African Americans may be the most resilient members of their birth cohort. There are also limitations associated with cognitive assessments used by HRS and WHICAP. While both WHICAP and HRS used measures assessing a range of cognitive domains (with substantially more comprehensive cognitive assessments in WHICAP), neither study used an exhaustive neuropsychological battery.

For example, assessment of working memory attention, and executive function was limited in both studies. It is possible that the effects of geographic region on cognition are underestimated in this analysis because these domains were not thoroughly covered by the cognitive assessment batteries in HRS and WHICAP. In addition, the cognitive assessment measures in the HRS study differed from those used in WHICAP, making it difficult to combine or directly compare the results in the two cohorts. Finally, the generalizability of our study results remains an open question. Our study sample consisted of a cohort of African Americans and whites who lived through *de jure* segregation era. While the macro-level processes that contribute to inequalities are no longer legal, the micro-level experiences of inequality in school resources and school quality may still persist. The reality of social and economic disadvantage and residential segregation in an era of *de facto* segregation still results in significant racial disparities in the educational experience. Further research should investigate whether variability in cognitive performance attributed to state of childhood residence changes across cohorts. Despite these limitations, this study had notable strengths including the use of two separate datasets and several cognitive measures. The limitations outlined above also do not fundamentally change the implications of our findings.

While cardiovascular risk factors and health behaviors have been widely studied as contributors to racial disparities in cognitive performance (Izquierdo-Porrera & Waldstein, 2002), few studies have examined childhood environment as a potential source of variance in late-life cognitive function. An emerging body of work suggests that the geographic context in which people live may be related to their level of later-life cognitive functioning (Glymour, Avendano, & Berkman, 2007; Obisesan et al., 2000). Our study suggests that the geography of our childhood may be associated with late-life cognition and that these differences may contribute to racial disparities in cognitive aging. We hypothesized that the major mechanisms by which childhood geography influences cognitive outcomes related to schooling. Therefore, outcomes most closely related to schooling would be most associated with place of birth. Among the cognitive measures we used, vocabulary and language, which are associated with literacy, are most likely to be influenced by place of schooling and educational quality. Indeed, the correlation between years of education and cognitive outcomes is strongest for education and vocabulary and education and language, consistent with this hypothesis (results not shown). Further research is needed to better understand the factors associated with geography which may be responsible for these patterns and whether such factors are amenable to long-term interventions.

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REFERENCES

Anderson, J.D. (1988). *The education of blacks in the South, 1860-1935*. Chapel Hill: University of North Carolina Press.

Ashendorf, L., Jefferson, A.L., Green, R.C., & Stern, R.A. (2009). Test–retest stability on the WRAT-3 reading subtest in geriatric cognitive evaluations. *Journal of Clinical and Experimental Neuropsychology*, *31*(5), 605–610.

Benton, A.L. (1955). *The Benton Visual Retention Test*. New York: The Psychological Corporation.

Benton, A.L. (1974). *Revised Visual Retention Test* (4th ed.). New York: The Psychological Corporation.

Benton, A.L., & Hamsher, K.d. (1976). *Multilingual Aphasia Examination*. Iowa City, IA: University of Iowa.

Blessed, G., Tomlinson, B.E., & Roth, M. (1968). The association between quantitative measures of senile change in the cerebral grey matter of elderly subjects. *British Journal of Psychology*, *114*, 797–811.

Brand, C. (1987). Intelligence-testing - Bryter Still and Bryter. *Nature*, *328*(6126), 110.

Brandt, J., Spencer, M., & Folstein, M. (1988). The telephone interview for cognitive status. *Neuropsychiatry, Neuropsychology, & Behavioral Neurology*, *1*(2), 111–117.

Buschke, H., & Fuld, P.A. (1974). Evaluating storage, retention, and retrieval in disordered memory and learning. *Neurology*, *24*, 1019–1025.

Card, D., & Krueger, A.B. (1992a). Does school quality matter? Returns to education and the characteristics of public schools in the United States. *The Journal of Political Economy*, *100*(1), 1–40.

Card, D., & Krueger, A.B. (1992b). School quality and black-white relative earnings: A direct assessment. *The Quarterly Journal of Economics*, *107*(1), 151–200.

Corti, M.C., Guralnik, J.M., Ferrucci, L., Izmirlian, G., Leveille, S.G., Pahor, M., … Havlik, R.J. (1999). Evidence for a black-white crossover in all-cause and coronary heart disease mortality in an older population: The North Carolina EPESE. *American Journal of Public Health*, *89*(3), 308–314.

Crowe, M., Clay, O.J., Martin, R.C., Howard, V.J., Wadley, V.G., Sawyer, P., & Allman, R.M. (2013). Indicators of childhood quality of education in relation to cognitive function in older adulthood. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *68*(2), 198–204.

D'Elia, L.F., Satz, P., Uchiyama, C.L., & White, T. (1994). *Color Trails Test Professional Manual*. Odessa, FL: Psychological Assessment Resources.

Fang, J., Madhavan, S., & Alderman, M.H. (1996). The association between birthplace and mortality from cardiovascular causes among black and white residents of New York City. *New England Journal of Medicine*, *335*(21), 1545–1551.

Folstein, M., Folstein, S., & McHugh, P. (1975). "Mini-mental state": A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *12*, 189–198.

Frisvold, D., & Golberstein, E. (2010). School quality and the education - health relationship: Evidence from Blacks in segregated schools. *Journal of Health Economics*, *30*(6), 1232–1245.

Glymour, M.M., Avendano, M., & Berkman, L. (2007). Is the 'stroke belt' worn from childhood?: Risk of first stroke and state of residence in childhood and adulthood. *Stroke*, *38*, 2415–2421.

Glymour, M.M., & Manly, J. (2008). Lifecourse social conditions and racial and ethnic patterns of cognitive aging. *Neuropsychology Review*, *18*(3), 223–254.

Goodglass, H., & Kaplan, D. (1983). *The assessment of aphasia and related disorders* (2nd ed.). Philadelphia: Lea and Febiger.

Greenberg, M., & Schneider, D. (1992). Region of birth and mortality of blacks in the United-States. *International Journal of Epidemiology*, *21*(2), 324–328.

Gurland, B., Golden, R.R., Teresi, J., & Challop, J. (1984). The SHORT-CARE: An efficient instrument for the assessment of depression, dementia, and disability. *Journals of Gerontology*, *39*, 166–169.

Heeringa, S.G., & Connor, J. (1995). *Technical description of the Health and Retirement Study sample design* (HRS/AHEAD Documentation Report No. DR-002). Ann Arbor, MI: Survey Research Center, University of Michigan.

Hobbs, F., & Stoops, N. (2002). Demographic trends in the 20th century. In C. Bureau (Ed.), *Census 2000 special reports, series CENSR-4*. Washington, DC: U.S. Government Printing Office.

Howard, V.J., Kleindorfer, D.O., Judd, S.E., McClure, L.A., Safford, M.M., Rhodes, J.D., … Howard, G. (2011). Disparities in stroke incidence contributing to disparities in stroke mortality. *Annals of Neurology*, *69*(4), 619–627.

Izquierdo-Porrera, A.M., & Waldstein, S.R. (2002). Cardiovascular risk factors and cognitive function in African Americans. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *57*(4), P377–P380.

Johnson, N. (2000). The racial crossover in comorbidity, disability, and mortality. *Demography*, *37*(3), 267–283.

Johnson, R.C. (2011). *Long-run impacts of school desegregation & school quality on adult attainments*. NBER Working Paper 16664. Cambridge, MA: National Bureau of Economic Research.

Kaplan, E., Goodglass, H., & Weintraub, S. (1983). *Boston Naming Test*. Philadelphia, PA: Lea & Febiger.

Lemann, N. (1991). *The promised land: The great black migration and how it changed America*. New York: AA Knopf.

Manly, J.J., Bell-McGinty, S., Tang, M.X., Schupf, N., Stern, Y., & Mayeux, R. (2005). Implementing diagnostic criteria and estimating frequency of mild cognitive impairment in an urban community. *Archives of Neurology*, *62*, 1739–1746.

Margo, R.A. (1985). *Disenfranchisement, School finance, and the economics of segregated schools in the United States South, 1980-1910*. New York: Garland Publishing.

Margo, R.A. (1990). *Race and schooling in the South, 1880-1950: An economic history*. Chicago: University of Chicago Press.

Mattis, S. (1988). *Dementia Rating Scale: Professional manual*. Odessa, FL: Psychological Assessment Resources.

Mehta, K.M., Simonsick, E.M., Rooks, R., Newman, A.B., Pope, S.K., Rubin, S.M., & Yaffe, K. (2004). Black and white differences in cognitive function test scores: What explains the difference? *Journal of the American Geriatrics Society*, *52*(12), 2120–2127.

Morgan, A.A., Marsiske, M., & Whitfield, K.E. (2007). Characterizing and explaining differences in cognitive test performance between African American and European American older adults. *Experimental Aging Research*, *34*(1), 80–100.

Obisesan, T.O., Vargas, C.M., & Gillum, R.F. (2000). Geographic variation in stroke risk in the United States - Region, urbanization, and hypertension in the Third National Health and Nutrition Examination Survey. *Stroke*, *31*(1), 19–25.

Ofstedal, M.B., McAuley, G.F., & Herzog, A.R. (2002). *Documentation of cognitive functioning measures in the health and retirement study* (HRS/AHEAD Documentation Report). Ann Arbor, MI: Survey Research Center, University of Michigan.

Rosen, W. (1981). *The Rosen Drawing Test*. Bronx, NY: Veterans Administration Medical Center.

Sayegh, P., Arentoft, A., Thaler, N.S., Dean, A.C., & Thames, A.D. (2014). Quality of education predicts performance on the wide range achievement test-4th edition word reading subtest. *Archives of Clinical Neuropsychology*, *29*(8), 731–736.

Schneider, D., Greenberg, M.R., & Lu, L.L. (1997). Region of birth and mortality from circulatory diseases among black Americans. *American Journal of Public Health*, *87*(5), 800–804.

Schwartz, B.S., Glass, T.A., Bolla, K.I., Stewart, W.F., Glass, G., Rasmussen, M., … Bandeen-Roche, K. (2004). Disparities in cognitive functioning by race/ethnicity in the Baltimore Memory Study. *Environmental Health Perspectives*, *112*(3), 314–320.

Sellers, A.H., Burns, W.J., & Guyrke, J. (2002). Differences in young children's IQs on the Wechsler Preschool and Primary Scale of Intelligence-Revised as a function of stratification variables. *Applied Neuropsychology*, *9*(2), 65–73.

Siedlecki, K.L., Honig, L.S., & Stern, Y. (2008). Exploring the structure of a neuropsychological battery across healthy elders and those with questionable dementia and Alzheimer's disease. *Neuropsychology*, *22*, 400–411.

Siedlecki, K.L., Manly, J.J., Brickman, A.M., Schupf, N., Tang, M.X., & Stern, Y. (2010). Do neuropsychological tests have the same meaning in Spanish speakers as they do in English speakers? *Neuropsychology*, *22*, 402–411.

Sloan, F.A., & Wang, J. (2005). Disparities among older adults in measures of cognitive function by race or ethnicity. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *60*(5), P242–P250.

Snijders, T.A.B., & Bosker, R.J. (1994). Modeled variance in two-level models. *Sociological Methods & Research*, *22*(3), 342–363.

Stern, Y., Andrews, H., Pittman, J., Sano, M., Tatemichi, T., Lantigua, R., & Mayeux, R. (1992). Diagnosis of dementia in a heterogeneous population. Development of a neuropsychological paradigm-based diagnosis of dementia and quantified correction for the effects of education. *Archives of Neurology*, *49*, 453–460.

Tang, M.X., Cross, P., Andrews, H., Jacobs, D.M., Small, S., Bell, K., … Merchant, C., Mayeux, R. (2001). Incidence of Alzheimer's disease in African-Americans, Caribbean Hispanics and Caucasians in northern Manhattan. *Neurology*, *56*, 49–56.

Tolnay, S.E. (2003). The African American "Great Migration" and beyond. *Annual Review of Sociology*, *29*, 209–232.

Wallace, R.B., & Herzog, A. (1995). Overview of the health measures in the health and retirement study. *Journal of Human Resources*, *30*(Suppl.), S84–S107.

Wechsler, D. (1981). *Wechsler Adult Intelligence Scale-Revised*. New York, NY: The Psychological Corporation.

Wilkinson, G.S. (1993). *Wide Range Achievement Test 3 - administration manual*. Wilmington, DE: Jastak Associates, Inc.

Williams, W. (1998). Are we raising smarter children today? School and home influences on IQ. In U. Neisser (Ed.), *The rising curve: Long-term gains in IQ and related measures* (pp. 125–154). Washington, DC: American Psychological Association.

Yao, L., & Robert, S.A. (2011). Examining the racial crossover in mortality between African American and white older adults: A multilevel survival analysis of race, individual socioeconomic status, and neighborhood socioeconomic context. *Journal of Aging Research*, *2011*, 132073.