Published in final edited form as:

Exp Aging Res. 2008 ; 34(1): 80–100.

Characterizing and explaining differences in cognitive test performance between African American and European American older adults

Adrienne T. Aiken Morgan and Michael Marsiske

Department of Clinical and Health Psychology, College of Public Health and Health Professions, University of Florida, Gainesville, Florida, USA

Keith E. Whitfield

Department of Psychology: Social and Health Sciences, Arts and Sciences and Trinity College, Duke University, Durham, North Carolina, USA

Abstract

The present study examined differences in cognitive performance of African American and European American older adults on cognitive and intellectual measures, and the extent to which literacy status or reading level was useful in explaining these group differences. African American elders performed more poorly than European American elders on twelve of thirteen cognitive tests administered, $p < .05$. After controlling for reading level achievement, differences in performance became non-significant for five of these twelve tests. Nonetheless, some differences persisted, suggesting that other potential mediators of race differences remain to be explored in future research.

The goal of the present study was to characterize and explain differences in cognitive performance between African American and European American older adults. The current research was guided by studies showing that while African American adults achieved lower scores than European American adults on several types of cognitive measures, after statistically controlling for one hypothesized proxy for education quality, reading achievement level, residual performance differences were lessened or disappeared completely (e.g., Manly, Byrd, Touradji, & Stern, 2004). The following background section focuses on three lines of research, which informed the current investigation: racial differences in cognitive performance, the influence of education on test performance, and the role of education quality in understanding performance differences.

Racial Differences in Cognitive Performance

Many research studies have suggested that, across the lifespan, African Americans show lower performance than European Americans on measures of intelligence (e.g., Heaton, Ryan, Grant, & Matthews, 1996; Kaufman et al., 1988; Kush, Watkins, Ward, Ward, Canivez, & Worrell, 2001; Vincent, 1991) and cognitive screening tests/batteries (e.g., Manly, Jacobs, Sano, Bell, Merchant, Small, & Stern, 1998; Manly, Jacobs, Touradji, Small, & Stern, 2002; Patton, Duff, Schoenberg, Mold, Scott, Adams, 2003; Unverzagt, Hall, Torke, Rediger, Mercado, Gureje, Osuntokun, & Hendrie, 1996). This phenomenon seems to have heightened importance in later life, where persistently lower performance leads to earlier and more frequent cognitive

Address correspondence to Adrienne T. Aiken Morgan, Doctoral Candidate, or Michael Marsiske, Associate Professor, Department of Clinical and Health Psychology, University of Florida, PO Box 100165, Gainesville, FL., 32610-0165. E-mail: aaiken@php.ufl.edu or mmarsisk@php.ufl.edu. Correspondence may also be addressed to Keith E. Whitfield, Ph.D., Research Professor, Department of Psychology: Social and Health Sciences, Box 90085, Durham, NC 27708-0085. E-mail: keith.whitfield@duke.edu.

impairment classifications and diagnoses, such as Alzheimer's disease and other dementias, in African American elders (e.g., Whitfield, 2002); indeed, older African Americans are judged to be cognitively impaired more frequently than European Americans on dementia batteries (Carlson, Brandt, Carson, & Kawas, 1998; Inouye et al., 1993; Manly et al., 1998; Marcopulos et al., 1997; Ripich et al., 1997; Unverzagt et al., 1996). While it is likely that numerous mediating factors (e.g., education, health conditions, and socioeconomic status, etc.) account for the lower performance of African Americans on tests of cognitive ability and functioning, several researchers have noted that such demographic and health factors are infrequently considered in many existing published studies exploring racial group differences in cognition (Whitfield, Fillenbaum, Pieper, Albert, Berkman, Blazer, Rowe, & Seeman, 2000; Izquierdo-Rorrera & Waldstein, 2002; Zsembik & Peek, 2001).

The Role of Education in Cognitive Performance

One of the most common general findings in neuropsychological research and gerontological research on cognitive aging has been the major role of education in explaining individual differences in verbal and non-verbal cognition (Schaie, 1996). Studies have indicated that African American adults, on average, are likely to have attained less formal education than European American adults (e.g., Harper & Alexander, 1990), and these differences exist over and above cohort differences in education attainment (Adams-Price, 1993). However, years of education alone has been an inadequate explanation for group differences in cognitive performance; controlling for group differences in educational attainment has generally not explained the lower performance of African American elders on cognitive and neuropsychological measures (Manly et al., 1998; Manly & Jacobs, 2002). Several have argued that the "years of education" does not have similar meaning across older racial groups in the United States. This non-equivalence is at least in part due to the historical effects of school segregation in the US prior to 1954, and associated factors like lower education expenditures, shorter school years, and higher student/teacher ratios that were experienced by African American students (Loewenstein, Arguelles, Arguelles, & Linn-Fuentes, 1994; Whitfield & Wiggins, 2003; Manly et al., 2002). Investigators have suggested future research should explore the role of education, both quantitatively and qualitatively, in the epidemiology of cognitive impairment associated with Alzheimer's disease (e.g., Folstein, Anthony, & Parhad, 1985; Whitfield, 2002; Whitfield & Wiggins, 2003). Furthermore, Whitfield (1996, 2002) suggested that studies should examine the practical aspects of cognitive functioning, including performance on measures of everyday problem solving, in the assessment of cognitive status. In general, everyday problem solving measures, by assessing cognition within contextually relevant domains (i.e., medication use, transportation, and other instrumental activities of daily living), have been thought to have more ecological value in determining older adults' daily functioning, than traditional cognitive measures (Allaire & Marsiske, 1999; Willis, 1991).

The Role of Education Quality in Understanding Group Differences

There have been several studies examining the role of education quality, as approximated by reading achievement, in accounting for racial group differences in cognitive and neuropsychological test performance (Manly, Jacobs, Sano, Bell, Merchant, Small, & Stern, 1999; Manly et al. 2002, 2003, 2004a, 2004b; Zsembik & Peek, 2001). First, Manly et al. (1999) compared neuropsychological test performance in non-demented literate and illiterate elderly adults and found an overall effect for literacy status on neuropsychological test performance when groups were matched on years of education (Manly et al., 1999). Next, Manly et al. (2002) showed when cognitive scores were adjusted for literacy as measured by reading performance on the Wide Range Achievement Test — 3rd Edition (WRAT-3, Wilkinson, 1993), group performance differences between African American and European American elders (matched on education) was greatly reduced and racial differences on most

tests became non-significant (Manly et al., 2002). Furthermore, Manly and colleagues (2003, 2004a) showed WRAT-3 reading score predicted declines in memory performance in a diverse sample of elders (African American, Hispanic, and Caucasian), and they also demonstrated reading level remained a significant influential predictor of cognitive performance in African American elders, even after controlling for age, sex, years of education, and acculturation level (Manly et al., 2004b). Thus, the variable of education quality (as measured by reading level attainment) appears to be an important factor when considering the cognitive performance of older adults, particularly that of African American elders.

The Present Study

The present investigation explored the potential mediating role of reading level, as a proxy for education and acculturation-related variance that is not captured by years of education, in explaining racial group differences in cognition (e.g., Manly & Jacobs, 2002). This study is unique from Manly et al.'s work in that it utilized data from a normal cognitive aging study: the unusual resource of the pilot study for the ACTIVE (Advanced Cognitive Training for Independent and Vital Elderly) clinical trial (Jobe, Smith, Ball, et al., 2001; Ball, Berch, Helmers, Jobe, Leveck, Marsiske, Morris, Rebok, Smith, Tennstedt, Unverzagt, & Willis, 2002), which included a substantial over-sampling of African American participants ($n=95$, approximately 60% of the pilot sample) and a relatively wide sampling of measures commonly examined in cognitive aging research. This pilot sample was also unique in that the African American participants were significantly younger but had the same years of education as the European Americans in the sample ($n=67$) (see Table 1), in contrast to many other studies (Zsembik & Peek, 2001). While this African American sample could be considered particularly non-representative, thereby limiting the generalizability of findings, it has the benefit of constituting a "natural experiment" in which cognitive differences between groups that are due to years of education would be expected to be minimized. Moreover, the analyses reported below statistically controlled for group differences in these demographic variables (i.e., race, education). It is important to emphasize that our African American and European American samples were more equivalent, demographically, than in many other studies.

The current study had two major aims. First, we sought to determine whether there were, as in many other studies, significant mean differences in cognitive test performance between African American and European American older adults. It was anticipated there would be differences in performance on cognitive measures between African American and European American older adults, typically favoring European Americans. Next, this study sought to determine whether these group differences might be attenuated when controlling for reading level. It was expected that differences in cognitive test performance in African American and European American elders would be attenuated when controlling for this reading level variable (WRAT-3 Total Reading performance).

METHODS

The ACTIVE Study and Pilot

The ACTIVE study is a randomized, controlled, single-masked clinical trial designed to examine whether cognitive training can affect cognitively based measures of daily functioning (Ball et al., 2002; Jobe et al., 2001). Data for the current study are taken from the ACTIVE pilot study, which was completed prior to the launch of the main trial. The pilot had two major goals: (a) to verify the feasibility of recruiting large numbers of diverse elders, particularly from historically under-represented populations; (b) to verify the usability and tolerability of the study's planned assessment instruments and training protocols with diverse elders; most of the prior cognitive aging and cognitive training research had included few or no participants of color. A variety of recruitment strategies (e.g., through local churches and senior

organizations) were employed by each of six field sites (Birmingham, AL; Boston, MA; Indianapolis, IN; Baltimore, MD; Detroit, MI; and north central Pennsylvania).

Although the main ACTIVE trial is a training study, data for this study come from the initial testing of pilot study participants, and no interventions or repeated assessments were available for inclusion. It is important to note that the analyses from the current study could not have been conducted with the full ACTIVE study, because investigators did not assess reading level (WRAT-3) in the main ACTIVE trial.

Participants

There were a total of 170 participants in the sample; eight of these older adults were excluded from the present analyses because they did not identify themselves as African American/Black or European American/Caucasian/White, and thus represented categories of insufficient frequency to permit group comparisons. The present analyses were based on the remaining sample of 162 adults aged 65 and older, of whom 83% were women, with a mean age of 73.7 years and a mean of 12 years of education (Table 1). The sample was comprised of approximately fifty-nine percent ($n = 95$) African Americans. The African American group was significantly younger ($p < .05$) than the European American group ($mean\ age = 72.2$ years vs. 75.7 years) and included significantly more females ($p < .05$; 90% versus 75%). The two groups did not differ in self-reported years of education or reading level performance.

Inclusion/Exclusion Criteria.—Potential participants in the pilot study were screened to exclude individuals based on the following criteria: age < 65 years at initial screening; a score of 221 or lower on the Mini-Mental Status Examination (Folstein, Folstein, & McHugh 1975), a widely used screening tool for the identification of probable dementia, and/or a self-reported physician diagnosis of Alzheimer's disease; substantial functional decline, as determined by self-reported need for assistance in performing the activities of daily living (ADL) of bathing, dressing, or personal hygiene; specific medical conditions, such as stroke in the past 12 months, certain high-fatality cancers (e.g., liver, lung, esophagus), or current chemotherapy and or radiation treatment for any cancer; severe sensory loss; communication difficulties; recent or current participation in cognitive training studies; or unavailability during any phase of the study. The sample was not restricted to people born in the US, nor was it restricted to persons for whom English was the first language. Trained telephone screeners were asked to score whether participants could understand, and make themselves understood, as part of the inclusion/exclusion criteria. The rationale for these exclusion criteria related to the goals of this pilot study; investigators wanted to determine whether these criteria (which were planned for the main ACTIVE trial; Ball et al., 2002) would yield sufficient numbers of participants.

Procedure

Potential participants were screened via telephone to determine their eligibility and willingness to participate. During this screening, information about participants' socio-demographic and health status, ADL, mood, and study availability was obtained. Next, eligible and willing individuals were invited to an in-person screening. In this session, mental status and visual acuity were screened, and non-eligibility-related physical measurements (e.g. blood pressure, pulse, grip strength, height, weight, etc.) and information regarding instrumental activities of daily living (IADL) were gathered. Following this session, those who met eligibility requirements and were still interested in the study were invited to consent to all further study activities. Two additional sessions included an individual baseline cognitive assessment and a group cognitive assessment.

Cognitive Outcome Domains

The cognitive battery consisted of measures of episodic memory, inductive reasoning, perceptual speed, global cognitive status, everyday problem solving, and language (see Table 2). The chosen measures represent commonly used cognitive instruments to test cognitive performance in aging populations. In addition, the pilot measures were selected to reflect the endpoints of the larger ACTIVE clinical trial (i.e., measures of memory, reasoning and speed, which were the planned targets of training for the full study).

Additional health predictors

In the context of analyzing study data, follow-up analyses (presented in the Results section) examined the additional race-effect attenuation, if any, of covarying on selected health conditions known to have higher prevalence in African American elders (e.g., Berkman & Mullen, 1997, Whitfield, Weidner, Clark, & Anderson, 2002). The conditions included were arthritis, diabetes, heart disease, and cancer. For each condition, participants were asked (during the telephone screener), “Has a doctor or nurse ever told you have <condition>?” Participants answered “yes” or “no”. Proportions indicating the presence of the condition were as follows: arthritis, 63.6%; diabetes, 20.4%; heart disease, 23.8%; cancer, 11.7%. Chi-square analyses revealed that the prevalence of none of these conditions varied significantly ($p > .05$) by race. Participants were also asked about stroke or Alzheimer’s disease, but participants answering, “yes” to these questions were excluded from the study; thus, these variables are not available for the current analyses.

Depression symptoms, as measured by the Centers for Epidemiological Studies Depression Scale (CES-D; Radloff et al., 1977) was also included in this list of follow-up health covariates. A minority of participants met the conventional criterion (16) for probable depression (9%). T-test comparison revealed that depression symptoms did not vary significantly by race ($p > .05$).

Statistical Methods

The cognitive measures used in the ACTIVE study, and the associated pilot, were selected to study most cognitive domains at the latent level. For the current analyses, we examined each of these hypothesized cognitive tests separately, with univariate hierarchical multiple regressions on each test.

Pilot investigators were not able to equate racial groups in age or gender, nor were they able to recruit equal proportions of African Americans and European Americans from each field site. Therefore, the analyses that follow are covaried on age and gender. Following the analysis plan of the larger study (Jobe et al, 2001), due to substantial but non-specific variation associated with field site, dummy codes representing the study field sites were also covaried (see Ball et al., 2002 for further explication). In addition, although African Americans and European Americans did not differ in years of education, cognitive scores were nonetheless adjusted on this variable as well, to ensure that any subsequent effects of controlling for WRAT-3 performance were independent of even small, non-significant group differences in educational level. Thus, age, education, gender and recruitment site were covariates in every analysis that follows in this study. To determine whether controlling for reading level might attenuate racial group differences, WRAT-3 (Wilkinson, 1993) total reading performance was used as a covariate following previous work (Manly et al., 1999; 2002; 2003; 2004a; 2004b). Controlling for the demographic covariates (age, education, gender, and recruitment site), two models were compared for each cognitive measure, using a hierarchical regression approach (i.e., assessing the increment in explained variance when a second predictor is added, after first assessing the effect of a first predictor). For each dependent variable, a first model examined race as the only independent variable. This permitted a test of whether there were significant

group differences in cognitive performance. In a second model, WRAT-3 total reading performance was added as a second independent variable, to determine whether racial group differences were attenuated by the addition of the WRAT-3. The unique effect of race, both with and without control of the WRAT-3, was calculated as the squared semi-partial correlation coefficient; that is, the effect of the race variable when it was entered last, after all other predictors had been accounted for.

Preliminary analyses revealed that the covariates in this study were uniformly associated with cognition. Educational level and WRAT-3 scores were significantly correlated ($p < .05$) with all cognitive measures (range: $r = 0.240 - 0.462$); age was significantly correlated ($p < .05$) with all measures but Vocabulary and the Finding As test (range: $r = -0.131 - -0.315$). Gender was correlated only with the Finding As test ($r = .166$) and with the Number Series test ($r = .199$). These relationships were generally the same across African American and White groups. However, there were small, but significant, race-by-educational level interactions ($p < .05$) for four cognitive variables (AVLT and HVL memory tests, and Digit Symbols and Identical Pictures perceptual speed measures), as well as race*WRAT-3 interactions ($p < .05$) for the two perceptual speed variables (Digit Symbols and Identical Pictures).

RESULTS

Initial Analysis: Racial Group Differences in Cognition

We began by examining differences between African American and European American participants on cognitive measures (Model 1), after controlling for baseline demographics (age, education, gender, and recruitment site, as described above). The results, summarized in Table 3, showed there were significant mean differences in performance, favoring European American elders on all tests except Finding A's, a test of perceptual speed.

WRAT-3 Adjustment of Racial Group Differences

Next, the extent to which racial group differences in performance could be attenuated by controlling for the effects of reading level was examined (Model 2). These analyses suggested after controlling for WRAT-3 Total Reading performance (and, again, the baseline demographic covariates of age, education, gender, and recruitment site), previously significant differences were no longer significant for the HVL-R total recall Total ($p = .069$), MMSE ($p = .067$), EPT ($p = .078$), and Vocabulary ($p = .074$). For all remaining measures, where a significant effect of race persisted, controlling for the WRAT-3 performance reduced the unique effect of race. As Table 3 shows, race explained a relatively small unique, but significant, portion of the variance on various measures (r^2 ranging from .010 to .099). Nevertheless, these r^2 values were reduced after controlling for WRAT-3 performance (.005 to .090). The unique effect of race, as indexed by the squared semi-partial correlation coefficients shown in the table, was reduced in magnitude in every case when the influence of reading level performance was considered.

Follow-up analysis: Does health account for additional race-related variance?

The ACTIVE pilot study was not designed to collect health-related information. However, given that the inclusion of the WRAT-3 Total Reading scores did not fully mediate race-related variance in cognition for most measures—a finding in contrast to previous studies—we conducted an additional model (Model 3), in which we further controlled for mental and physical health covariates. These analyses suggested after controlling for physical and mental health (and, again, the baseline demographic covariates of age, education, gender, and recruitment site, as well as WRAT-3 Total Reading performance), there was no substantial difference in any of the findings. The race variable remained significant for all dependent variables for which it had been previously significant in Model 2. The unique contribution of

the race variable actually appeared to increase slightly, but this is a reflection of a small loss in the number of participants due to missing health information, and does not reflect a true change. Thus, as measured in the ACTIVE pilot, health variables played no additional role in attenuating race differences.

DISCUSSION

The aim of the current study was to characterize and examine the extent to which controlling for individual differences in reading level attenuates racial differences in cognitive performance of older adults, as has been shown in prior research. The 162 participants in the present analyses were selected from a pool of participants recruited by six field sites for a pilot study that preceded the full ACTIVE clinical trial (Ball et al., 2002). Our analyses showed, in accordance with previous studies and our hypotheses, that there were significant mean differences in performance, with African American participants showing lower performance on all but one cognitive measure. Numerous studies have shown this between-group performance differential (e.g., Lichtenberg, Ross, & Christensen, 1994; Boekamp, Straus, & Adams, 1995; Adams, Boake, & Crain, 1982).

Next, the extent to which racial group differences in performance could be attenuated when controlling for the effects of reading level, as measured by the WRAT-3 Total Reading score, was analyzed. Results indicated an attenuation of group differences for several measures, suggesting the possible role of reading level as an important mediating factor in cognitive test performance. Additionally, the measures for which reading level reduced the effect of race to a non-significant difference were all tests that intact reading level may be an important predictor of performance (i.e., HVLT-R total recall, MMSE, EPT, and Vocabulary). Specifically, Vocabulary and EPT tests present verbal information to participants and require them to either select correct synonyms, or answer challenging word problems about everyday printed stimuli. Both the HVLT-R and MMSE include verbal recall tasks, which have been shown to be strongly related to participants' verbal knowledge (Just & Carpenter, 1992; Verhaeghen, 2003). The MMSE also includes tasks of orientation, common everyday knowledge, and phrase repetition. The model of fluid and crystallized intelligence (e.g., Horn & Cattell, 1966) may be a useful lens through which to consider these findings. As defined by Horn and Cattell, crystallized abilities represent those cognitive skills acquired through education and transaction with the culture. Verbal measures are commonly found to load on crystallized intelligence factors (Daneman & Carpenter, 1980; 1983; Daneman & Green, 1986; Just & Carpenter, 1992); prior studies have specially shown that both Vocabulary and EPT either load on, or are strongly related to, crystallized intelligence (Daneman & Carpenter, 1980; 1983; Daneman & Green, 1986; Just & Carpenter, 1992). Verbal memory (as assessed in both MMSE and HVLT) has also been shown to relate strongly to crystallized verbal measures in many studies (e.g., Daneman & Carpenter, 1980; 1983; Daneman & Green, 1986; Just & Carpenter, 1992). Thus, partialing WRAT scores out of other verbally saturated measures may therefore remove that portion of crystallized variance that is most sensitive to race differences. However, in less crystallized measures, for which race differences could be largely attributable to other sources (e.g., health disparities), the removal of relatively crystallized WRAT-3-related variance could be expected to have less of an attenuation effect on those race differences.

Thus, the present findings differ fairly substantially from those of Manly and colleagues, likely due to sampling differences. While much of prior research has relied on reading level performance (as measured by the WRAT-3) to explain differences in cognitive performance between African American and European American older adults, this method may only be the first step in our understanding. Our data suggest that, in a specific sample of African American elders, with similar educational background to a European American comparison sample, mean differences in cognition cannot be fully mediated by a reading level variable. This points to

the need to further deconstruct the variables that underlie these race differences. This is consistent with the work of Whitfield and colleagues (2000) who have argued the socio-cultural influences captured by reading level measures represent just one possible source of racial group differences in late life cognition. They have argued, in particular, that health factors should also be considered. Indeed, evidence has shown, across the lifespan, there are substantial disparities in the health status of African Americans compared to European Americans (e.g., Berkman & Mullen, 1997, Whitfield, Weidner, Clark, & Anderson, 2002). Explanations for such disparities are varied, ranging from genetic or environmental factors (e.g., socioeconomic status, education) to differences in medical care access (e.g., Farmer & Ferraro, 2005).

One particularly meaningful direction for future research concerns cardiovascular functioning (which did not receive substantial measurement attention in the ACTIVE pilot). As the follow-up analyses in this study reveal, inclusion of a small number of physical and mental health covariates (heart disease, diabetes, hypertension, arthritis, depression) did not further help to explain the race differences observed. This is likely a reflection of the limited health data collection in the ACTIVE pilot and the relative absence of substantial (race-related) health disparities data in this sample. African Americans are at greater risk for developing conditions such as hypertension, diabetes, heart disease and stroke (National Center for Health Statistics (NCHS), 1990), and these in turn have been identified as strong predictors of late-life cognitive individual differences (Waldstein, 1995; Izquierdo-Porrera & Waldstein, 2002; Breteler, van Swieten, Bots, & Grobbee, 1994). Thus, future directions of study, in this regard, include the use of stronger health status data as mediators, in addition to reading level attainment. Furthermore, the compelling simplicity of the WRAT-3 measure probably under-emphasizes the complexities of cultural contributions to racial group differences in cognitive performance. More direct estimates of individual differences in educational quality, particularly in the era of school segregation, have been emerging. Approaches have included educational questionnaires (e.g., Whitfield & Wiggins, 2003), consultation of school district archival records (Glymour & Berkman, 2003), and other questions about school/educational environment (i.e., did you have a library? did you have your own books? what kind of education did your teachers have?). Since the current study constituted a secondary data analysis, further primary data collection to determine participants' school districts or access to educational resources was not possible. This study was therefore constrained to using only those data available in the existing ACTIVE pilot data set; nonetheless, future work should examine such direct estimates of individual differences in educational quality.

This study has several limitations that are important to consider. The ACTIVE pilot study was not designed explicitly for the purpose of cognitive comparison between African American and European American older adults; in addition, using a selective convenience sample means that generalizability to the broader population of older adults requires further consideration (although the resulting equivalence of the two groups in terms of years of education means that gross race differences in education could not be the basis of the differences observed). While essentially a sample of convenience, our sample of African Americans and European Americans were well matched on mean education and closely matched in reading level performance. To the extent that reading is a proxy for quality of education, this would suggest that these two groups had similar educational experiences, both in terms of quantity and quality. In this respect, this sample is relatively unique in the literature. This assertion may extend to the cognitive status screening (only participants with MMSE scores of 23 or higher were admitted into the study). Some investigators have argued that different MMSE cutoffs should be used for African American and European American elders (Bohnstedt, Fox, & Kohatsu, 1994). The decision of the ACTIVE investigators not to do this could further have led to disproportionately positive selection in the African American group although, it should be noted, it also produced two racial/ethnic groups who were closely matched in terms of their absolute MMSE performance.

In the US, it is almost certain that racial discrimination made access to education highly discrepant across African American and European American groups (Whitfield & Wiggins, 2003). The African-Americans in this study, who on average completed a dozen years of education, are less typical overall of African American elders. In contrast, the European Americans in this sample, who on average completed 12 years of school, are quite typical. We therefore acknowledge the possibility that the selection process into this study yielded a group of African Americans for whom the relationship of reading level to test performance is atypical of most African American elders. This is a potential limitation, and requires follow-up study, in a more educationally heterogeneous sample, to see whether the reading level/cognition relationship varies educational level. Next, the ACTIVE pilot study did not include a measure of socioeconomic status to permit analysis of the possible influences of this variable. Additionally, the pilot data were collected to measure specific clinical trial endpoints (i.e., measures of reasoning, memory, and perceptual speed that would be intervention outcomes in the main ACTIVE cognitive training trial); so the breadth of cognitive assessment was necessarily limited. This could be problematic when comparing this study's findings with that of other studies employing broader neuropsychological testing batteries in older adults (Manly et al. 1999; Manly et al. 2002). It is important to note measures of reasoning and speed in this study have substantial variability and are suitable for use with broad range levels of performance, and thus the range restriction problem that is common to some neuropsychological measures (e.g., Langeluddecke & Lucas, 2004, McGurk et al, 2000) is less of a concern here.

In sum, the current study confirmed previous research showing that differences in cognitive performance between African American and European American older adults can be attenuated when accounting for differences in educational quality. In this study, reading achievement level, as measured by the WRAT-3, was used as an approximation of education quality. In contrast to the fairly universal reduction (to non-significant) of racial differences in the work of Manly et al. (2002) the current study suggested that (a) reductions were greatest (both in terms of proportional reductions in variance explained by race, and in reduction to non-significant) for verbally saturated measures of vocabulary, everyday problem solving, list memory, and cognitive status, and (b) for many other measures of cognition, there were relatively small reductions in race-related variance. Other important sources of group differences must be investigated in future work, as reading level alone did not fully capture the cognitive performance differences observed. One source already under investigation is the effect health status on cognitive performance in African American older adults. As the minority older adult population continues to grow, the challenges and issues addressed and discussed in this study become more salient. Increasingly, more racial minority older adults will need health care related to both cognitive and physical function in late life. It is critical that both future research and clinical practice are informed by this and related research.

Acknowledgements

This study was funded by grant U01AG014276, including a Minority Supplement award, from the National Institute on Aging. This work was initiated as part of Ms. Aiken's Masters Thesis. We gratefully acknowledge Ms. Aiken's masters committee (Dawn Bowers, Samuel Sears) for comments on this work. We also thank the ACTIVE Steering Committee for permission to use the data, and for feedback on the initial proposal for this work (Karlene Ball, University of Alabama-Birmingham; Jeffrey Elias, National Institute on Aging, Kathy Mann-Koepke, National Institute of Nursing Research; George Rebok, Johns Hopkins University; Fred Unverzagt, Indiana University School of Medicine; Sherry L. Willis, The Pennsylvania State University)

REFERENCES

Adams RL, Boake C, Crain C. Bias in neuropsychological test classification related to age, education and race. *Journal of Consulting and Clinical Psychology* 1982;50:143–145. [PubMed: 7056909]

- Adams-Price CE. Age, education, and literacy skills of adult Mississippians. *The Gerontologist* 1993;33:741–746. [PubMed: 8314100]
- Allaire JC, Marsiske M. Everyday cognition: age and intellectual ability correlates. *Psychology and Aging* 1999;14(4):627–644. [PubMed: 10632150]
- Ball K, Berch DB, Helmers KF, Jobe JB, Leveck MD, Marsiske M, Morris JN, Rebok GW, Smith DM, Tennstedt SL, Unverzagt FW, Willis SL. Effects of cognitive training interventions with older adults. *Journal of the American Medical Association* 2002;288:2271–2281. [PubMed: 12425704]
- Benedict RHB, Schretlen D, Groninger L, Brandt J. Hopkins Verbal Learning Test – Revised: Normative data and analysis of inter-form and test-retest reliability. *The Clinical Neuropsychologist* 1998;12(1): 43–55.
- Berkman, LF.; Mullen, JM. How health behaviors and the social environment contribute to health differences between black and European American older Americans. In: Martin, LG.; Soldo, BJ., editors. *Racial and Ethnic Differences in the Health of Older Americans*. National Academy Press; Washington, D.C.: 1997. p. 163-182.
- Boekamp JR, Strauss ME, Adams N. Estimating premorbid intelligence in African American and European American elderly veterans using the American version of the National Adult Reading Test. *Journal of Clinical and Experimental Neuropsychology* 1995;17:645–653. [PubMed: 8557806]
- Bohnstedt M, Fox PJ, Kohatsu ND. Correlates of Mini-Mental Status examination scores among elderly demented patients- the influence of race-ethnicity. *Journal of Clinical Epidemiology* 1994;47(12): 1381–1387. [PubMed: 7730847]
- Carlson MC, Brandt J, Carson KA, Kawas CH. Lack of relation between race and cognitive test performance in Alzheimer's disease. *Neurology* 1998;50:1499–1501. [PubMed: 9596021]
- Cohen, J. *Statistical power analysis for the behavioral sciences*. 2nd ed.. Erlbaum; Hillsdale, NJ: 1988.
- Daneman M, Carpenter PA. Individual differences in working memory and reading. *Journal of Verbal Learning & Verbal Behavior* 1980;19(4):450–466.
- Daneman M, Carpenter PA. Individual differences in integrating information between and within sentences. *Journal of Experimental Psychology: Learning, Memory, & Cognition* 1983;9(4):561–584.
- Daneman M, Green I. Individual differences in comprehending and producing words in context. *Journal of Memory & Language* 1986;25(1):1–18.
- Ekstrom, RB.; French, JW.; Harman, H.; Derman, D. *Kit of Factor Referenced Cognitive Tests*. Revised ed.. Educational Testing Service; Princeton, NJ: 1976.
- Farmer MM, Ferraro KF. Are racial disparities in health conditional on socioeconomic status? *Social Science & Medicine* 2005;60(1):191–204. [PubMed: 15482878]
- Folstein MF, Folstein SE, McHugh PR. Mini — Mental State: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research* 1975;12:189–198. [PubMed: 1202204]
- Folstein MS, Anthony JC, Parhad L. The meaning of cognitive impairment in the elderly. *Journal of the American Geriatrics Society* 1985;33:228–235. [PubMed: 3989183]
- Glymour, M.; Berkman, L. Using Natural Experiments to Estimate Education Effects on Cognitive Function; Paper presented at the 56th Annual Scientific Meeting of the Gerontological Society of America; San Diego, CA. 2003, November;
- Harper, MS.; Alexander, CD. Profile of the black elderly. In: Harper, MS., editor. *Minority aging: essential curricula content for selected health and allied health professions*. 1990. p. 193-222. DHHS Publication No. HRS-R-DV 90-4
- Heaton, RK.; Ryan, L.; Grant, I.; Matthews, CG. Demographic influences on neuropsychological test performance. In: Grant, I.; Adams, KM., editors. *Neuropsychological assessment of neuropsychiatric disorders*. Second Edition. Oxford University Press; New York: 1996. p. 141-163.
- Horn JL, Cattell RB. Refinement and test of the theory of fluid and crystallized intelligence. *Journal of Educational Psychology* 1966;57:253–270. [PubMed: 5918295]
- Inouye SK, Albert MS, Mohs R, Sun K, Berkman JF. Cognitive performance in a high-functioning community-dwelling elderly population. *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* 1993;48:146–151.

- Izquierdo-Porrera AM, Waldstein SR. Cardiovascular risk factors and cognitive function in African Americans. *Journals of Gerontology: Series B: Psychological Sciences & Social Sciences* 2002;57B(4):P377–P380.
- Jobe JB, Smith DM, Ball K, et al. ACTIVE: A cognitive intervention trial to promote independence in older adults. *Controlled Clinical Trials* 2001;4:453–479. [PubMed: 11514044]
- Just MA, Carpenter PA. A capacity theory of comprehension: Individual differences in working memory. *Psychological Review* 1992;99(1):122–149. [PubMed: 1546114]
- Kaufman AS, McLean JE, Reynolds CR. Sex, race, residence, region and educational differences on the 11 WAIS-R subtests. *Journal of Clinical Psychology* 1988;44(2):231–248. [PubMed: 3360941]
- Kush JC, Watkins MW. Construct validity of the WISC-III verbal and performance factors for Black special education students. *Assessment* 1997;4:297–304.
- Langelluddecke P, Lucas S. Evaluation of Two Methods for Estimating Premorbid Intelligence on the WAIS-III in a Clinical Sample. *The Clinical Neuropsychologist* 2004;18:423–432. [PubMed: 15739813]
- Lichtenberg PA, Ross T, Christensen B. Preliminary normative data on the Boston Naming Test for an older urban population. *Clinical Neuropsychologist* 1994;8:109–111.
- Loewenstein DA, Arguelles T, Arguelles S, Linn-Fuentes P. Potential cultural bias in the neuropsychological assessment of the older adult. *Journal of Clinical and Experimental Neuropsychology* 1994;16(4):623–629. [PubMed: 7962363]
- Manly JJ, Byrd DA, Touradji P. Acculturation, reading level, and neuropsychological test performance among African American elders. *Applied Neuropsychology* 2004a;11(1):37–46. [PubMed: 15471745]
- Manly JJ, Byrd DA, Touradji P. Literacy and cognitive change among ethnically diverse elders. *International Journal of Psychology* 2004b;39(1):47–60.
- Manly, JJ.; Jacobs, DM. Future directions in neuropsychological assessment. In: Ferraro, FR., editor. *Minority and cross-cultural aspects of neuropsychological assessment. Studies on neuropsychology, development, and cognition.* Swets & Zeitlinger Publishers; Bristol, PA: 2002. p. 79-96.
- Manly JJ, Jacobs DM, Sano M, Bell K, Merchant CA, Small SA, Stern Y. Cognitive test performance among nondemented elderly African Americans and whites. *Neurology* 1998;50(5):1238–1245. [PubMed: 9595969]
- Manly JJ, Jacobs DM, Sano M, Bell K, Merchant CA, Small SA, Stern Y. Effect of literacy on neuropsychological test performance in nondemented, education-matched elders. *Journal of the International Neuropsychological Society* 1999;5(3):191–202. [PubMed: 10217919]
- Manly JJ, Jacobs DM, Touradji P, Small SA, Stern Y. Reading level attenuates differences in neuropsychological test performance between African American and European American elders. *Journal of the International Neuropsychological Society* 2002;8(3):341–348. [PubMed: 11939693]
- Manly JJ, Touradji P, Tang M-X. Literacy and memory decline among ethnically diverse elders. *Journal of Clinical & Experimental Neuropsychology: Special issue: Cognitive Reserve* 2003;25(5):680–690.
- Marcopulos BA, McLain CA, Giuliano AJ. Cognitive impairment or inadequate norms: A study of healthy, rural, older adults with limited education. *The Clinical Neuropsychologist* 1997;11:111–131.
- McGurk SR, Moriarty PJ, Harvey PD, Parrella M, White L, Friedman J, Davis KL. Relationship of cognitive functioning, adaptive life skills, and negative symptom severity in poor-outcome geriatric schizophrenia patients. *Journal of Neuropsychiatry and Clinical Neuroscience* 2002;12:257–264.
- National Center for Health Statistics. *Current Estimates from the National Health Interview Survey.* Public Health Service; Hyattsville, MD: 1990. 1989.
- Patton DE, Duff K, Schoenberg MR. Performance of Cognitively Normal African Americans on the RBANS in Community Dwelling Older Adults. *The Clinical Neuropsychologist* 2003;17(4):515–530. [PubMed: 15168916]
- Radloff LS. The CES-D scale : A self-report depression scale for research in the general population. *Applied Psychological Measurement* 1977;1:385–401.
- Rey A. L'examen psychologique dans les cas d'encephalopathie tramatique. *Archives de Psychologie* 1941;28:21.

- Ripich DN, Carpenter B, Ziol E. Comparison of African-American and white persons with Alzheimer's disease on language measures. *Neurology* 1997;48:781–783. [PubMed: 9065567]
- Schaie, KW. Schaie — Thurstone adult mental abilities test manual. Consulting Psychologists Press; Palo Alto, CA: 1985.
- Schaie, KW. Adult intellectual development: The Seattle Longitudinal Study. Cambridge University Press; New York: 1996.
- Unverzagt FW, Hall KS, Torke AM, Rediger JD. Effects of age, education, and gender on CERAD neuropsychological test performance in an African American sample. *The Clinical Neuropsychologist* 1996;10:180–190.
- Verhaeghen P. Aging and vocabulary score: A meta-analysis. *Psychology & Aging* 2003;18(2):332–339. [PubMed: 12825780]
- Vincent KR. Black/White IQ differences: Does age make a difference? *Journal of Clinical Psychology* 1991;47:266–270. [PubMed: 2030133]
- Waldstein SR. Hypertension and neuropsychological function: A lifespan perspective. *Experimental Aging Research* 1995;21(4):321–352. [PubMed: 8595801]
- Wechsler, D. Manual for the Wechsler Adult Intelligence Scale — Revised. The Psychological Corporation; New York, NY: 1981.
- Whitfield KE. Studying cognition in older African Americans: Some conceptual considerations. *Journal of Aging and Race* 1996;1(1):35–45.
- Whitfield KE. Challenges in cognitive assessment of African Americans in research on Alzheimer's disease. *Alzheimer's Disease & Associated Disorders* 2002;16(S2):S80–S81.
- Whitfield KE, Fillenbaum GG, Pieper C, Albert MS, Berkman LF, Blazer DG, Rowe JW, Seeman T. The effect of race and health-related factors on naming and memory: The MacArthur studies of successful aging. *Journal of Aging & Health* 2000;12(1):69–89. [PubMed: 10848126]
- Whitfield KE, Weidner G, Clark R, Anderson NB. Sociodemographic diversity and behavioral medicine. *Journal of Consulting and Clinical Psychology* 2002;70(3):463–481. [PubMed: 12090363]
- Whitfield KE, Wiggins S. The impact of desegregation on cognition among older African Americans. *Journal of African American Psychology* 2003;29(3):275–291.
- Wilkinson, GS. Jastak Associates, Inc.; Wilmington, DE: 1993. Wide Range Achievement Test 3 — Administration manual.
- Willis, SL.; Marsiske, M. Psychometric characteristics of the Everyday Problems Test. 1994. Unpublished manuscript, University Park, Pennsylvania State University
- Willis SL. Everyday cognitive competence in elderly persons: Conceptual issues and empirical findings. *Gerontologist* 1996;36(5):595–601. [PubMed: 8942103]
- Wilson, BA.; Cockburn, J.; Baddeley, AD. The Rivermead Behavioral Memory Test. Thames Valley Test Co.; Bury St. Edmunds, UK: 1985.
- Zsembik BA, Peek MK. Race differences in cognitive functioning among older adults. *Journal of Gerontology: Social Sciences* 2001;56(B5):S266–S274.

Table 1

Participants' Characteristics

Overall	African American Group		European American Group
Sample size	<i>n</i> = 162	<i>n</i> = 95	<i>n</i> = 67
Age	<i>m</i> = 73.68 (6.08)	<i>m</i> = 72.24 (5.92)	<i>m</i> = 75.71 (5.75)
Gender *	83.3% F 16.7% M	90% F 10% M	75% F 25% M
Years of Education	<i>m</i> = 12.07 (2.97)	<i>m</i> = 11.93 (3.39)	<i>m</i> = 12.27 (2.25)
WRAT-3 score	<i>m</i> = 44.95 (5.60)	<i>m</i> = 43.60 (5.87)	<i>m</i> = 46.87 (4.56)

* Significant at $p < .05$; *m* = mean score, (standard deviation)

Table 2**Battery of Cognitive Measures**

Cognitive Domain	Measure	Source
Episodic Memory	Rey Auditory Verbal Learning Test (AVLT)	Rey, 1964
	Hopkins Verbal Learning Test — Revised (HVLT)	Benedict et al., 1998
Inductive Reasoning	Rivermead Behavioural Memory Test	Wilson et al., 1985
	Letter Series ^b	Schaie, 1985
	Word Series Test ^b	Schaie, 1985
	Letter Sets ^a	Ekstrom et al., 1976
Perceptual Speed	Number Series Test, Form B (Adapted) ^a	Ekstrom et al., 1976
	Digit Symbol Substitution Test	Wechsler, 1981
	Finding As ^a	Ekstrom et al., 1976
	Identical Pictures ^a	Ekstrom et al., 1976
Global Cognitive Status	Mini Mental State Examination (MMSE)	Folstein, Folstein, & McHugh, 1975
Everyday Problem Solving	Everyday Problems Test (EPT)	Willis & Marsiske, 1994
Language	Wide Range Achievement Test — 3rd Ed. (WRAT-3)	Wilkinson, 1993
	Vocabulary Tests ^a	Ekstrom et al., 1976

^a from the Kit of Factor-Cognitive Reference Tests.

^b from Schaie — Thurstone Adult Mental Abilities Test.

Table 3

Effect of race and WRAT-3 reading score on cognitive test score

Measure	Means before WRAT-3 adjustment		Model 1: Effect of race			Model 2: Effect of Race after WRAT-3 adjustment			Model 3: Effect of Race after WRAT-3 and health adjustment		
	African Americans	European Americans	β	p	Unique Contribution of Race (semi-partial r ²)	β	p	Unique Contribution of Race after WRAT-3 adjustment (semi-partial r ²)	β	p	Unique Contribution of Race after WRAT-3 and health adjustment (semi-partial r ²)
Episodic Memory											
AVLT total recall	39.8 (1.5)	50.0 (1.9)	-.472	.001	.053	-.376	.005	.032	-.381	.007	.031
HVLT total recall	20.5 (0.7)	24.4 (1.0)	-.348	.013	.028	-.235	.069	.013	-.225	.090	.011
Rivermead	4.4 (0.4)	7.1 (0.5)	-.532	<.001	.067	-.438	.002	.044	-.415	.006	.037
Inductive Reasoning											
Letter Series	3.9 (0.4)	5.8 (0.5)	-.354	.017	.030	-.321	.032	.024	-.357	.022	.027
Word Series	4.5 (0.5)	9.2 (0.7)	-.531	<.001	.067	-.478	<.001	.053	-.510	<.001	.056
Number Series	2.3 (0.4)	4.3 (0.5)	-.367	.014	.032	-.362	.017	.030	-.393	.012	.033
Letter Sets	3.2 (0.4)	7.1 (0.5)	-.647	.000	.098	-.627	<.001	.090	-.620	<.001	.082
Perceptual Speed											
Digit Symbol	28.3 (1.9)	43.6 (2.4)	-.501	<.001	.059	-.464	<.001	.049	-.488	<.001	.051
Finding A's	20.6 (1.1)	23.8 (1.5)	-.207	.169	.010	-.148	.322	.005	-.177	.250	.007
Identical Pictures	18.1 (1.0)	24.6 (1.3)	-.423	.001	.042	-.413	.002	.039	-.308	.025	.020
Global Status											
MMSE	26.4 (0.3)	27.8 (0.4)	-.320	.022	.024	-.252	.067	.014	-.272	.048	.016
Everyday Problem Solving											
EPT	11.9 (0.9)	15.9 (1.1)	-.308	.022	.021	-.223	.078	.011	-.217	.096	.009
Language											
Vocabulary Tests	5.1 (0.4)	7.3 (0.5)	-.314	.014	.023	-.212	.074	.010	-.222	.065	.011

Note: Group means shown are estimated marginal means before WRAT-3 adjustment, standard errors are presented in parenthesis. Age, education, gender, and site of recruitment were used as background covariates in all models. Semi-partial r-squared values for race represent the squared semi-partial correlations after adjusting for all other background covariates; i.e., the change in r-squared resulting when race was entered in a final step of a hierarchical regression in which all other predictors had been added in an earlier step. Model 1: Score = Block 1 (age, education, gender, site) + Block 2 (race); Model 2: Score = Block 1 (age, education, gender, site, WRAT-3) + Block 2 (race); Model 3: Score = Block 1 (age, education, gender, site, WRAT-3, arthritis, diabetes, heart disease, cancer, CES-D score) + Block 2 (race).