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Black-White variation in the relationship between early educational experiences and trajectories of cognitive function among US-born older adults

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ABSTRACT

Black adults face a substantially higher risk for dementia in later life compared to their White peers. Given the critical role of educational attainment and cognitive function in later life dementia risk, this paper aims to determine if early educational experiences and educational attainment are differentially related to trajectories of cognitive status across race and if this further varies by education cohort. We use data from the Life History Mail Survey (LHMS) and prospective data on cognition from the Health and Retirement Study (HRS). We restrict our sample to Black and White US-born adults who provided at least one measure of cognitive status from 1995/6–2016. We find evidence of Black-White differences in the association between educational experiences and level of cognitive function, episodic memory, and working memory, but little evidence of Black-White differences in these associations with decline. Having a learning problem was associated with lower levels of cognitive function, episodic memory, and working memory for White and Black older adults, but was more strongly related to these outcomes among Black older adults. Further, the Black-White difference in this association was generally found in older cohorts that completed schooling after enactment of federal policies that improved educational resources for children with learning disabilities. Attending racially discordant schools was positively associated with level of these cognitive outcomes for Black older adults but not for White older adults. We also find that the educational gradient in level of cognitive function was larger for Black compared to White older adults in older cohorts not benefiting from the *Brown v Board of Education* decision but was similar for Black and White older adults attending school in the post-*Brown* era.

1. Introduction

Dementia prevalence is 10–12 percentage points higher among older Black adults compared to their White peers (Chen & Zissimopoulos, 2018; Farina et al., 2020). The roots of this differential dementia risk, however, remain poorly understood. A key possibility, especially for current cohorts of older adults, is that dementia risk is partially shaped by variation in early educational experiences, which were profoundly impacted by structural racism.

Focusing on racialized inequities in educational experiences is important given that education is a strong and consistent predictor of cognitive health (Lövdén et al., 2020); older adults with more education have, on average, higher levels of cognitive function and lower risk for cognitive impairment and dementia than those with less education (Crimmins et al., 2018; Lövdén et al., 2020). Other aspects of education, including academic ability, school context, and educational content, are also associated with later life cognitive health, even after adjustment for educational attainment (Greenfield & Moorman, 2019; Leist et al., 2021; Moorman et al., 2019; Walsemann & Ailshire, 2020).

Education's benefits to cognitive health, however, likely do not accrue equally. Indeed, differences in educational attainment do not fully account for race differences in dementia risk (Garcia et al., 2018). But evidence is limited as to whether educational experiences, including academic ability, school context, and educational content, are equally beneficial for cognitive function for White and Black older adults. For example, school segregation and racist practices within desegregated

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schools meant that Black children disproportionately attended schools with more limited school resources than White children (Johnson, 2019). This impacted not only degree attainment, but also the quality of the educational experience, with potential implications for cognitive development and later life cognitive function. Further, because educational experiences differed across cohorts – for example, 80% of Black older adults born before 1945 attended segregated schools in the context of the Jim Crow South, whereas later cohorts were more likely to be educated in desegregated schools – the relationship between education and cognitive function may differ by race *and* cohort. Consequently, we test whether later life cognition is patterned by educational experiences and educational attainment, and whether these relationships vary across race and by cohort. We use newly released retrospective data on educational experiences among a nationally representative sample of older White and Black adults.

1.1. Race, education, and cognitive health: structural racism versus individual explanations

While dementia risk is greater for Black compared to White older adults, the underlying causes of that increased risk are still debated, including the role of education. A common approach to understanding these racial health disparities focuses on individual-level explanations – or the extent to which racial differences in educational attainment "explain" racial disparities in cognitive status and dementia (Chen & Zissimopoulos, 2018; Xiong et al., 2020; Yaffe et al., 2013).

More recent theory and consequent empirical research, however, focuses on structural racism as an explanation for racial disparities in cognitive status and dementia (Bailey et al., 2021; Peterson et al., 2021). This approach places attention on institutional rather than individual-level explanations. For example, compared to White students, Black students were and are more likely to attend segregated and under-resourced schools, less likely to have access to high quality curriculum, and more likely to face bias in their school environments (Johnson, 2019). These early educational experiences influence later life cognitive function, independent from attainment (Aiken-Morgan et al., 2015; Allaire & Whitfield, 2004; Crowe et al., 2013; Lamar et al., 2020; Sisco et al., 2015).

Indeed, preliminary evidence finds that aspects of school context such as school resources – i.e., per-pupil funding and student-teacher ratio – and school segregation are associated with cognitive function in several community or state-based samples (Aiken-Morgan et al., 2015; Allaire & Whitfield, 2004; Crowe et al., 2013; Lamar et al., 2020; Peterson et al., 2021; Sisco et al., 2015). For example, among a sample of Black Baltimore residents aged 50 or older, attending racially mixed schools was associated with better cognitive performance than attending racially segregated schools, although school segregation had no relationship to cognitive decline (Aiken-Morgan et al., 2015). Locality of schools – rural vs. urban – may also be related to cognitive function years later (c.f., Greenfield et al., 2022; Walsemann & Ailshire, 2020), possibly due to differences in school resources.

Educational content may also structure Black-White disparities in later life cognitive function. Enrollment in college preparatory courses, taking a foreign-language, or participating in creative arts were associated with higher levels of cognitive function, but not decline, among a nationally representative sample of US older adults (Walsemann & Ailshire, 2020). Few, if any, studies have considered Black-White heterogeneity in these relationships, however. It may be that Black older adults do not reap the same cognitive benefits from various educational content if, for example, they faced discrimination or otherwise hostile learning environments (Hope et al., 2015; Keels et al., 2017).

Others have found that academic performance, such as reading and math ability or cognitive skills, is related to later life cognitive function (Greenfield et al., 2020; Herd & Sicinski, 2022; Moorman et al., 2019; Walsemann & Ailshire, 2020; Zhang et al., 2020). While promising, these studies used geographically limited samples or national samples that did not consider Black-White differences in academic performance. The benefits that accrue to high academic ability may vary by race. For example, experiments have shown that at similar levels of academic ability, White male students are more likely to be referred to gifted programs than Black male students (Fish, 2017). Further, Black students with disabilities tend to receive fewer supports and services than White students, yet are more likely to be diagnosed, particularly with behavioral disabilities, in predominantly White schools (Elder et al., 2021; Fish, 2017).

Attention to structural racism must also take seriously cohort differences in the relationship between early educational experiences and later life cognitive function. The context of schooling changed dramatically over the 20th century and did so differentially by race. Prior to the 1950s, there was significant state heterogeneity in school term length – how many days of instruction students received in a given school year (U.S. Department of Education, 2003). This was even starker in the Jim Crow South, which required racially segregated school systems by law, where annual school term lengths were 50–100% longer for White compared to Black students (Walsemann et al., 2022). Consequently, even at similar levels of educational attainment, Black older adults who grew up in the Jim Crow South received, on average, fewer days of instruction than their White peers. Walsemann et al. (2022) found that differences in time spent in school explained almost 50% of the Black-White disparities in level of cognitive function decades later. By the end of the 1950s, school term length was more standardized across the United States; thus, other factors – like educational content – could be more important predictors of cognitive health among recent cohorts. Given considerable race inequities in early educational experiences, it is important to determine if these factors play similar roles in cognitive function for Black and White older adults.

Declines in school segregation may have also shaped the educational gradient in cognitive function for Black and White older adults. While *Brown v Board of Education* (1954) was critical to school desegregation, in practice, substantial declines in school segregation did not occur until the prohibition of federal aid to segregated schools in the Civil Rights Act of 1964, and the provision of additional federal aid to desegregated school districts in the Elementary and Secondary Education Act of 1965 (Boozer et al., 1992). Prior to 1964, only a small fraction of Black children had access to schooling that was equivalent to White children's schooling (Johnson, 2019). Desegregating schools, however, reduced inequities in school resources, and it was this change that improved the academic outcomes of Black children rather than increased exposure to White students (Johnson, 2019). Consequently, if early educational experiences, not just educational attainment, predicts cognitive outcomes in later life, we would anticipate that the improvements in schooling experienced by Black Americans in the post-*Brown* era (i.e., after 1964) would manifest in similar educational gradients for Black and White adults, but larger educational gradients in earlier educational cohorts of Black adults that experienced substantially lower quality schooling due to structural racism.

To better understand relationships between race, education, and cognition, this study addresses two key questions. First, we consider if early educational experiences and educational attainment are differentially associated with level and decline in cognition for US-born Black and White community-dwelling older adults. Second, we consider if Black-White differences in these relationships varied by educational cohort, which we define in reference to *Brown v Board of Education* (1954) and the passage of the Civil Rights Act of 1964.

2. Methods

2.1. Data and sample

Data come from the Health and Retirement Study (HRS), a nationally representative, longitudinal study of US adults over age 50 (Sonnega & Weir, 2014). Since 1992, the HRS has conducted core interviews with

age-eligible respondents and their spouses approximately every 2 years. In 2015 and 2017, HRS collected information on respondents' schooling history through a Life History Mail Survey (LHMS). Respondents were sampled for the LHMS if they completed their last core interview and had not participated in the most recent Consumption and Activities Mail Survey (CAMS). Further details on the sampling strategy are available elsewhere (Larkina et al., 2021). A total of 11,769 HRS respondents have completed the HRS-LHMS.

We restricted our sample to age-eligible HRS-LHMS respondents who self-reported their race as non-Hispanic White (n=7888) or non-Hispanic Black (n=2029). We excluded respondents who were foreign-born (n=416), never attended primary school (n=24), did not provide data on cognitive status at least once between 1995/6 and 2016 (n=41), or did not have a sampling weight (n=96). Our final analytic sample included 7460 White and 1880 Black respondents providing 59,575 (White) and 11,734 (Black) person-period observations (mean number of observations = 8 and 6.2, respectively). Approximately 18% of respondents had missing data on one covariate and 19% had missing data on at least two covariates. Item nonresponse ranged from <0.5% (educational attainment) to 14.4% (learning problem). Because we used the imputed cognition variables provided by HRS, there were no missing data on the dependent variables (Fisher et al., 2017). To address item nonresponse on covariates, we employed multiple imputation (details below).

Due to LHMS eligibility requirements and the timing of its administration, the HRS-LHMS sample is less cognitively impaired (13.3% vs. 15.6%) and slightly more educated than the HRS sample overall (see Supplemental Table A1). As compared to the full sample, the LHMS sample also includes more women, White respondents, and respondents 65 years or older.

2.2. Measures

Cognitive Outcomes. All respondents were administered the Telephone Instrument for Cognitive Status (TICS) to assess cognitive function at each interview either by phone or face-to-face. The cognitive assessment evaluates the respondent's memory using 10 word immediate and delayed recall, and attention and processing speed using a serial 7s subtraction test of working memory and counting backwards. *Episodic memory* is summed across immediate and delayed 10-word recall, resulting in scores ranging from 0 to 20, and *working memory* is summed across the serial 7s subtraction test and counting backwards, resulting in scores ranging from 0 to 7. *Cognitive function* is summed across all items in the TICS assessment, resulting in scores ranging from 0 to 27.

Independent Variables include measures of academic ability, school context, educational content, and educational attainment. *Academic ability.* Respondents were classified as having a *learning problem* if they reported that during elementary school a professional told them they had a problem learning in any of 4 subjects – reading, writing, mathematics, speaking/language – or they were diagnosed with attention deficit hyperactivity disorder, dyslexia, or another learning disorder. Respondents self-assessed their *reading and math ability at age 10* in comparison with their peers (1=much better, 2=better, 3=average, 4=worse, 5=much worse). *School context.* We classified respondents as ever having attended a *race-discordant school* if they reported that in at least one of the schools they attended most students in their school were White (for Black adults) or non-White (for White adults). We coded respondents as attending a *rural school* if they lived in a rural area during their schooling. Respondents also reported if they ever attended a *private* elementary or secondary school (yes/no). *Educational Content.* Respondents indicated whether their *high school curriculum* was primarily vocational, general, college preparatory, or they did not attend high school. We also classified respondents as having studied a *foreign language* (yes/no) or participated in *creative arts* (yes/no; playing a musical instrument, singing, dancing, or painting/drawing). *Educational attainment.* Respondents reported the number of years of schooling they completed (range: 1 to 17).

Covariates. Childhood factors that could confound the relationship between educational experiences and cognitive function included *parent's education* measured as the highest year of schooling completed by either parent, the *number of books* in the childhood home (1=none or few, 2=1 shelf, 3=1 bookcase, 4=2 bookcases, 5= >2 bookcases), *father's unemployment history* (unemployed for ≥6 months, employed with no bouts of unemployment ≥6 months, or never knew father), and *self-reported childhood health* (1=excellent, 2=very good, 3=good, 4=fair, 5=poor). *Demographic covariates* included *education cohort*, defined as pre-*Brown* (completed primary/secondary schooling by 1954), *Brown* (completed primary/secondary schooling between 1955 and 1964), or post-*Brown* (completed primary/secondary schooling after 1964), *gender* (male or female), *region* of residence at age 10 (South or non-South), and whether they *completed the LHMS* on their own or with assistance.

2.3. Statistical analysis

To address item nonresponse, we imputed data on the independent variables and covariates using the *mi impute* command with chained equations in Stata, version 17 (Stata-Corp LP, College Station, TX). Imputation models included all analytical variables as well as variables not included in our analysis that were theoretically related to item nonresponse (e.g., childhood moves, childhood SES, financial help during childhood). Analyses were replicated across 30 generated data sets and combined using *mi estimate* (Heeringa et al., 2017).

We used linear mixed models to account for repeated observations of cognitive status within individuals and varying numbers of observations per person (Singer & Willet, 2003). Age represents time (i.e., rate of change), and was centered at 65 years, the mean age of respondents across the period of investigation and divided by 10 to reflect change over a decade. We interacted all independent variables and covariates with age to examine their influence on the rate of change in cognitive status. Linear mixed models included a random-intercept assumed to be normally distributed with mean zero and independent of within-person error and all model covariates.

Before model fitting, we plotted mean cognitive function, episodic memory, and working memory by age across race and determined that a quadratic specification of age fit the data best, which we confirmed in unconditional linear mixed models. Interacting covariates with quadratic age did not improve model fit, leading to difficulties with model convergence. Thus, we included quadratic age in the model to fit the functional form but did not interact it with covariates.

We race-stratified linear mixed models to determine whether associations between education measures and cognitive status varied across White and Black older adults. We compared regression coefficients across groups (H_0: $b_{white}=b_{black}$) using an adjusted *F* test.

We estimated several models in preliminary analyses that progressively adjusted for demographics and childhood factors, educational experiences, and years of schooling; however, we only present results from the fully adjusted model. We employed person-level weights from the respondents' last interview to account for complex sampling and respondent attrition.

3. Results

3.1. Sample characteristics

Table 1 presents sample characteristics by race. Across the period under investigation, White adults scored higher on cognitive function, episodic memory, and working memory than Black adults. Most respondents were women (56.3% and 59.7% for White and Black adults, respectively) and most completed their schooling in the post-*Brown* era (>51% for White and Black adults). About two-thirds of Black adults lived in the South during school compared to only 23.9% of White

Table 1
Sample characteristics of US-born White (n=7460) and Black (n=1880) HRS-LHMS respondents.

	White	Black	Black-White [a]
	Mean (SE) or %	Mean (SE) or %	Difference
Cognitive Health			
Cognitive Function	17.2 (0.02)	14.0 (0.05)	***
Episodic Memory	11.1 (0.01)	9.4 (0.04)	***
Working Memory	6.0 (0.01)	4.6 (0.02)	***
Demographics			
Age (years)	63.6 (0.04)	63.0 (0.10)	***
Women	56.3%	59.7%	*
Educational Cohort			***
Pre-*Brown*	15.4%	12.0%	
Brown	33.0%	30.8%	
Post-*Brown*	51.6%	57.2%	
Lived in U.S. South during school	23.9%	64.4%	***
Childhood Factors			
Self-rated health [b]	1.6 (0.01)	1.9 (0.04)	***
Parent education (years)	12.1 (0.04)	10.0 (0.11)	***
Number of books in household [c]	2.5 (0.02)	1.9 (0.03)	***
Father's employment			***
Unemployed, ≥ 6 mo	18.4%	16.9%	
No Unemployment ≥6 mo	77.8%	65.2%	
Never knew father	3.8%	18.0%	
Academic Ability			
Learning problem	14.2%	20.9%	***
Reading ability [d]	2.4 (0.01)	2.4 (0.03)	
Math ability [d]	2.6 (0.01)	2.6 (0.03)	*
School Context			
Race-discordant school	5.0%	8.3%	***
Rural school	43.9%	43.6%	
Private school	24.7%	8.1%	***
Educational Content			
High school curriculum			***
Did not attend high school	1.8%	5.8%	
Vocational	17.4%	20.0%	
General	46.9%	52.0%	
College preparatory	33.9%	22.2%	
Foreign language	55.1%	40.1%	***
Creative arts	54.0%	51.5%	
Adult Attainment			
Years of education	13.9 (0.03)	12.8 (0.08)	***

Notes.
[a] F-test for continuous variables, chi-square test for categorical outcomes.
[b] 1=excellent, 5 =poor.
[c] 1=none/few, 5=>2 bookcases.
[d] 1=much better, 5=much worse.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

adults.

We found Black-White differences in early educational experiences. Black adults reported higher rates of learning problems (20.9% vs 14.2% for White adults) even while reporting similar levels of reading and math ability as White adults (mean=2.4 (reading) and mean=2.6 (math)). Few adults ever attended a race-discordant school (5% White and 8.3% Black adults). More White adults were enrolled in foreign language or college preparatory coursework than Black adults. Finally, White adults completed more years of schooling (mean=13.9), on average, than Black (mean=12.8) adults.

3.2. Linear mixed models

Fig. 1 presents predicted trajectories of (A) cognitive function, (B) episodic memory, and (C) working memory from unadjusted linear mixed models for White and Black adults. Across all ages, White adults scored higher than Black adults on cognitive function, episodic memory, and working memory. For each domain, cognitive status was higher at younger ages and declined with age. This functional form was similar across race for cognitive function and episodic memory; however, the decline was less steep among White adults for working memory (Fig. 1C).

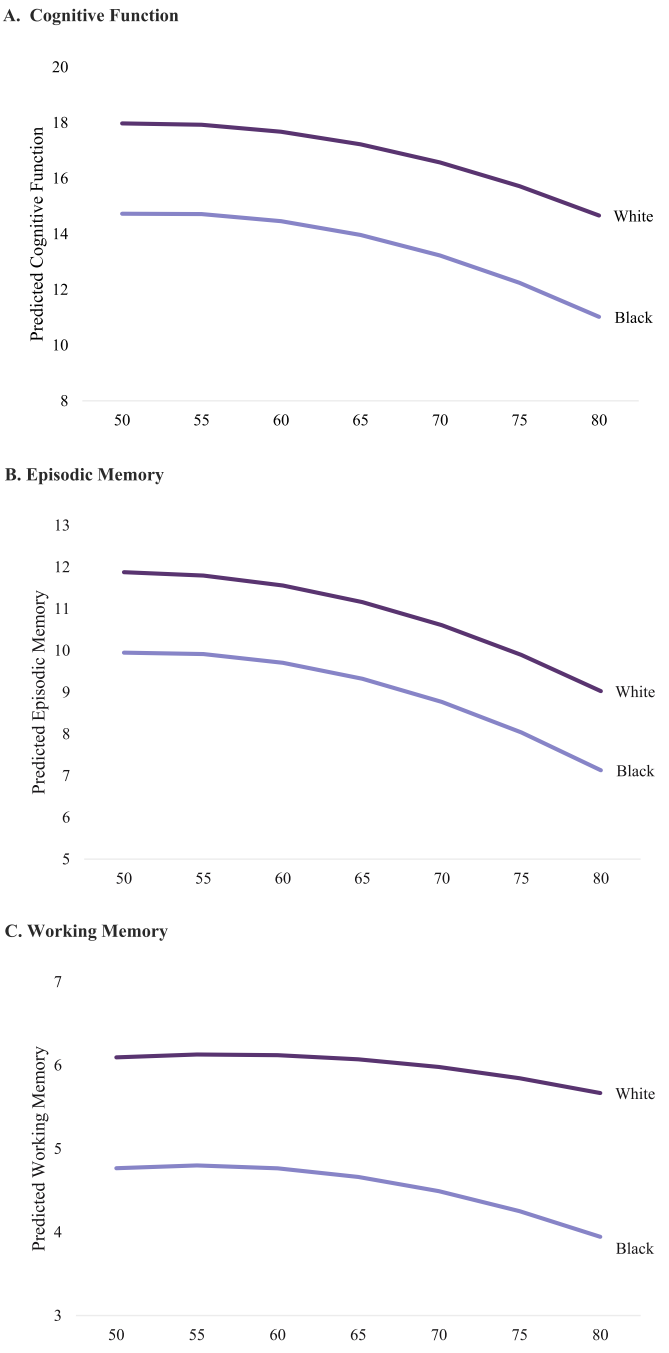

Fig. 1. Predicted trajectories of (A) cognitive function, (B) episodic memory, and (C) working memory for US-born non-Hispanic White (n=7460) and non-Hispanic Black (n=1880) older adults, Life History Mail Survey, 1995/6–2016. Figure Notes: Estimates from unconditional race-stratified random-intercept models.

3.2.1. Cognitive function

Table 2 presents results from race-stratified linear mixed models predicting cognitive function. First, all educational experiences were associated with level of cognitive function for White adults, except for taking creative arts and attending a race discordant school, and none were associated with rate of change in cognitive function. Fewer of these

Table 2
Estimates from random-intercept linear models predicting cognitive function for White (n=7460) and Black (n=1880) US-born older adults, 1995/6–2016, Life History Mail survey, weighted analysis.

	White		Black		Black-White Difference [b]	
	At Age 65	Rate of Change	At Age 65	Rate of Change	At Age 65	Rate of Change
Constant	16.29 (0.12)*	−0.71 (0.10)*	13.47 (0.31)*	−0.85 (0.27)*	*	
Academic Ability						
Learning problem	−0.48 (0.11)*	−0.13 (0.08)	−1.43 (0.24)*	−0.18 (0.18)	*	
Reading ability [a]	−0.15 (0.04)*	−0.03 (0.03)	−0.02 (0.11)	0.18 (0.08)*		*
Math ability [a]	−0.42 (0.04)*	0.06 (0.03)	−0.40 (0.11)*	−0.11 (0.08)		
School Context						
Race discordant school	−0.34 (0.19)	0.17 (0.12)	1.11 (0.35)*	−0.17 (0.27)	*	
Rural school	−0.25 (0.07)*	−0.04 (0.05)	−0.27 (0.18)	0.02 (0.13)		
Private school	0.32 (0.08)*	−0.04 (0.06)	0.80 (0.32)*	−0.18 (0.20)		
Educational Content						
High school curriculum (ref = General)						
Did not attend high school	−1.30 (0.36)*	0.33 (0.19)	−0.34 (0.40)	0.62 (0.30)*		
Vocational	0.33 (0.09)*	0.05 (0.06)	0.19 (0.22)	0.23 (0.16)		
College preparatory	0.35 (0.08)*	0.00 (0.06)	0.06 (0.24)	0.12 (0.18)		
Foreign language	0.51 (0.08)*	0.06 (0.06)	0.58 (0.18)*	0.08 (0.13)		
Creative arts	0.00 (0.07)	−0.02 (0.05)	0.16 (0.18)	0.18 (0.13)		
Educational attainment, years	0.31 (0.02)*	0.01 (0.01)	0.49 (0.05)*	0.03 (0.04)	*	
Person-period observations	59,575		11,734			

Notes: Adjusted for quadratic age, gender, education cohort, proxy interview, region at age 10, child self-rated health, parent education, number of books in the household, and father's unemployment. Continuous variables centered at race-specific means, except age which is centered at 65 and divided by 10. Rate of change is measured as [age-65]/10. Independent variables and covariates (not shown) are interacted with [age-65]/10 to determine their association with rate of change. [a] 1=much better, 5=much worse. [b] H_0: b_{white}= b_{black}.
*p<0.05.

Table 3
Estimates from random-intercept linear models predicting episodic memory for White (n=7460) and Black (n=1880) US-born older adults, 1995/6–2016, Life History Mail survey, weighted analysis.

	White		Black		Black-White Difference [b]	
	At Age 65	Rate of Change	At Age 65	Rate of Change	At Age 65	Rate of Change
Constant	10.11 (0.10)*	−0.61 (0.09)*	8.45 (0.22)*	−0.65 (0.21)*	*	
Academic Ability						
Learning problem	−0.18 (0.09)*	−0.09 (0.07)	−0.80 (0.16)*	−0.19 (0.15)	*	
Reading ability [a]	−0.15 (0.04)*	−0.02 (0.03)	−0.01 (0.08)	0.10 (0.06)		
Math ability [a]	−0.16 (0.03)*	0.08 (0.03)*	−0.10 (0.08)	−0.07 (0.06)		*
School Context						
Race discordant school	−0.25 (0.15)	0.15 (0.10)	0.62 (0.27)*	−0.01 (0.22)	*	
Rural school	−0.20 (0.05)*	−0.01 (0.04)	−0.14 (0.13)	−0.01 (0.10)		
Private school	0.24 (0.07)*	−0.03 (0.05)	0.43 (0.22)*	−0.08 (0.17)		
Educational Content						
High school curriculum (ref = General)						
Did not attend high school	−0.45 (0.23)	0.22 (0.14)	−0.09 (0.28)	0.45 (0.24)		
Vocational	0.19 (0.07)*	0.03 (0.05)	0.17 (0.15)	0.29 (0.13)*		
College preparatory	0.28 (0.07)*	0.01 (0.05)	0.09 (0.17)	0.14 (0.14)		
Foreign language	0.33 (0.06)*	0.06 (0.05)	0.29 (0.13)*	−0.03 (0.10)		
Creative arts	0.08 (0.06)	−0.02 (0.04)	0.20 (0.12)	0.15 (0.10)		
Educational attainment, years	0.22 (0.02)*	−0.00 (0.01)	0.29 (0.03)*	−0.01 (0.03)	*	
Person-period observations	59,575		11,734			

Notes: Adjusted for quadratic age, gender, education cohort, proxy interview, region at age 10, child self-rated health, parent education, number of books in the household, and father's unemployment. Continuous variables centered at race-specific means, except age which is centered at 65 and divided by 10. Rate of change is measured using [age-65]/10. Independent variables and covariates (not shown) are interacted with [age-65]/10 to determine their association with rate of change. [a] 1=much better, 5=much worse. [b] H_0: b_{white}= b_{black}.
*p<0.05.

educational experiences were associated with level of cognitive function for Black adults. Several coefficients, however, significantly differed across race. Having a learning problem showed a stronger inverse association with cognitive function among Black (b=−1.43, SE=0.24) than White adults (b=−0.48, SE=0.11). Attending a race-discordant school was unrelated to level of cognitive function among White adults, but Black adults who attended a race discordant school had higher levels of cognitive function (b=1.11, SE=0.35) than Black adults who did not. Finally, years of schooling was positively associated with level of cognitive function for White (b=0.31, SE=0.02) and Black adults (b=0.49, SE=0.05), but this association was larger for Black adults.

3.2.2. *Episodic memory*

Table 3 presents results from race-stratified linear mixed models predicting episodic memory. All educational experiences were associated with level of episodic memory for White adults, except for taking creative arts and attending a race discordant school, and only math ability was associated with rate of change. Fewer of these factors were significantly associated with level of episodic memory among Black adults; however, several coefficients significantly differed across race. Having a learning problem was inversely associated with level of episodic memory for White (b=−0.18, SE=0.09) and Black (b=−0.80, SE=0.16) adults, but the association was larger for Black adults. Attending a race discordant school was associated with higher levels of episodic memory among Black adults (b=0.62, SE=0.27), an association that statistically differed in size and direction from White adults (b=−0.25, SE=0.15). Finally, whereas more years of schooling was associated with higher levels of episodic memory for Black (b=0.29; SE=0.03) and White (b=0.22; SE=0.02) adults, the positive association was larger for Black adults.

3.2.3. *Working memory*

Table 4 presents results from race-stratified linear mixed models predicting working memory. Most educational experiences were associated with working memory among White adults except for reading ability, attending a race discordant school, or attending a rural school, and only math ability was associated with rate of change. Fewer of these factors were related to level of working memory among Black adults;

Table 4
Estimates from random-intercept linear models predicting working memory for White (n=7460) and Black (n=1880) US-born older adults, 1995/6–2016, Life History Mail survey, weighted analysis.

	White		Black		Black-White Difference [b]	
	At Age 65	Rate of Change	At Age 65	Rate of Change	At Age 65	Rate of Change
Constant	6.18 (0.05)*	−0.10 (0.04)*	5.02 (0.17)*	−0.20 (0.15)*	*	
Academic Ability						
Learning problem	−0.31 (0.05)*	−0.03 (0.03)	−0.64 (0.14)*	0.01 (0.08)	*	
Reading ability [a]	−0.00 (0.02)	−0.02 (0.01)	−0.01 (0.06)	0.06 (0.04)		
Math ability [a]	−0.26 (0.02)*	−0.02 (0.01)*	−0.28 (0.06)*	−0.02 (0.04)		
School Context						
Race discordant school	−0.08 (0.07)	0.03 (0.05)	0.52 (0.19)*	−0.12 (0.12)	*	
Rural school	−0.05 (0.03)	−0.03 (0.02)	−0.14 (0.10)	−0.01 (0.07)		
Private school	0.09 (0.03)*	−0.01 (0.02)	0.34 (0.16)*	−0.15 (0.12)		
Educational Content						
High school curriculum (ref = General)						
Did not attend high school	−0.85 (0.16)*	0.11 (0.08)	−0.23 (0.22)	0.16 (0.13)	*	
Vocational	0.13 (0.04)*	0.02 (0.03)	0.02 (0.12)	−0.07 (0.08)		
College preparatory	0.07 (0.03)*	−0.02 (0.02)	−0.06 (0.13)	−0.06 (0.09)		
Foreign language	0.19 (0.03)*	0.00 (0.02)	0.29 (0.10)*	0.11 (0.07)		
Creative arts	−0.08 (0.03)*	0.01 (0.02)	−0.04 (0.10)	0.01 (0.07)		
Educational attainment, years	0.09 (0.01)*	0.01 (0.01)	0.20 (0.03)*	0.04 (0.02)*	*	
Person-period observations	59,575		11,734			

Notes: Adjusted for quadratic age, gender, education cohort, proxy interview, region at age 10, child self-rated health, parent education, number of books in the household, and father's unemployment. Continuous variables centered at race-specific means, except age which is centered at 65 and divided by 10. Rate of change is measured using [age-65]/10. Independent variables and covariates (not shown) are interacted with [age-65]/10 to determine their association with rate of change. [a] 1=much better, 5=much worse. [b] H_0: $b_{white}= b_{black}$.
*p<0.05.

however, several coefficients significantly differed across race. Having a learning problem was inversely associated with level of working memory for Black (b=−0.64, SE=0.14) and White (b=−0.31; SE=0.05) adults, but the association was larger for Black adults. Attending a race discordant school was associated with higher levels of working memory among Black (b=0.52, SE=0.19), but not White adults. Finally, more years of schooling was positively associated with level of working memory for both groups, but the positive association was significantly larger for Black adults (b=0.20; SE=0.03).

3.2.4. Black-White differences across educational Cohort

Next, we estimated race-stratified models by educational cohort. Complete cohort-stratified results are included in online supplemental material. In Table 5 we highlight key findings. First, the stronger association between having a learning problem and the three cognitive outcomes for Black adults reported in our main analyses was only found for cognitive function in the post-*Brown* cohort (b_{white}=−0.32 vs. b_{black}=−1.58; p<0.05). Second, attending a race discordant school was associated with higher levels of cognitive function and episodic memory for Black adults in the *Brown* cohort and higher levels of working memory in the post-*Brown* cohort; however, Black-White differences in these associations were only statistically different for cognitive function (b_{white}=0.04 vs. b_{black}=1.61, p<0.05) and working memory (b_{white}=−0.00 vs. b_{black}=0.72, p<0.05). Finally, the stronger

Table 5
Regression coefficients predicting level of cognitive status at age 65 for learning problem, school race composition, and years of schooling for White and Black US-born adults by education cohort (pre-Brown, Brown, post-Brown), LHMS-HRS sample.

	White b (SE)	Black b(SE)	Black-White Difference [a]
Cognitive Function			
Learning problem, Pre-*Brown* [b]	−0.49 (0.27)	−0.38 (0.51)	
Learning problem, *Brown* [c]	−0.60 (0.20)*	−1.36 (0.46)*	
Learning problem, Post-*Brown* [d]	−0.32 (0.24)	−1.58 (0.50)*	*
Race discordant school, pre-*Brown*	−0.20 (0.45)	2.54 (1.58)	†
Race discordant school, *Brown*	0.04 (0.38)	1.61 (0.55) *	*
Race discordant school, post-*Brown*	−0.45 (0.37)	0.96 (0.67)	†
Years of schooling, pre-*Brown*	0.30 (0.04) *	0.53 (0.10) *	*
Years of schooling, *Brown*	0.32 (0.03) *	0.49 (0.08) *	*
Years of schooling, post-*Brown*	0.35 (0.05) *	0.40 (0.11) *	
Episodic Memory			
Learning problem, pre-*Brown*	−0.23 (0.21)	−0.10 (0.40)	
Learning problem, *Brown*	−0.21 (0.16)	−0.77 (0.29)*	†
Learning problem, post-*Brown*	−0.00 (0.20)	−0.87 (0.42)*	†
Race discordant school, pre-*Brown*	−0.12 (0.36)	1.63 (1.11)	
Race discordant school, *Brown*	0.13 (0.32)	1.12 (0.40) *	†
Race discordant school, post-*Brown*	−0.45 (0.32)	0.14 (0.53)	
Years of schooling, pre-*Brown*	0.19 (0.03) *	0.30 (0.08) *	
Years of schooling, *Brown*	0.23 (0.02) *	0.33 (0.06) *	
Years of schooling, post-*Brown*	0.27 (0.04) *	0.24 (0.09) *	
Working Memory			
Learning problem, pre-*Brown*	−0.27 (0.13)*	−0.27 (0.29)	
Learning problem, *Brown*	−0.39 (0.09)*	−0.59 (0.25)*	
Learning problem, post-*Brown*	−0.32 (0.10)*	−0.76 (0.23)*	†
Race discordant school, pre-*Brown*	−0.09 (0.18)	0.91 (0.68)	
Race discordant school, *Brown*	−0.09 (0.13)	0.49 (0.29)	†
Race discordant school, post-*Brown*	−0.00 (0.14)	0.72 (0.32) *	*
Years of schooling, pre-*Brown*	0.11 (0.01) *	0.24 (0.06) *	*
Years of schooling, *Brown*	0.09 (0.01) *	0.16 (0.04) *	†
Years of schooling, post-*Brown*	0.08 (0.02) *	0.17 (0.05) *	†

Notes.
[a] H_0: $b_{white}= b_{black}$.
[b] n=1869 White adults, n=264 Black adults.
[c] n=2753 White adults, n=499 Black adults.
[d] n=2838 White adults, n=1117 Black adults.
†p<0.10; *p<0.05.

educational gradient in level of cognitive function for Black adults was only found in the pre-*Brown* (b_{white}=0.30 vs. b_{black}=0.53, $p<0.05$) and *Brown* (b_{white}=0.32 vs. b_{black}=0.49, $p<0.05$) cohorts. We found no race differences in the educational gradient for episodic memory across cohorts but did find a significant Black-White difference in the educational gradient for working memory in the pre-*Brown* cohort (b_{white}=0.11 vs. b_{black}=0.24, $p<0.05$).

4. Discussion

Black older adults are over two times more likely to have dementia than White older adults (Chen & Zissimopoulos, 2018; Farina et al., 2020; Hayward et al., 2021; Zhu et al., 2020). The roots of this risk, however, remain poorly understood. Education – measured as attainment or as academic ability, school context, or educational content – is protective against lower cognitive function and dementia (Crimmins et al., 2018; Lövdén et al., 2020; Walsemann & Ailshire, 2020), but research on whether education is similarly beneficial across race was noticeably missing from the literature, despite well-known inequities in the U.S. educational system due to structural racism. Consequently, we used retrospective data on early educational experiences, and prospective data on cognitive function using a nationally representative sample of Black and White older adults to address this research gap.

Overall, we found that early educational experiences were related to level of cognitive status across three domains – function, episodic memory, and working memory – but not, in general, to rate of decline. Importantly, several educational experiences were significantly related to level of cognitive status after accounting for educational attainment, indicating the potential that educational experiences may underpin the relationship between education and cognition, but are often unobserved due to a scarcity of population data on early educational experiences. Our findings are generally consistent with recent studies that show a relationship between academic ability, school context, or educational content, and cognitive function (Crowe et al., 2013; Moorman et al., 2019; Sisco et al., 2015; Walsemann & Ailshire, 2020).

We also found that the relationship between early educational experiences and cognitive status differed for Black and White adults. For example, although having a learning problem was associated with lower levels of cognitive function and memory for both groups, it was more strongly related to these outcomes among Black older adults. Further, the stronger association with cognitive function only appeared in the post-*Brown* cohort. Over the past six decades, schools have disproportionately assigned Black students to special education classrooms (Skiba et al., 2008). Similarly, we find that Black older adults were more likely than White older adults to be diagnosed with a learning problem. This race gap, however, differed by education cohort (Supplemental Table A2); the Black-White gap was largest in the pre-*Brown* cohort (9.9%) and smallest in the post-*Brown* cohort (4.1%) – the cohort for which we find a statistically significant Black-White difference in the association between having a learning problem and cognitive function. During the 1960s and 1970s, federal policies to improve access to education for children with disabilities were enacted, including the Elementary and Secondary Education Act of 1965 and the 1970 Education of the Handicapped Act (Wright & Wright, 2007). Prior to these policy changes, being diagnosed with a learning problem often restricted the educational and career opportunities of students (Dunn, 1968), but after their passage, more resources were available to mitigate the learning problem. Diagnosis, however, is more likely to occur in well-resourced schools with larger White student populations, and, even among those diagnosed, White children in better-resourced schools have access to more intervention resources (Shifrer & Fish, 2020). Thus, we would expect to see an increase in diagnosis among White children after the passage of federal policies that provided schools with funding specifically to improve the education of children diagnosed with learning problems as White parents availed themselves of these resources. And, indeed, this trend emerges in our descriptive data. These enhanced resources may reduce the negative association of being diagnosed with a learning problem on later cognitive function among those who could take advantage of them – White students – and strengthen this association among those who had limited access to them, such as Black students in under-resourced schools.

The relationship between school segregation and cognitive status also differed by race. We found no statistically significant relationship between attending a race discordant school and cognitive status for White older adults. Few White older adults in our sample attended race discordant schools and most that did completed school after 1955 (92%). The lack of association for White older adults may reflect little exposure to race discordant schools, regardless of education cohort, but is also consistent with prior work that finds White Americans were neither harmed by, nor benefited from, school desegregation (Johnson, 2019).

Conversely, Black older adults who attended predominately White schools exhibited higher levels of cognitive function, episodic, and working memory than those who attended predominantly non-White schools. The positive benefits of school desegregation for cognitive function accrued to the *Brown* cohort who attended school prior to the 1964 Civil Rights Act, when the federal government tied school funding to desegregation efforts. In the post-*Brown* cohort after states accelerated school desegregation, the size of the relationship was halved and null. This pattern, however, was not found for working memory; for this outcome, the positive benefits were only found for Black adults in the post-*Brown* cohort. Overall, our findings echo those of a handful of studies using community samples of Black residents that document a significant positive association between attending desegregated and/or integrated schools and level of cognitive function (Aiken-Morgan et al., 2015), executive function, and semantic memory (Peterson et al., 2021). Conversely, some have documented an inverse association between attending desegregated schools and level of cognitive function – at least for Black adults who grew up in the U.S. South (Lamar et al., 2020) or who were the first cohorts to desegregate their schools (Allaire & Whitfield, 2004). To our knowledge, our study is the first to use a national sample of U.S. Black adults who attended school pre, during, and post-*Brown* to assess level and change in cognitive status and thus results may not be comparable to those from other studies relying on very different study populations.

We also tested whether the relationship between years of schooling and cognitive status varied by race *and* cohort. Specifically, did broader access to better schooling for Black Americans lead to reduced educational disparities in cognitive function between older Black and White adults? We found evidence to support this hypothesis. In short, while the educational gradient in level of cognitive function was much larger for Black than White adults in the pre-*Brown* and *Brown* cohorts, these differences were not found in the post-*Brown* cohort. While this is a descriptive finding, it is consistent with the hypothesis that broader improvements in access to higher quality schooling may have reduced educational disparities between Black and White Americans.

4.1. Limitations

The study is subject to limitations. The data collected on early educational experiences are self-reported and retrospective, which leaves potential for measurement error. The HRS-LHMS, however, uses a life history calendar method that is known to reduce recall bias and increase accuracy (Axinn et al., 1999). Another important limitation is selection into the HRS-LHMS sample, as only those who survived to certain ages were surveyed. Thus, our sample was more cognitively intact than the full HRS sample likely leading to conservative estimates of the association between education and cognitive status across race. Given the study design, the HRS does not provide data on cognitive function before age 50, which limits our ability to understand how cognitive function changes throughout the life course. Finally, the HRS-LHMS did not include some measures, such as school term length,

per-pupil spending, and level of local investment in schools, which could be related to cognitive function and vary across race.

5. Conclusion

Early educational experiences, including having a learning problem or attending a desegregated school, continue to shape cognitive status later in life. These experiences are more strongly related to the cognitive status of Black adults and vary by educational cohort. Racial inequality in the early educational experiences of older Black adults undoubtedly played a role in the differential impacts on cognitive function. Improvements in the educational experiences of Black Americans in the post-*Brown* era may have reduced educational disparities in later life cognitive health between Black and White Americans. Exploring how early educational experiences affect cognition is critical for understanding how inequalities in school experiences shape risk for cognitive aging in later life.

Ethical statement

This is an analysis of secondary data that have been de-identified and are publicly available. Ethical approval was obtained from the University of Maryland, College Park Institutional Review Board.

Declaration of interes

None.

Katrina Walsemann: Conceptualization, Methodology, Formal Analysis, Writing – Original Draft, Supervision, Funding acquisition. Eleanor Kerr: Writing – Original Draft. Jennifer Ailshire: Writing – Review & Editing. Pam Herd: Conceptualization, Writing – Original Draft.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2022.101184.

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