Published in final edited form as:

Psychol Aging. 2017 March ; 32(2): 118–130. doi:10.1037/pag0000154.

Socioeconomic, health, and psychosocial mediators of racial disparities in cognition in early, middle, and late adulthood

Laura B. Zahodne,
Department of Psychology, University of Michigan

Jennifer J. Manly,
Cognitive Neuroscience Division, Department of Neurology and Taub Institute for Research on Alzheimer's Disease and The Aging Brain, Columbia University

Jacqui Smith,
Department of Psychology and Institute for Social Research, University of Michigan

Teresa Seeman, and
Departments of Medicine and Epidemiology, University of California, Los Angeles

Margie Lachman
Department of Psychology, Brandeis University

Abstract

Racial disparities in cognitive performance exist across the life course, but it is not known whether mediators of disparities differ by age. Understanding sources of cognitive disparities at different ages can inform policies and interventions. Data were obtained for non-Hispanic Black and White respondents to The National Survey of Midlife Development in the United States (MIDUS-II) from three age groups: 28–44 (N=1210; 20% Black); 45–64 (N=2693; 15% Black), 65–85 (N=1298; 11% Black). Moderated mediation models characterized direct and indirect effects of race on episodic memory and executive function composite scores through economic, health, and psychosocial variables as a function of age group. Education, income, chronic health conditions, and external locus of control mediated cognitive disparities across the life course, though income was a stronger mediator at younger ages. Perceived discrimination was a weaker mediator among young adults due to an absence of racial differences in perceived discrimination in that group. Despite multiple indirect effects, there were still significant unexplained effects of race on cognition that were not moderated by age group. Interventional work is needed to determine whether increasing educational attainment and income, and reducing chronic health conditions and perceived constraints among Blacks, reduce cognitive disparities. Targeting income inequality and discrimination (or buffering the impact of those variables) may be differently effective at reducing cognitive disparities at different stages of the adult life course.

Keywords

African Americans; Memory; Executive functioning; Socioeconomic Status; Discrimination

Correspondence concerning this article should be addressed to Laura B. Zahodne, Department of Psychology, University of Michigan, 530 Church Street, Ann Arbor, MI 48109, lzahodne@umich.edu.

Racial disparities in cognitive test performance have been documented across the life course (Manly & Mungas, 2015). Much of the research on cognitive disparities in adulthood has focused on older adults, likely because cognitive impairment during late life is a major public health burden, and substantial effort has been made to obtain cognitive data on large, representative samples of racially diverse older adults. In these samples, older African Americans obtain lower scores on measures of global cognition than non-Hispanic Whites (Sloan & Wang, 2005; Castora-Binkley, Peronto, Edwards & Small, 2015). In studies that have examined specific cognitive domains, results indicate significant racial disparities across domains of episodic memory, semantic memory, executive functioning, working memory, perceptual speed, vocabulary, and visuospatial function. (Brewster et al., 2014; Liu, Glymour, Zahodne, Weiss & Manly, 2015; Sisco, et al., 2015; Wilson, Capuano, Sytsma, Bennett & Barnes, 2015).

Extant research suggests that racial disparities in cognitive outcomes are multiply determined. Specifically, evidence from disparate bodies of literature provides rationale for the overall hypothesis that poorer cognitive outcomes among African Americans may be linked to socioeconomic, physical health, and psychosocial factors. For example, African Americans in the U.S. attend fewer years of school, on average, compared to non-Hispanic Whites (Garibaldi 1997), and more years of schooling is causally related to better cognition decades later (Glymour, Kawachi, Jencks, & Berkman, 2008). Similarly, African American families' median income is approximately 60% as high as non-Hispanic White families' median income, a disparity that has remained unchanged since the 1960's (Bloome, 2014). Higher income is consistently associated with higher cognitive status in adulthood (Gonzalez, Tarraf, Bowen, Johnson-Jennings, & Fisher, 2013; Goveas et al., 2016). Accounting for racial differences in education and income has been shown to attenuate racial disparities in cognitive status (Mehta et al., 2004; Schwartz et al., 2004).

Cognitive disparities also appear to reflect underlying physical health disparities. For example, African Americans have a higher prevalence of diabetes (Chatterjee et al., 2014), hypertension (Ong, Cheung, Man, Lau, & Lam, 2007) and other cardiovascular diseases (Margellos, Silva, & Whitman, 2004) than non-Hispanic Whites. These health conditions, particularly when assessed in mid-life, are associated with poorer cognitive functioning (Harrison et al., 2014) via pathways such as cerebral hypoperfusion (Alosco et al., 2013). African Americans also exhibit higher body mass index (BMI) than non-Hispanic Whites across the life course (Flegal, Carroll, Ogden, & Johnson, 2002), and higher BMI has been linked to worse cognitive functioning (Gonzales et al., 2012; Kantarci et al., 2002).

Finally, recent work has highlighted the role of psychosocial factors in racial disparities in cognitive outcomes. For example, higher levels of external locus of control among African Americans compared to non-Hispanic Whites partially mediated racial disparities in cognitive training outcomes in the largest randomized controlled trial conducted to date (Zahodne et al., 2015). Specifically, African Americans are more likely than non-Hispanic Whites to perceive environmental constraints that limit control over life outcomes (Mirowsky & Ross, 2007; Ross & Mirowsky, 2013; Kelly, 2006), and more perceived constraints have been linked to lower cognitive performance later in life (Seeman, McAvay,

Merrill, Albert, & Rodin, 1996). In addition, African Americans perceive more daily discrimination (i.e., unfair treatment or personal rejection due to characteristics such as gender, race, or physical appearance) than non-Hispanic Whites (Barnes et al., 2004; Hausmann, Jeong, Bost, & Ibrahim, 2008). While the amount of race-related variance in cognitive performance that can be explained by this racial difference in perceived discrimination has not yet been demonstrated, perceived discrimination has been associated with worse cognition within African American adult samples (Thames et al., 2013; Barnes et al., 2012).

Using two large datasets (including the National Survey of Midlife in the United States) comprising adults aged 40–102, we recently demonstrated that the magnitude of racial disparities in cognitive function is smaller at older ages, likely due to selective survival (Zahodne, Manly, Azar, Brickman, & Glymour, 2016). However, it is not known whether the determinants of racial disparities also vary as a function of age. Different mediators of racial disparities at different phases of the adult life course may be expected given that patterns of interaction with different societal structures change over the adult life course, and the effects of different risk factors accumulate over time at different rates. Understanding sources of cognitive disparities across the life course can inform policies and interventions to reduce disparities. Specifically, it is possible that targeting different socioeconomic, health, and psychosocial factors at different ages may lead to a greater reduction of cognitive disparities. Unfortunately, research studies on cognitive disparities typically focus on only one potential mediator or category of mediators (e.g., cardiovascular health) in samples with a limited age range.

The current study adds to the literature in four important ways. First, we provide formal tests of whether certain variables (e.g., perceived discrimination) mediate cognitive disparities by quantifying race-related cognitive variance that is explained by each of the socioeconomic, physical health, and psychosocial factors. Second, we consider multiple potential mediators from these different classes of factors in the same model in order to clarify independent pathways involving inter-related variables (e.g., education versus income). Third, we focus on two domains of cognition, since domain-specific effects may hint at separable neural mechanisms. Finally, we include a broad range of ages (28–85) and formally test for moderation by age group to explore the possibility that cognitive disparities are differently determined across the adult life course.

The overall goal of the current project was to characterize the socioeconomic, physical health, and psychosocial mediators of African American-White disparities in episodic memory and executive function performance across three broad stages of the adult life course: early adulthood (ages 28–44), middle age (ages 45–64), and late life (ages 65–85). We hypothesized that socioeconomic variables (i.e., education, income) would similarly mediate cognitive disparities across age groups, based on evidence that socioeconomic conditions are a fundamental cause of disease, broadly defined (Link & Phelan, 1995). The theory of fundamental causes was developed to explain the persistent association between socioeconomic status (SES) and health despite dramatic changes in specific mechanisms linking SES and health (Phelan, Link & Tehranifar, 2010). According to the theory of fundamental causes, SES affects multiple disease outcomes through multiple pathways that

change over time because it is associated with flexible resources (e.g., knowledge, money, power, beneficial social connections) that can be used no matter what the risk and protective factors are in a given circumstance (Link & Phelan, 1995). We also hypothesized that health variables (i.e., number of chronic conditions, BMI) would more strongly mediate cognitive disparities later in life, when health conditions have accumulated, and the brain exhibits age-related vulnerability. Finally, we hypothesized that psychosocial variables (i.e., external locus of control, perceived discrimination) would more strongly mediate cognitive disparities in mid-life, when individuals and their families have high levels of interaction with societal structures such as the workplace, where race-related environmental constraints and discrimination are highly conspicuous.

Method

Data

Data for this cross-sectional study were drawn from the second wave of the National Survey of Midlife Development in the United States (MIDUS-II), including the Milwaukee oversample. MIDUS is a sample of non-institutionalized, English-speaking adults living in the 48 contiguous United States who were selected by random digit dialing and originally recruited between January 1995 and September 1996 (Brim, Ryff, & Kessler, 2004). The second wave of MIDUS (MIDUS-II), which took place between January 2004 and August 2005, was used in this study because it included a cognitive battery, as described below. During this period, an additional group of African Americans was recruited using a stratified area probability sample of households in Milwaukee County, Wisconsin. Census blocks were stratified by income.

Inclusion criteria for the current study were: (1) self-reported ethnicity of “non-Hispanic” and (2) self-reported race of either “White” or “Black/African American” at the time of MIDUS-II. If data on racial/ethnic identity were not available for the MIDUS-II visit (16 participants), responses to the race/ethnicity questions from the first wave of MIDUS were used. Note that Hispanics were not included due to low representation in MIDUS-II. For example, only 27 older adults self-identified as Hispanic. The final sample included 4,405 non-Hispanic Whites and 796 African Americans. Participants were separated into three groups representing major segments of the adult life course: early adulthood (i.e., ages ≤ 44), mid-life (i.e,. ages 45–64), and late life (i.e., ages ≥ 65). Characteristics of the sample are shown in Table 1. MIDUS was approved by the appropriate institutional review board, including informed consent. In addition, the current secondary data analysis was approved by the institutional review board of Columbia University Medical Center.

Cognitive Outcomes

Cognitive testing in MIDUS-II was carried out over the phone with the Brief Test of Adult Cognition by Telephone (BTACT; Lachman, Agrigoroaei, Tun, & Weaver, 2014). Previous exploratory and confirmatory factor analyses of the BTACT in MIDUS-II revealed that it comprises two, moderately correlated factors reflecting episodic memory and executive functioning (Lachman et al., 2010). The episodic memory factor comprised Immediate and Delayed recall trials from the Rey Auditory-Verbal Learning Test (Lezak, 1995; Rey, 1964).

The executive functioning factor comprised Category Fluency (Borkowski, Benton & Spreen, 1967; Tombaugh, Kozak & Rees, 1999), Digit Span Backward (Wechsler, 1997), Number Series (Salthouse & Prill, 1987; Schaie, 1996), the 30 Seconds and Counting Task (Lachman et al., 2010), in which participants counted backwards from 100 as quickly as possible for 30 seconds, and the Stop & Go Switch Task (Lachman et al., 2010), in which participants switch responses of "stop" and "go" to experimenter cues of "red" and "green." In a subset of 299 participants, the convergent validity of the BTACT was supported by significant correlations between individual BTACT test scores and scores obtained during a 90-minute in-person assessment with a comprehensive neuropsychological battery. Specifically, correlations ranged from r=.41 to r=.55 (Lachman et al., 2014). Composite scores for episodic memory and executive functioning were computed as mean z-scores within each domain in the overall sample. In the overall sample of the current study, these cognitive composites were significantly correlated (r=.44; p<.001).

Potential Mediators of Cognitive Disparities

Potential mediators of cognitive disparities were chosen from among socioeconomic, health, and psychosocial variables collected by MIDUS-II based on existing literature on cognitive disparities and findings of significant racial differences in the current sample. Bivariate correlations between the cognitive outcomes and each of the potential mediators described below are available in the Supplemental Table, where they are presented for the overall sample as well as by age group.

Socioeconomic—Socioeconomic status was indexed by two commonly used variables: education and income. Self-reported education was quantified as a 12-category variable ranging from "no school/some grade school" to "PhD, EdD, MD, DDS, LLB, LLD, JD, or other professional degree." Of particular relevance, a value of 5 corresponds to "graduated from high school," a value of 6 corresponds to "1 to 2 years of college, no degree yet," a value of 7 corresponds to "3 or more years of college, no degree yet," a value of 8 corresponds to "graduated from a 2-year college, vocational school, or associates degree," and a value of 9 corresponds to "graduated from a 4- or 5-year college, or bachelor's degree." Participants were asked to report annual household income in the last calendar year from all sources, including wages, pensions, social security, and government assistance. Prior to analysis, income was separated into quintiles with the following values: 0=income less than or equal to 20,000; 1=income between 20,001 and 41,250; 2=income between 41, 251 and 66,500; 3=income between 66,501 and 102,500; 4=income greater than 102,500. In the overall sample of the current study, education and income were significantly correlated (r=.37; p<.001).

Health—Physical health status was indexed by body mass index (BMI) and self-reported chronic conditions. BMI was calculated by dividing body weight in kilograms by height in meters squared. Self-reported chronic conditions was the number of the following 12 conditions: asthma/bronchitis/emphysema, joint/bone diseases, thyroid disease, urinary/ bladder problem, AIDS/HIV, lupus/autoimmune disorder, high blood pressure/hypertension, diabetes/high blood sugar, neurological disorder, stroke, ulcer, hernia. In the overall sample of the current study, BMI and number of chronic conditions were correlated (r=.22; p<.001).

Psychosocial—Psychosocial experiences were indexed by perceived discrimination and external locus of control. Perceived discrimination was quantified as the sum of 9 Likert-type items querying experiences of daily discrimination with the stem question, "How often on a day-to-day basis do you experience each of the following types of discrimination" (e.g., "You were treated with less respect than other people;" "People act as if they think you are dishonest") (Williams, Yu, Jackson, & Anderson, 1997; Essed, 1991). Scores can range from 9 to 36, with higher scores corresponding to greater perceived discrimination. In the current sample, reliability of these items was high (Cronbach's alpha = .92) and similar across racial groups (African American Cronbach's alpha = .93; non-Hispanic White Cronbach's alpha = .91). If participants report any of these experiences, they are then asked, "What was the main reason for the discrimination you experienced?" and are given the following options: age, gender, race, ethnicity or nationality, religion, height or weight, some other aspect of your appearance, physical disability, sexual orientation, or some other reason. Participants are allowed to identify more than one reason. For the 2,563 participants who reported experiencing discrimination, Table 2 shows the proportion within each age and race group who attributed their experiences to each reason. Participants reporting any discrimination experiences are also asked two questions assessing the impact of discrimination on a four-point Likert-type scale: "Overall, how much has discrimination interfered with you having a full and productive life" and "Overall, how much harder has your life been because of discrimination."

External locus of control was quantified with the Perceived Constraints subscale of the Perceived Control scale (Lachman & Weaver, 1998), which is the mean of 9 Likert-type items (e.g., "What happens in my life is often beyond my control;" "I sometimes feel I am being pushed around in my life"). Scores can range from 1 to 7, with higher scores corresponding to more external locus of control. In the overall sample of the current study, perceived discrimination and external locus of control were significantly correlated (r=.22; p<.001).

Statistical Analysis

Racial differences were described using t-tests for continuous variables and chi square tests for sex in SPSS version 22. Effect sizes were computed as Cohen's d for continuous variables and phi (equivalent to Pearson's r) for sex. Moderated mediation analyses (Preacher, Rucker & Hayes, 2007) were conducted separately for episodic memory and executive functioning with structural equation models in Mplus version 7.4 (Muthén & Muthén, 1998–2011). As shown in Figure 1, African American race was the binary exposure, episodic memory or executive functioning composite score was the outcome, and socioeconomic (i.e., education, income), health (i.e., BMI, number of chronic conditions), and psychosocial (i.e., daily discrimination, external locus of control) factors were simultaneous mediators. The cognitive composite was also regressed onto covariates (age in years, sex). In initial models, the exogenous, three-category variable of age group (i.e., young adulthood, midlife, late life) was allowed to moderate the indirect path (product of "a" and "b" paths in Figure 1) via interactions with the exposure (path "mod(a)" in Figure 1) and all mediators (path "mod(b)" in Figure 1), as well as the direct path (path "c" in Figure 1) via interactions with the exposure (path "mod(c)"). Final models were refined by

eliminating non-significant interactions, and significant interactions were probed graphically. Model fit was evaluated with the following commonly used fit indices: comparative fit index (CFI), root-mean-square error of approximation (RMSEA), and standardized root-mean square residual (SRMR). Both RMSEA and SRMR range from 0 to 1 with lower values indicating better fit; CFI values range from 1 to 0 with higher values indicating better fit. CFI > 0.95, RMSEA < 0.06, and SRMR < 0.05 were used as criteria for adequate model fit (Hu & Bentler, 1999).

Results

Racial Differences

Racial differences are shown in Table 1. Racial differences in cognitive performance were significant in all age groups. Across age groups, cognitive disparities were more apparent in the executive function composite, as compared to the episodic memory composite. A repeated measures analysis of variance confirmed that this racial difference was significantly larger for executive functioning, compared to episodic memory ($F(1,4220) = 83.0$; $p < .001$). Significant racial differences were identified for all of the potential mediators of cognitive disparities across all age groups, with the exception of a non-significant difference in perceived discrimination between African American and non-Hispanic White young adults. As shown in Table 2, African Americans in all age groups were more likely than non-Hispanic Whites to attribute their experiences to their race, ethnicity or nationality. Non-Hispanic Whites in all age groups were less likely to identify a reason for their experiences, as evidenced by significant racial differences in the proportion of "refused" responses. In addition, African Americans in all age groups were more likely to affirm the perception that discrimination interfered with their ability to have a full and productive life (all p's < .001) and that life has been harder because of discrimination (all p's < .001).

In the young adult group, the largest racial differences were in education and income, followed by BMI. In the middle-aged group, the largest racial difference was in income, followed by education, BMI, chronic conditions, and daily discrimination. In the late-life group, the largest racial difference was in education, followed by daily discrimination. Overall, racial differences were most consistent (i.e., all effect sizes above Cohen's d of 0.3) in the middle-aged group, although the largest effect sizes for individual variables (i.e., education and income) were observed in young adulthood.

Moderated Mediation Models

Results from tests of direct and indirect effects of race on the cognitive outcomes are shown in Table 3. Compared to non-Hispanic Whites, African Americans scored lower on both episodic memory and executive functioning composites, independent of age and sex. Direct effects of African American race on both cognitive outcomes (path "c" in Figure 1) remained significant after accounting for the socioeconomic, health, and psychosocial mediators. There was no evidence that age group moderated the direct effects of race (path "mod(c)" in Figure 1) on episodic memory or executive functioning.

As shown in Table 3, indirect effects (i.e., products of “a” and “b” paths in Figure 1) of African American race through education, income, and external locus of control were significant and independent for both cognitive outcomes. Specifically, African Americans reported lower education, lower income, and higher external locus of control than non-Hispanic Whites. In turn, lower education, lower income, and higher external locus of control were each independently associated with lower scores on the episodic memory and executive functioning composites. An additional indirect effect through chronic conditions was significant for executive functioning, such that African Americans reported more chronic conditions than non-Hispanic Whites, and more chronic conditions was associated with worse executive functioning performance.

Age group moderation of each specific indirect effect was tested via interactions between African American race and the mediators (“mod(a)” paths in Figure 1) and interactions between the mediators and cognition (“mod(b)” paths in Figure 1). For both cognitive outcomes, significant moderation was only identified via “mod(a)” paths. Specifically, there were significant interactions between age group and African American race in the prediction of income (episodic memory model estimate = 0.437; SE = 0.073; $p < 0.001$; executive functioning model estimate = 0.439; SE = 0.261; $p < 0.001$) and daily discrimination (episodic memory model estimate = 0.789; SE = 0.261; $p = 0.003$; executive functioning model estimate = 0.812; SE = 0.261; $p = 0.002$). In other words, the strength of associations between African American race and these variables (“a” paths in Figure 1) differed by age group. These age group differences can be appreciated by comparing racial differences in income and daily discrimination across age groups in Table 1. For income, racial differences were largest in young adulthood, smaller in middle age, and smallest at older ages. These racial differences in income were significant for all age groups. For daily discrimination, racial differences were significant for middle-aged and older adults, but not younger adults.

In contrast, strength of associations between the mediators and cognition did not differ by age group, as evidenced by no significant “mod(b)” paths. Therefore, the following “b” path results are reported for the entire sample. Irrespective of age, higher income was independently associated with better episodic memory (estimate = 0.033; SE = 0.012; $p = 0.006$) and executive functioning (estimate = 0.054; SE = 0.011; $p < 0.001$), but daily discrimination was not independently associated with episodic memory (estimate = −0.001; SE = 0.003; $p = 0.791$) or executive functioning (estimate = −0.006; SE = 0.003; $p = 0.069$).

Figure 2 plots the specific indirect effects of African American race on cognition through income and daily discrimination for each age group. These indirect effects represent the product of “a” and “b” paths in Figure 1. As shown, income significantly mediated racial disparities in both cognitive outcomes in all three age groups, as evidenced by the non-inclusion of “0” in the 95% confidence interval around all of the indirect effects plotted in Figure 2. Indeed, both “a” and “b” paths involving income were significant for both cognitive outcomes as noted above. The slopes of the lines in Figure 2 correspond to the significant age group moderation of the specific indirect effects as described above. As shown, indirect effects through income were significantly stronger (i.e., more negative) in younger age groups due to the larger racial differences in income in these groups (i.e., stronger “a” paths).

As shown in Figure 2, daily discrimination was not a significant mediator of racial disparities in either cognitive outcome in any age group, as evidenced by the inclusion of 0 in the 95% confidence interval around the indirect effects. Indeed, “b” paths involving daily discrimination, which constitute half of the indirect effects, were not significant for either cognitive outcome as noted above. The slopes of the lines in Figure 2 correspond to the significant age group moderation of the specific indirect effects as described above. As shown, indirect effects through daily discrimination were significantly smaller (i.e., closer to 0) in young adulthood for both cognitive outcomes due to the absence of a racial difference in daily discrimination (i.e., non-significant “a” path) in this group, in addition to the lack of a significant association between daily discrimination and cognition that was observed in all age groups (i.e., non-significant “b” paths).

Discussion

The results of this cross-sectional study indicate that education, income, chronic health conditions, and external locus of control each significantly mediate racial disparities in cognition across the adult life course. However, the pattern and strength of several mediating relationships differed by age group and/or cognitive domain. Specifically, chronic health conditions only mediated racial disparities in executive functioning. Income was a stronger mediator of both episodic memory and executive functioning disparities in younger groups. In contrast, perceived discrimination was a weaker mediator among young adults, though the indirect effect of race on cognition through perceived discrimination did not reach significance for any age group. For both income and perceived discrimination, age group moderated racial differences in level of the mediator, but not associations between the mediator and cognitive outcomes.

Education

The finding that education at least partially mediated racial disparities in both cognitive domains across all age groups highlights the centrality of early-life educational experiences to later-life cognitive disparities. Lower mean educational attainment among African Americans, compared to non-Hispanic Whites, has been attributed to structural inequities (e.g., racial disparities in socioeconomic background) (Donovan, 1984; Keith & Benson, 1992; Reynolds, 1989), as well as differences in achievement beliefs. For example, African American youth are more likely to receive negative environmental messages about the value of academic persistence and their own capabilities, which can lead to negative achievement beliefs and lower educational attainment (Chavous et al., 2003). Because educational attainment is linked to such important resources as money, knowledge, prestige, power and beneficial social connections, educational disparities have profound effects on a wide range of physical and mental health outcomes that persist, and even accumulate, across the life course, as articulated in the theory of fundamental causes (Link & Phelan, 1995; Crystal & Shea, 1990). Education is also a source of cognitive stimulation, which may protect cognitive health independent of economic resources. For example, cognitive stimulation related to formal education could lead to improved strategy selection, increased neural efficiency, and/or structural and functional reorganization of brain networks (Barulli & Stern, 2013).

It should be noted that the importance of educational experiences to cognitive disparities was likely underestimated in this study because we only considered racial differences in educational quantity, and not educational quality. Research has shown that racial disparities in quality of schooling explain race-related variance in cognitive outcomes above and beyond years of school (Manly, Jacobs, Touradji, Small & Stern, 2002). This is because years of school is not an equivalent measure of educational experience across racial groups, as African Americans are more likely to have attended schools characterized by less funding, higher student/teacher ratios, fewer special facilities, and shorter school years than non-Hispanic Whites (Coleman, 1966; Hanushek 1989; Hedges, Laine, & Greenwald, 1994; O'Neill, 1990). These differences, in part, contribute to the observation that economic returns to education are lower for African Americans than for non-Hispanic Whites (Carliner, 1976). In addition to economic returns, these differences in educational quality may also affect the degree and/or quality of cognitive stimulation resulting from formal education for African Americans versus non-Hispanic Whites.

Income

Independent of education, income also partially mediated racial disparities in both cognitive domains across all age groups, in line with the theory of fundamental causes (Phelan, Link & Tehranifar, 2010), though these effects were stronger in younger groups due to a stronger association between race and income in younger adults. After age 65, many adults in the U.S. retire and begin to collect social security, which can reduce inter-individual and inter-group variability. Indeed, Table 1 shows that income variance in this study was smallest in the oldest age group. This restricted range may have contributed to the smaller role of income in mediating cognitive disparities in this study. Income may also play less of a role in late-life disparities due to Medicare, which allows more universal access to high quality health care for older adults in the U.S. Compared to income during late life, income during young adulthood and middle age may also be more reflective of occupational characteristics (e.g., physical versus cognitive demands), and research has consistently linked occupation to cognitive functioning (Ihle, Oris, Fagot, Maggiori, & Kliegel, 2015; Ribeiro, Lopes, & Lourenco, 2013). Importantly, the association between race and income was independent of education, which is consistent with the observation of lower economic returns to education for African Americans. Associations between income and both cognitive domains were also independent of education, suggesting that education and income likely contribute to cognitive health in unique ways (e.g., cognitive stimulation versus economic resources).

Physical Health

Consistent with the frequent observation that racial disparities in health are attenuated at later ages (Crimmins, Hayward, & Seeman, 2004; Kim & Miech, 2009; Zahodne et al., 2016), the racial difference in self-reported number of chronic conditions in this study was twice as large in young adulthood and middle age, as compared to late life (Cohen's d 0.4 versus 0.2). Similarly, racial differences in BMI were largest in young adulthood, smaller in middle age, and smallest but still significant in late life. This narrowing of health disparities at later ages is most frequently attributed to the higher mortality rate observed for African Americans, which results in a smaller, more highly selected subgroup of African Americans surviving to late life, compared to non-Hispanic Whites. By definition, survivors are hardier

(i.e., more physically and/or mentally resilient) than other members of their racial group who did not survive (Glymour, Weuve, & Chen, 2008; Johnson, 2000).

Both BMI and number of chronic conditions were higher among African Americans than non-Hispanic Whites in all age groups. Of these health variables, only number of chronic conditions mediated cognitive disparities, and this effect was specific to executive functioning. This specificity to the domain of executive functioning may be due to the larger racial difference in the executive functioning composite, compared to the episodic memory composite (i.e., 0.5 versus 1.0 standard deviation in the overall sample). It should also be noted that the chronic medical conditions variable, which summed the presence/absence of 12 chronic conditions, is a relatively coarse measure of health. It is possible that more precise, objective measures of chronic illness burden (e.g., blood pressure or an indicator of severity or length of disease) may have emerged as significant mediators of racial disparities in episodic memory performance. It is also possible that the executive functioning composite used in this study, which included timed tasks and working memory tasks, is more sensitive to chronic illness burden than the episodic memory composite, which included an untimed verbal word list learning task. In contrast to our hypothesis, we did not find that health variables were stronger mediators of cognitive disparities later in life. Rather, results suggest that chronic illness burden was similarly associated with worse executive functioning across adulthood.

External Locus of Control

Independent of socioeconomic status and physical health, external locus of control at least partially mediated racial disparities in both cognitive outcomes. In contrast to our hypothesis, these effects did not differ by age group. A previous study reported that greater external locus of control among older African Americans partially mediated racial disparities in cognitive benefits from memory and reasoning interventions (Zahodne et al., 2015). The current study extends these results to different cognitive outcomes (i.e., levels of episodic memory and executive functioning performance) in a wider age range (i.e., young adulthood to late life).

The extant literature suggests that African Americans exhibit more external locus of control due to experiences of inequity and racism, which can manifest in greater social and/or economic constraints among African Americans, leading to demoralization and fatalism (Mirowsky & Ross, 2007; Ross & Mirowsky, 2013; Kelly, 2006). For example, retrospective, self-reported attendance of a desegregated school, compared to a segregated school, in childhood was associated with greater external locus of control at age 58–74 in a sample of African Americans, presumably due to race-based discrimination in this setting (Wolinsky et al., 2012). Control beliefs have been linked to mid- and late-life cognitive performance in cross-sectional (Agrigoroaei & Lachman, 2011; Seeman, Rodin, & Albert, 1993; Lachman 1983; Lachman 1986; Lachman, Baltes, Nesselroade, & Willis, 1982), longitudinal (Seeman, McAvay, Merrill, Albert, & Rodin, 1996), and intervention (Rodin 1983; Langer, Rodin, Beck, Weinman, & Spitzer, 1979) studies. Greater external locus of control may interfere with cognitive performance by heightening anxiety, cognitive rumination, and/or self-doubt (Bandura 1989; Bandura & Wood, 1989; Wood & Bandura,

1989). It may also reduce the range of challenging activities in which one chooses to participate and/or one's perseverance in the face of difficulties (Bandura, 1981; Bandura, 1986; Bandura 1988), which could limit exposure to experiences that enrich cognitive capacity. Further research is needed to explore these potential pathways linking control beliefs to racial disparities in cognition across the life course.

Perceived Discrimination

Previous studies have shown that African Americans typically report higher levels of discrimination than non-Hispanic Whites (Barnes et al., 2004; Hausmann, Jeong, Bost, & Ibrahim, 2008), and this difference contributes to racial disparities in physical health (Gee, 2002; Williams, Neighbors, & Jackson, 2003; Williams et al., 1997; Brondolo et al., 2008; Lewis, Kravitz, Janssen, & Powell, 2011). The potential mechanism underlying an association between perceived discrimination and cognition (independent of physical health) is unclear, but it may involve depressed mood or stress-induced physiological changes (Barnes et al., 2012) and/or social forces that limit access to high-quality educational experiences and other resources important for cognitive health. Both Thames et al. (2013) and Barnes et al. (2012) found that associations between perceived discrimination and cognitive performance in African Americans were unique to domains of episodic memory and processing speed, which may point to the psychological impact of perceive discrimination as a likely mechanism since these cognitive domains are among those most frequently associated with depressive symptom severity (McDermott & Ebmeier, 2009). Indeed, associations between perceived discrimination and cognition in both Thames et al. (2013) and Barnes et al. (2012) were attenuated by the inclusion of a measure of depressive symptoms. In the current study of African Americans and non-Hispanic Whites, associations between perceived discrimination and cognitive domains of episodic memory and executive functioning did not reach significance (path "b" in Figure 1), and there was no evidence that these associations differed across age groups (path "mod(b)" in Figure 1).

A novel finding of this study was that the magnitude of the indirect effect of African American race on cognition (product of "a" and "b" paths in Figure 1) differed across age groups due to differences in the magnitude of racial disparities in perceived discrimination (path "a" in Figure 1). Specifically, the relatively smaller indirect effect of race on cognition through perceived discrimination in young adulthood reflected the fact that African American young adults in this study did not report significantly more daily discrimination than non-Hispanic White young adults. However, it should be noted that African Americans in all age groups reported that discrimination had a greater negative impact on their lives than did non-Hispanic Whites. The discrimination measure used in this and most previous studies queries discrimination experiences due to any reason (e.g., gender, age, body shape), and the reasons for discrimination differed across racial groups in this study. Interestingly, many non-Hispanic Whites declined to identify a reason for their experiences. Future work should explore racial differences in the experience of discrimination and how attributions affect associations between discrimination and health outcomes across racial groups.

Limitations, Strengths, and Directions for Future Research

A main limitation of this study is that it is cross-sectional. As such, it is not possible to disentangle age group from differences in the historical experiences of participants. For example, older adults in this study experienced the Civil Rights Movement of the 1950s and 1960s during young adulthood. In contrast, middle-aged adults experienced these events as children and adolescents, and young adults were born just after the end of the Civil Rights Movement. Therefore, it is not clear whether differences identified in this study reflect aging and life stage versus differential exposure to social and political events. However, it is noteworthy that most of the mediators examined in this study (i.e., education, chronic health conditions, and external locus of control) did not differ by age group. The cross-sectional design also disallows an examination of rate of cognitive change in addition to cognitive level. However, it should be noted that racial differences in rate of cognitive change in late life are much smaller than racial differences in cognitive level (Manly & Mungas, 2015). Therefore, the study of racial differences in cognitive level is most relevant to the issue of racial disparities in late-life cognitive health and dementia. Another important limitation of this study is that it did not include participants under age 28. Because racial differences in cognitive performance are measurable in childhood, and because early life experiences can have a significant impact on later-life health, future studies should address the question of age group differences in the mediators of cognitive disparities using data on children as well as adults.

Another limitation of this study is that it is not fully population-based. Separate recruitment strategies specifically designed to target African Americans in the Milwaukee area may have magnified or diminished certain differences between the two racial groups or influenced the role of mediators. Therefore, these results should be replicated in more representative, population-based studies of African Americans and non-Hispanic Whites in the U.S. It should also be noted that the sample included far fewer African Americans than non-Hispanic Whites (796 versus 4,405), which could be limiting statistical power. Another limitation is that this study only considered cognitive domains of episodic memory and executive functioning. Because racial disparities in cognition have been documented across cognitive domains, future research is needed to determine whether the mediators of these disparities differ for these other domains. For example, it is possible that different variables drive racial disparities in fluid versus crystallized abilities. Finally, this study used a brief, telephone-based cognitive battery rather than a comprehensive, in-person neuropsychological assessment due to resource limitations typical in this type of large-scale, national work. Results may have underestimated effects that may have been more easily detected with more sensitive cognitive measures. Similarly, quantification of other constructs (e.g., number of chronic conditions) was limited to relatively brief self-report questions that were asked over the phone. Future studies should employ rigorous measures to confirm the specificity of findings.

Strengths of this study include the large age range, consideration of multiple categories of potential mediators of disparities (i.e., socioeconomic, health, and psychosocial), inclusion of multiple indicators within each category, and evaluating two important cognitive domains. Despite multiple significant indirect effects, persistent unexplained effects of race on

cognition suggest that other factors that were not measured in this study (e.g., genetic risks or gene by environment interactions, social factors, specific medical conditions or disease processes) may also contribute to racial disparities in cognition.

Interventional work is needed to determine whether raising the average level of educational attainment, increasing income, reducing the number of chronic health conditions, and lowering perceived constraints among African Americans reduce cognitive disparities throughout the life course. Interventions specifically targeting income inequality and daily discrimination (or buffering the impact of those variables) may be differently effective at reducing racial disparities in cognition at different stages of the adult life course.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This study uses data from the Midlife Development in the United States (Ryff et al., 2012a; Ryff et al., 2012b), including the Milwaukee African American sample (Ryff et al., 2012c). Some of these data were used in a prior publication (Zahodne et al., 2016), but the ideas and analyses appearing in this manuscript have not previously been published or presented. This work was supported by the National Institute on Aging of the National Institutes of Health under Award Numbers P01AG020166 and K99AG047963. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

References

Agrigoroaei S, Lachman ME. Cognitive functioning in midlife and old age: Combined effects of psychosocial and behavioral factors. Journals of Gerontology: Psychological Sciences. 2011; 66B:i130–i140. DOI: 10.1093/geronb/gbr017

Alosco ML, Gustad J, Jerskey BA, Xu X, Clark US, Hassenstab J, Sweet LH. The adverse effects of reduced cerebral perfusion on cognition and brain structure in older adults with cardiovascular disease. Brain and Behavior. 2013; 3:626–636. [PubMed: 24363966]

Bandura, A. Self-referent thought: A developmental analyses of self-efficacy. In: Flavell, J., Ross, L., editors. Social cognitive development. Newark: Cambridge University Press; 1981. p. 200-239.

Bandura, A. Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice-Hall; 1986.

Bandura, A. Self-regulation of motivation and action through goal systems. In: Hamilton, V.Bower, GH., Frijda, NH., editors. Cognitive perspectives on emotion and motivation. Dordrecht, Netherlands: KJuwer Academic; 1988. p. 37-61.

Bandura A. Regulation of cognitive processes through perceived self-efficacy. Developmental Psychology. 1989; 25:729–735.

Bandura A, Wood RE. Effect of perceived controllability and performance standards on self-regulation of complex decision making. Journal of Personality and Social Psychology. 1989; 56:805–814. [PubMed: 2724068]

Barnes LL, Lewis TT, Begeny CT, Yu L, Bennett DA, Wilson RS. Perceived discrimination and cognition in older African Americans. Journal of the International Neuropsychological Society. 2012; 18:856–865. [PubMed: 22595035]

Barnes LL, Mendes De Leon CF, Wilson RS, Bienias JL, Bennett DA, Evans DA. Racial differences in perceived discrimination in a community population of older blacks and whites. Journal of Aging and Health. 2004; 16:315–337. [PubMed: 15155065]

Barulli D, Stern Y. Efficiency, capacity, compensation, maintenance, plasticity: emerging concepts in cognitive reserve. Trends in Cognitive Sciences. 2013; 17:5029–509.

Bloome D. Racial inequality trends and the intergenerational persistence of income and family structure. American Sociological Review. 2014; 79:1196–1225. [PubMed: 26456973]

Borkowski JG, Benton AL, Spreen O. Word fluency and brain damage. Neuropsychologia. 1967; 5:135–140.

Brewster PWH, Melrose RJ, Marquine MJ, Johnson JK, Napoles A, MacKay-Brandt A, Mungas D. Life experience and demographic influences on cognitive function in older adults. Neuropsychology. 2014; 28:846–858. [PubMed: 24933483]

Brim, O., Ryff, C., Kessler, R. How Healthy Are We? A National Study of Well-being at Midlife. Chicago: University of Chicago Press; 2004.

Brondolo E, Libby DJ, Denton EG, Thompson S, Beatty DL, Schwartz J, Sweeney M, Gerin W. Racism and ambulatory blood pressure in a community sample. Psychosomatic Medicine. 2008; 70:49–56. [PubMed: 18158368]

Carliner G. Returns to education for Blacks, Anglos, and five Spanish groups. The Journal of Human Resources. 1976; 11:172–184.

Castora-Binkley M, Peronto CL, Edwards JD, Small BJ. A longitudinal analysis of the influence of race on cognitive performance. Journals of Gerontology, Series B: Psychological and Social Sciences. 2015; 70:512–518.

Chatterjee R, Brancati FL, Shafi T, Edelman D, Pankow JS, Mosley TH, Selvin E, Yeh HC. Non-traditional risk factors are important contributors to the racial disparity in diabetes risk: the atherosclerosis risk in communities study. Journal of General Internal Medicine. 2014; 29:290–297. [PubMed: 23943422]

Chavous TM, Hilkene Bernat D, Schmeelk-Cone K, Caldwell CH, Kohn-Wood L, Zimmerman MC. Racial identity and academic attainment among African American adolescents. Child Development. 2003; 74:1076–1090. [PubMed: 12938705]

Coleman, J. Equality of educational opportunity. Washington, DC: Government Printing Office; 1966.

Crimmins, EM., Hayward, MD., Seeman, TE. Race/ethnicity, socioeconomic status, and health. In: Anderson, NB.Bulatao, RA., Cohen, B., editors. Critical Perspectives on Racial and Ethnic Differences in Health in Late Life. Washington, DC: National Academies Press; 2004.

Crystal S, Shea D. Cumulative advantage, cumulative disadvantage, and inequality among elderly people. The Gerontologist. 1990; 30:437–443. [PubMed: 2394380]

Donovan R. Path analysis of a theoretical model of persistence in higher education among low-income Black youth. Research in Higher Education. 1984; 21:243–259.

Essed, P. Understanding everyday racism. Newbury Park, CA: Sage; 1991.

Flegal KM, Carroll MD, Ogden CL, Johnson CL. Prevalence and trends in obesity among US adults, 1999–2000. Journal of the American Medical Association. 2002; 288:1723–1727. [PubMed: 12365955]

Garibaldi AM. Four decades of progress… and decline: an assessment of African American educational attainment. The Journal of Negro Education. 1997; 66:105–120.

Gee GC. A multilevel analysis of the relationship between institutional and individual racial discrimination and health status. American Journal of Public Health. 2002; 92:615–623. [PubMed: 11919062]

Glymour MM, Kawachi I, Jencks CS, Berkman LF. Does childhood schooling affect old age memory or mental status? Using state schooling laws as natural experiments. Journal of Epidemiology and Community Health. 2008; 62:532–537. [PubMed: 18477752]

Glymour MM, Weuve J, Chen JT. Methodological challenges in causal research on racial and ethnic patterns of cognitive trajectories: Measurement, selection, and bias. Neuropsychology Review. 2008; 18:194–213. [PubMed: 18819008]

Gonzales MM, Tarumi T, Eagan DE, Tanaka H, Vaghasia M, Haley AP. Indirect effects of elevated body mass index on memory performance through latered cerebral metabolite concentrations. Psychosomatic Medicine. 2012; 74:691–698. [PubMed: 22822230]

Gonzalez HM, Tarraf W, Bowen ME, Johnson-Jennings MD, Fisher GG. What do parents have to do with my cognitive reserve? Life course perspectives on twelve-year cognitive decline. Neuroepidemiology. 2013; 41:101–109. [PubMed: 23860477]

Goveas JS, Rapp SR, Hogan PE, Driscoll I, Tindle HA, Smith JC, Espeland MA. Predictors of optimal cognitive aging in 80+ women: the Women's Health Initiative Memory Study. Journals of Gerontology: Biological Sciences and Medical Sciences. 2016; 71:S62–S71. [PubMed: 26858326]

Hanushek E. The impact of differential expenditures on school performance. Educational Researcher. 1989; 18:45–51.

Harrison SL, Ding J, Tang EY, Siervo M, Robinson L, Jagger C, Stephan BC. Cardiovascular disease risk models and longitudinal changes in cognition: a systematic review. PLoS One. 2014; 9:E114431. [PubMed: 25478916]

Hausmann LR, Jeong K, Bost JE, Ibrahim SA. Perceived discrimination in health care and health status in a racially diverse sample. Medical Care. 2008; 46:905–914. [PubMed: 18725844]

Hedges LV, Laine RD, Greenwald R. Does money matter? A meta-analysis of studies of the effects of differential school inputs on student outcomes. Educational Researcher. 1994; 23:5–14.

Hu LT, Bentler PM. Cutoff criteria for fit indices in covariance structural analysis: Conventional criteria versus new alternatives. Structural Equation Modeling. 1999; 6:1–55.

Ihle A, Oris M, Fagot D, Maggiori C, Kliegel M. The association of educational attainment, cognitive level of job, and leisure activities during the course of adulthood with cognitive performance in old age: the role of openness to experience. International Psychogeriatrics. (in press).

Johnson NE. The racial crossover in comorbidity, disability, and mortality. Demography. 2000; 37:267–283. [PubMed: 10953803]

Kantarci K, Smith GE, Ivnik RJ, Petersen RC, Boeve BF, Knopman DS, Tangalos EG, Jack CR. 1H magnetic resonance spectroscopy, cognitive function, and apolipoprotein E genotype in normal aging, mild cognitive impairment and Alzheimer's disease. Journal of the International Neuropsychological Society. 2002; 8:934–942. [PubMed: 12405545]

Keith TZ, Benson MJ. Effects of manipulable influences on high school grades across five ethnic groups. Journal of Educational Research. 1992; 86:85–93.

Kelly, S. Cognitive-behavioral therapy with African Americans. In: Hays, PA., Gayle, Y., editors. Culturally responsive cognitive-behavioral therapy: Assessment, practice, and supervision. Washington, DC: American Psychological Association; 2006. p. 97-116.

Kim J, Miech R. The Black-White difference in age trajectories of functional health over the life course. Social Science in Medicine. 2009; 68:717–725.

Lachman ME. Perceptions of intellectual aging: Antecedentor consequences of intellectual functioning? Developmental Psychology. 1983; 19:482–498.

Lachman ME. Locus of control in aging research: A case for multidimensional and domain-specific assessment. Psychology and Aging. 1986; 1:34–40. [PubMed: 3267376]

Lachman ME, Weaver SL. The sense of control as a moderator of social class differences in health and well-being. Journal of Personality and Social Psychology. 1998; 74:763–773. [PubMed: 9523418]

Lachman ME, Baltes PB, Nesselroade JR, Willis SG. Examination of personality-ability relationships in the elderly: The role of the contextual (interface) assessment mode. Journal of Research in Personality. 1982; 16:485–501.

Lachman ME, Agrigoroaei S, Murphy C, Tun PA. Frequent cognitive activity compensates for education differences in episodic memory. American Journal of Geriatric Psychiatry. 2010; 18:4–10. [PubMed: 20094014]

Lachman ME, Agrigoroaei S, Tun PA, Weaver SL. Monitoring cognitive functioning: psychometric properties of the Brief Test of Adult cognition by Telephone. Assessment. 2014; 21:404–417. [PubMed: 24322011]

Langer EJ, Rodin J, Beck P, Weinman C, Spitzer L. Environmental determinants of memory improvement in late adulthood. Journal of Personality and Social Psychology. 1979; 37:2003–2013. [PubMed: 521899]

Lewis TT, Kravitz HM, Janssen I, Powell LH. Self-reported experiences of discrimination and visceral fat in middle-aged African-American and Caucasian women. American Journal of Epidemiology. 2011; 173:1223–1231. [PubMed: 21354991]

Lezak, MD. Neuropsychological assessment. 3rd. New York, NY: Oxford University Press; 1995.

Link BG, Phelan JC. Social Conditions as Fundamental Causes of Disease. Journal of Health and Social Behavior (extra issue). 1995:80–94.

Liu SY, Glymour MM, Zahodne LB, Weiss C, Manly JJ. Role of place in explaining racial heterogeneity in cognitive outcomes among older adults. Journal of the International Neuropsychological society. 2015; 21:677–687. [PubMed: 26412671]

Manly JJ, Jacobs DM, Touradji P, Small SA, Stern Y. Reading level attenuates differences in neuropsychological test performance between African American and White elders. Journal of the International Neuropsychological Society. 2002; 8:341–348. [PubMed: 11939693]

Manly JJ, Mungas D. JGPS special series on race, ethnicity, life experiences, and cognitive aging. Journals of Gerontology, Series B: Psychological Sciences and Social Sciences. 2015; 70:509–511. [PubMed: 25975291]

Margellos H, Silva A, Whitman S. Comparison of health status indicators in Chicago: are Black-White disparities worsening? American Journal of Public Health. 2004; 94:1612–1617.

McDermott LM, Ebmeier KP. A meta-analysis of depression severity and cognitive function. Journal of Affective Disorders. 2009; 119:1–8. [PubMed: 19428120]

Mehta KM, Simonsick EM, Rooks R, Newman AB, Pope SK, Rubin SM, Yaffe K. Black and White differences in cognitive function test scores: what explains the difference? Journal of the American Geriatrics Society. 2004; 52:2120–2127. [PubMed: 15571554]

Mirowsky J, Ross C. Life course trajectories of perceived control and their relationship to education. American Journal of Sociology. 2007; 112:1339–1382.

Muthén, LK., Muthén, BO. Mplus User's Guide Seventh Edition. Los Angeles, CA: Muthén & Muthén; 1998–2011.

O'Neill J. The role of human capitol in earning differences between Black and White men. Journal of Economic Perspectives. 1990; 4:25–45.

Ong KL, Cheung BMY, Man YB, Lau CP, Lam KSL. Prevalence, awareness, treatment and control of hypertension among United States adults 1999–2004. Hypertension. 2007; 49:69–75. [PubMed: 17159087]

Phelan JC, Link BG, Tehranifar P. Social conditions as fundamental causes of health inequalities: theory, evidence, and policy implications. Journal of Health and Social Behavior. 2010; 51:S28–S40. [PubMed: 20943581]

Preacher KJ, Rucker DD, Hayes AF. Addressing moderated mediation hypotheses: theory, methods, and prescriptions. Multivariate Behavioral Research. 2007; 42:185–227. [PubMed: 26821081]

Rey, A. The clinical examination in psychology. Paris, France: Presses Universitaries De France; 1964.

Reynolds AJ. A structural model of first-grade outcomes for an urban, low socioeconomic status, minority population. Journal of Educational Psychology. 1989; 81:594–603.

Ribeiro PC, Lopes CS, Lourenco RA. Complexity of lifetime occupation and cognitive performance in old age. Occupational Medicine. 2013; 63:556–562. [PubMed: 24253807]

Rodin J. Behavioral medicine: Beneficial effects of self-control training in aging. International Review of Applied Psychology. 1983; 32:153–181.

Ross, CE., Mirowsky, J. The sense of personal control: Social structural causes and emotional consequences. In: Aneshensel, CS.Phelan, JC., Bierman, A., editors. Handbook of the sociology of mental health. Second. Dordrecht: Springer; 2013.

Ryff, C., Almeida, D., Ayanian, JS., Carr, DS., Cleary, PD., Coe, C., Williams, D. National survey of midlife development in the United States (MIDUS-II), 2004–2006. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor]; 2012a. ICPSR04652-v62012-04-29. http://doi.org/10.3886/ICPSR25281.v5

Ryff, C., Almeida, D., Ayanian, JS., Carr, DS., Cleary, PD., Coe, C., Williams, D. National survey of midlife development in the United States (MIDUS-II): cognitive project, 2004–2006. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor]; 2012b. ICPSR25281-v52012-04-18. http://doi.org/10.3886/ICPSR04652.v6

Ryff, C., Almeida, D., Ayanian, JS., Carr, DS., Cleary, PD., Coe, C., Williams, D. Midlife Development in the United States (MIDUS-II): Milwaukee African American sample, 2005–2006. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor]; 2012c. ICPSR22840-v22012-05-21. http://doi.org/10.3886/ICPSR22840.v2

Salthouse TA, Prill KA. Inferences about age impairments in inferential reasoning. Psychology and Aging. 1987; 2:43–51. [PubMed: 3268191]

Schaie, KW. Intellectual development in adulthood: The Seattle Longitudinal Study. New York, NY: Cambridge University Press; 1996.

Schwartz BS, Glass TA, Bolla KI, Stewart WF, Glass G, Rasmussen M, Bandeen-Roche K. Disparities in cognitive functioning by race/ethnicity in the Baltimore Memory Study. Environmental Health Perspectives. 2004; 112:314–320. [PubMed: 14998746]

Seeman TE, Rodin J, Albert M. Self-efficacy and cognitive performance in high-functioning older individuals: MacArthur Studies of Successful Aging. Journal of Aging and Health. 1993; 5:455–474.

Seeman T, McAvay G, Merrill S, Albert M, Rodin J. Self-efficacy beliefs and change in cognitive performance: MacArthur Studies of Successful Aging. Psychology and Aging. 1996; 11:538–551. [PubMed: 8893321]

Sisco S, Gross AL, Shih RA, Sachs BC, Glymour MM, Manly JJ. The role of early-life educational quality and literacy in explaining racial disparities in cognition in late life. Journals of Gerontology, Series B: Psychological Sciences and Social Sciences. 2015; 70:557–567.

Sloan FA, Wang J. Disparities among older adults in measures of cognitive function by race or ethnicity. Journals of Gerontology, Series B: Psychological and Social Sciences. 2005; 60:P242–P250.

Thames AD, Hinkin CH, Byrd DA, Bilder RM, Duff KJ, Rivera Mindt M, Arentoft A, Streiff V. Effects of stereotype threat, perceived discrimination, and examiner race on neuropsychological performance: simple as Black and White? Journal of the International Neuropsychological Society. 2013; 19:583–593. [PubMed: 23388089]

Tombaugh TN, Kozak J, Rees L. Normative data stratified by age and education for two measures of verbal fluency: FAS and animal naming. Archives of Clinical Neuropsychology. 1999; 14:167–177. [PubMed: 14590600]

Wechsler, D. Wechsler Adult Intelligence Scale – III (WAIS-III) manual. New York, NY: The Psychological Corporation; 1997.

Williams DR, YU Y, Jackson JS, Anderson NB. Racial differences in physical and mental health: Socioeconomic status, stress and discrimination. Journal of Health Psychology. 1997; 2:335–351. [PubMed: 22013026]

Williams DR, Neighbors HW, Jackson JS. Racial/ethnic discrimination and health: Findings from community studies. American Journal of Public Health. 2003; 93:200–208. [PubMed: 12554570]

Wilson RS, Capuano AW, Sytsma J, Bennett DA, Barnes LL. Cognitive aging in older Black and White persons. Psychology and Aging. 2015; 30:279–285. [PubMed: 25961876]

Wolinsky FD, Andresen EJ, Malmstrom TK, Miller JP, Schootman M, Miller DK. Childhood school segregation and later life sense of control and physical performance in the African American Health cohort. BMC Public Health. 2012; 12:827–840. [PubMed: 23017218]

Wood RE, Bandura A. Impact of conceptions of ability on self-regulatory mechanisms and complex decision making. Journal of Personality and Social Psychology. 1989; 56:407–415. [PubMed: 2926637]

Zahodne LB, Manly JJ, Azar M, Brickman AM, Glymour MM. Racial disparities in cognitive performance across mid and late adulthood: analyses in two cohort studies. Journal of the American Geriatrics Society. 2016; 64:959–964. [PubMed: 27225354]

Zahodne LB, Meyer OL, Choi E, Thomas ML, Willis SL, Marsiske M, Parisi JM. External locus of control contributes to racial disparities in memory and reasoning training gains in ACTIVE. Psychology & Aging. 2015; 30:561–572. [PubMed: 26237116]

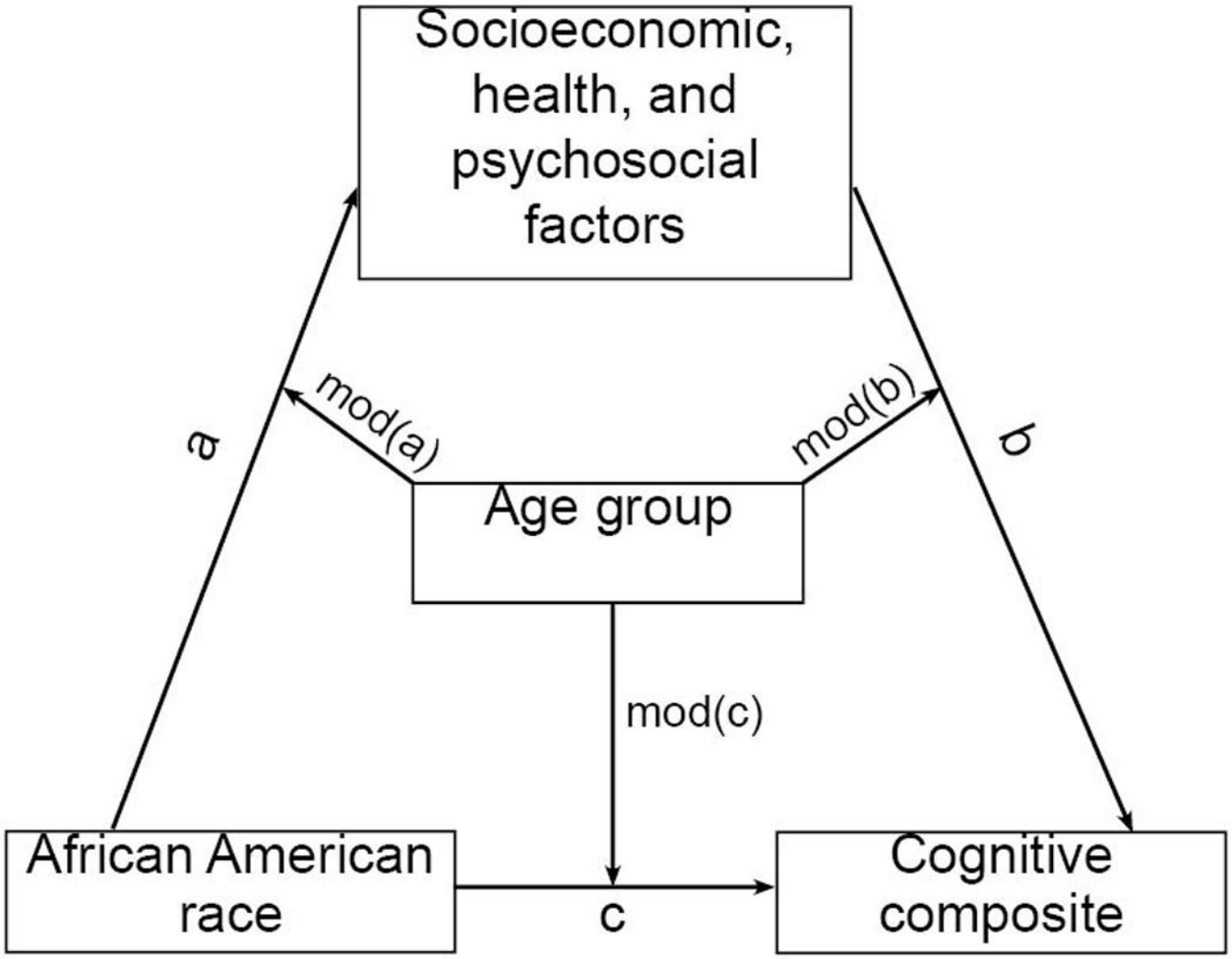

Figure 1.

Moderated mediation model. Path "a" reflects racial differences in the levels of the six potential mediating variables: education, income, body mass index, chronic conditions, daily discrimination, and external locus of control. Path "b" reflects associations between the six potential mediating variables and cognition. The indirect path is the product of the "a" and "b" paths. The direct path (path "c") reflects the association between race and cognition independent of the mediators. The exogenous, three-category variable of age group (i.e., young adulthood, midlife, late life) was allowed to moderate the indirect path via interactions with the exposure (path "mod(a)") and all mediators (path "mod(b)"), as well as the direct path via interactions with the exposure (path "mod(c)"). Separate models were run for episodic memory and executive functioning. All six potential mediating variables were included in each model.

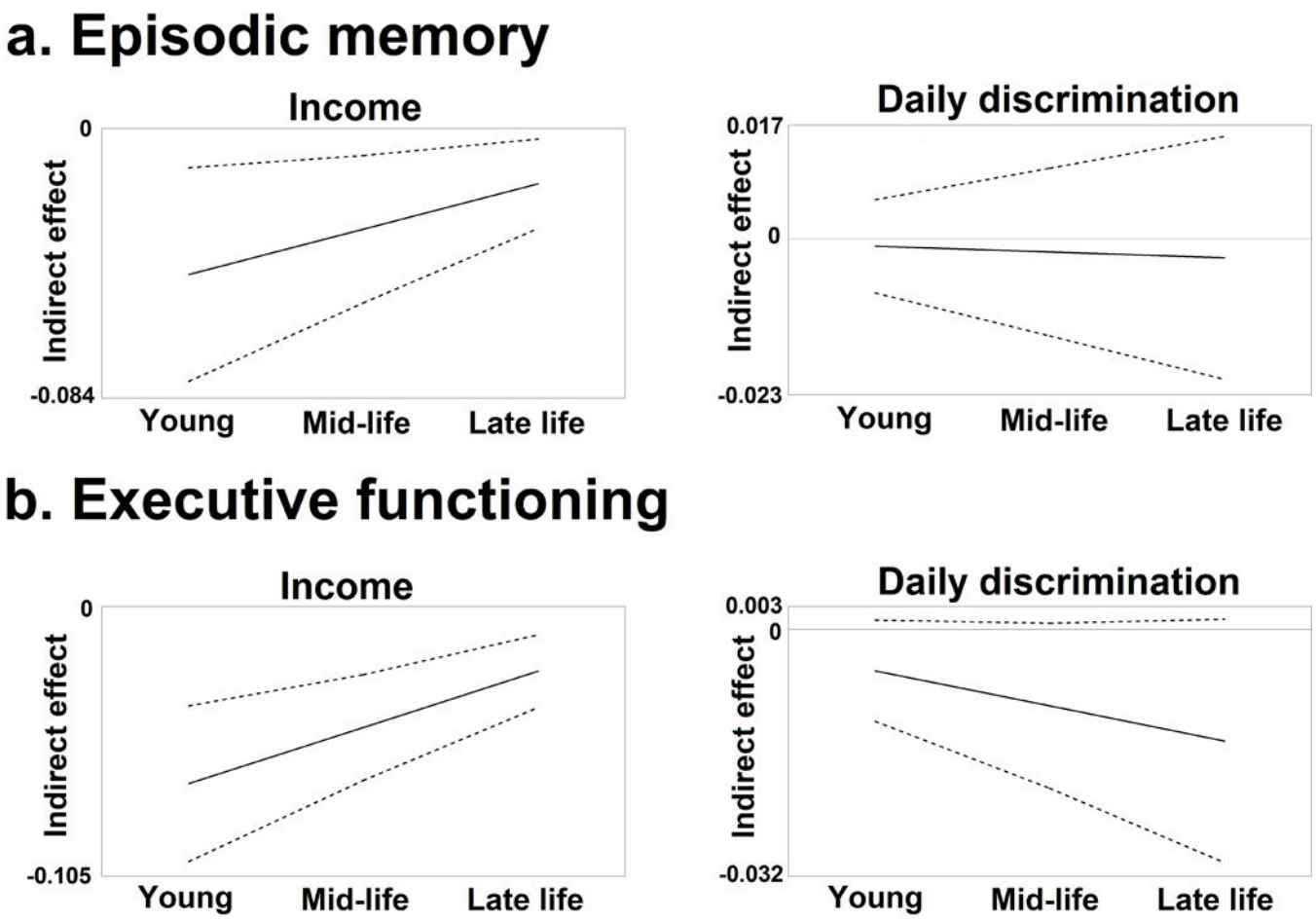

Figure 2.

Pure natural indirect effects of African American race on (a) episodic memory or (b) executive functioning as a function of age group. Dotted lines correspond to 95% confidence intervals around the indirect effect. Absence of overlap between the confidence interval and 0 indicates a significant indirect effect. Slopes reflect significant age group moderation of each indirect effect.

Table 1

Characteristics of African American and non-Hispanic White participants

	African American	Non-Hispanic White		
Young adulthood	**Mean (SD) or %**	**Mean (SD) or %**	**Effect Size**	***p***
N, %	246, 20.3	964, 79.7	–	–
Age (28–44)	39.3 (2.9)	39.6 (3.2)	0.1	.130
Sex (% female)	65.0	54.5	0.1	.003
Education (categories 1–12)	5.8 (2.0)	7.7 (2.3)	0.9	<.001
Annual household income (in thousands of dollars)	42.8 (44.1)	86.4 (60.8)	0.8	<.001
Body mass index	32.5 (15.3)	27.2 (5.7)	0.5	<.001
Chronic conditions (1–12)	0.9 (1.0)	0.5 (0.8)	0.4	<.001
Daily discrimination (9–36)	14.0 (5.5)	13.3 (4.6)	0.1	.108
External locus of control (1–7)	3.1 (1.5)	2.6 (1.1)	0.4	<.001
Episodic memory	−0.1 (1.0)	0.4 (0.9)	0.5	<.001
Executive functioning	−0.5 (0.9)	0.6 (0.8)	1.3	<.001
Middle age	Mean (SD) or %	Mean (SD) or %	Effect Size	*p*
N, %	401, 14.9	2292, 85.1	–	–
Age (45–64)	53.8 (5.5)	54.1 (5.6)	0.1	.431
Sex (% female)	60.1	51.2	0.1	.001
Education (categories 1–12)	6.3 (2.4)	7.3 (2.5)	0.4	<.001
Annual household income (in thousands of dollars)	43.4 (39.4)	82.0 (62.9)	0.7	<.001
Body mass index	32.2 (12.9)	28.3 (6.0)	0.4	<.001
Chronic conditions (1–12)	1.5 (1.4)	1.0 (1.1)	0.4	<.001
Daily discrimination (9–36)	15.0 (6.5)	12.7 (4.2)	0.4	<.001
External locus of control (1–7)	2.9 (1.4)	2.5 (1.1)	0.3	<.001
Episodic memory	−0.2 (0.9)	0.1 (0.9)	0.3	<.001
Executive functioning	−0.7 (1.0)	0.2 (0.9)	0.9	<.001
Late life	Mean (SD) or %	Mean (SD) or %	Effect Size	*p*
N, %	149, 11.5	1149, 88.5	–	–
Age (65–85)	71.7 (5.0)	72.2 (5.3)	0.1	.241
Sex (% female)	63.8	55.2	0.1	.047
Education category (1–12)	5.1 (2.7)	6.7 (2.6)	0.6	<.001
Annual household income (in thousands of dollars)	31.5 (37.0)	43.3 (45.3)	0.3	.004
Body mass index	30.5 (15.3)	27.2 (4.9)	0.3	.018
Chronic conditions (1–12)	1.9 (1.7)	1.6 (1.3)	0.2	.014
Daily discrimination (9–36)	13.3 (5.7)	11.5 (3.4)	0.4	<.001
External locus of control (1–7)	3.1 (1.4)	2.7 (1.2)	0.3	.005
Episodic memory	−0.8 (1.0)	−0.4 (1.0)	0.4	.002
Executive functioning	−1.3 (0.9)	−0.5 (0.9)	2.0	<.001

Table 2

Reasons for discrimination among those reporting discrimination

	African American	Non-Hispanic White		
Young adulthood	**%**	**%**	**Chi square**	***p***
N, %	141, 57.3	452, 46.9	1.0	.314
Age	23.6	14.4	6.5	.011
Gender	22.1	34.5	7.6	.006
Race	73.0	9.1	239.3	<.001
Ethnicity or nationality	40.7	5.0	121.6	<.001
Religion	15.8	6.6	11.2	.001
Height or weight	25.0	19.2	2.2	.141
Other aspect of appearance	20.4	13.3	4.2	.039
Physical disability	10.9	1.8	23.4	<.001
Sexual orientation	9.4	4.0	6.2	.013
Other reason	14.7	19.2	1.4	.229
More than one	68.4	33.6	51.2	<.001
Refused	3.8	23.2	25.5	<.001
Middle age	%	%	Chi square	*p*
N, %	237, 59.1	1161, 50.7	1.9	.165
Age	28.4	22.4	3.9	.047
Gender	23.2	25.3	.471	.493
Race	72.5	6.1	602.7	<.001
Ethnicity or nationality	44.9	2.9	383.4	<.001
Religion	8.1	5.8	1.765	.184
Height or weight	17.4	15.8	0.4	.539
Other aspect of appearance	12.4	8.7	3.1	.076
Physical disability	9.4	3.4	16.9	<.001
Sexual orientation	5.1	1.8	9.2	.002
Other reason	13.8	16.3	0.9	.344
More than one	64.9	27.1	123.8	<.001
Refused	6.1	31.4	62.6	<.001
Late life	%	%	Chi square	*p*
N, %	75, 50.3	497, 43.3	1.1	.286
Age	18.9	27.0	2.2	.141
Gender	12.2	14.3	0.2	.623
Race	67.6	4.2	237.3	<.001
Ethnicity or nationality	31.5	3.6	74.1	<.001
Religion	6.8	8.0	0.1	.700
Height or weight	6.8	6.0	0.1	.809
Other aspect of appearance	5.4	6.6	0.2	.687

	African American	Non-Hispanic White		
Young adulthood	**%**	**%**	**Chi square**	***p***
Physical disability	4.1	3.6	0.0	.854
Sexual orientation	2.7	0.8	2.2	.135
Other reason	6.8	13.7	2.8	.096
More than one	39.7	22.1	10.7	.001
Refused	19.2	44.3	16.6	<.001

Table 3

Direct and indirect effects of African American race on cognition

	Episodic Memory		Executive Functioning	
	Estimate (SE)	***p***	**Estimate (SE)**	***p***
Total effect of race	−0.523 (0.047)	<0.001	−1.001 (0.044)	<0.001
Direct effect of race	−0.338 (0.046)	<0.001	−0.697 (0.041)	<0.001
Total indirect effect of race	−0.185 (0.024)	<0.001	−0.305 (0.026)	<0.001
Specific indirect effects of race				
Education	−0.091 (0.010)	<0.001	−0.159 (0.013)	<0.001
Income	−0.060 (0.022)	0.008	−0.098 (0.021)	<0.001
Chronic conditions	−0.008 (0.006)	0.168	−0.028 (0.006)	<0.001
Body mass index	−0.002 (0.009)	0.775	0.008 (0.008)	0.303
Daily discrimination	0.000 (0.001)	0.833	−0.001 (0.003)	0.824
External locus of control	−0.024 (0.006)	<0.001	−0.027 (0.006)	<0.001
Model fit				
CFI	0.997		0.998	
RMSEA	0.014		0.014	
SRMR	0.008		0.006	

Note. These final models controlled for age and sex and included age group by race interactions for income and daily discrimination