

Cognitive Decline and Literacy Among Ethnically Diverse Elders

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ABSTRACT

Researchers on genetic and environmental influences on risk for Alzheimer's disease must be prepared for the growing ethnic and racial diversity of our participants. Within the investigation, years of education has typically served as a proxy for cognitive reserve, which may be one factor in influencing risk of cognitive decline among aging people. However, among ethnic minorities, years of education is a poor reflection of the value of educational experience and native ability. This study was conducted among 1002 ethnically diverse English-speaking residents of Northern Manhattan who were cognitively and functionally normal at a baseline evaluation. We found that literacy level was a better predictor of decline in memory, executive function, and language skills than was years of education. The results of this study suggest that in an ethnically diverse cohort, literacy level should be considered as a mediator of the interactions of biological and environmental factors on cognitive decline. (*J Geriatr Psychiatry Neurol* 2005;18:213–217)

Keywords: literacy; cognitive decline; ethnicity

A higher prevalence of Alzheimer's disease (AD) and dementia among elders with low levels of education has been found in several countries.¹⁻³ Higher incidence of dementia among those with low levels of education has been demonstrated in several studies.⁴⁻⁷ Cognitive decline appears to be faster⁸⁻¹⁰ and associated with increased risk of mortality¹¹ among highly educated minorities with AD, which suggests that the level of brain abnormality is greater by the time well-educated persons show the signs of dementia. There is also evidence for a role of education in age-related cognitive decline. Several studies of normal aging have reported more rapid cognitive and functional decline among persons with lower educational attainment.¹²⁻¹⁸ These studies suggest that the same education-related factors that delay the onset of dementia also allow individuals to cope more effectively with changes encountered in normal aging.

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In a prior study,¹⁹ we wanted to determine whether reading level was a stronger predictor of memory decline (and thus a more sensitive indicator of reserve) than years of education or racial/ethnic classification, although each of these variables were expected to influence baseline scores. Reading level was used (as opposed to other measures used to estimate premorbid functioning) because of its stability in early dementia, its ease of measurement, and the suggestion in prior studies that it would be an accurate indicator of quality of education among ethnic minorities.²⁰ We focused our analyses on immediate and delayed recall measures from a verbal word list learning task, because these measures are sensitive to age-related memory decline and the earliest signs of AD. Among 136 participants, we found that elders with both high and low reading levels declined in immediate and delayed memory over time; however, the decline was more rapid among elders with a low reading level. There were no interactions between time and either years of education or ethnicity, suggesting that in this diverse population of normal elders, reading level was the most sensitive predictor of memory decline. Unlike many prior studies that examined the relationship of education to dementia or normal aging, we did not find that low education (less than 12 years) was a risk factor for cognitive decline. This finding may be related to the fact that because of our interest in normal aging, we required that participants maintain normal everyday functioning at each visit. The current study was conducted to address this issue and to determine whether

reading level was a significant predictor of cognitive decline among an ethnically diverse cohort of elders who were normal at baseline but were not selected to *remain* normal over time. In addition, we sought to determine whether decline occurred in other cognitive domains besides memory, specifically executive function and language skills. We hypothesized that after accounting for covariates such as age, gender, race/ethnicity, and years of education, elders with low literacy will experience more rapid decline in memory and executive functioning over time, but change in language skill would not differ between the groups.

METHOD

Sample

The participants for our research described below were selected from the Washington Heights Inwood Columbia Aging Project (WHICAP), a community-based, epidemiological study of dementia in the ethnically diverse neighborhoods of Northern Manhattan, New York. The WHICAP study follows a random sample of elderly Medicare recipients older than 65 years residing in selected census tracts of Washington Heights, Hamilton Heights, and Inwood. The population from which participants were drawn comprises persons from several different countries of origin and represents 3 broadly defined ethnic categories (ie, Hispanic, African American, and non-Hispanic white). The cohort represents a combination of continuing members of a cohort originally recruited in 1992 and members of a new cohort recruited between 1999 and 2001. Recruitment of all participants was initially achieved by contacting a stratified random sample of 50% of all persons older than 65 years obtained from the Health Care Finance Administration (CMS: Center for Medicare Services). Data on literacy began to be collected in 1997, during the third follow-up of the 1992 cohort. At that time, 904 elderly participants were available; this evaluation wave is considered their baseline visit for the current study. Literacy was collected during the initial visit of the 1999 cohort ($n = 2183$). Thus, the baseline visit of the current study includes 3087 potentially eligible elders. The study was approved by our institution's internal review board, and written informed consent was obtained from all participants.

Inclusion/Exclusion Criteria

Potential participants in the current study were included only if English was their primary language; they self-identified as Hispanic, African American, or non-Hispanic white; and if they had at least 1 follow-up evaluation. Participants were excluded from the current study if they had a history of stroke or Parkinson's disease and if at baseline they were diagnosed with cognitive or functional deficit of any type at a consensus conference of neuropsychologists and physicians, who reviewed all data and used

standard research criteria for dementia and cognitive impairment.^{21,22} In addition, participants were excluded if they did not have complete data on the English reading level measure.

Procedures

At the baseline evaluation, demographic data were collected. Trained neuropsychological technicians administered a brief yet comprehensive neuropsychological battery.²³ A research physician performed an examination of medical, psychiatric, and neurologic functioning, as well as a measurement of functional status. Baseline examinations were followed every 18 months with repeat medical, neurologic, psychiatric, and neuropsychological examinations.

Reading Level

English reading level was measured using the Reading Recognition subtest from the Wide Range Achievement Test—Version 3 (WRAT-3).²⁴ On this test, participants were asked to name letters and pronounce words out of context. Scores can range from 0 to 57. The words are listed in order of decreasing familiarity and increasing phonological complexity.

Statistical Methods

A factor analysis of the neuropsychological test battery, as described elsewhere,²⁵ yielded 3 stable factors, which reflected cognitive domains of memory, executive functioning, and language. Longitudinal analysis was performed using generalized estimated equations (GEE).²⁶ This method is based on regression models that do not require outcome measures to be independent of each other (in this case, the repeated neuropsychological test scores), and it does not require that these measures have a normal distribution. To improve statistical power, GEE uses the correlations among outcome measures. For this study, GEE analyses were performed to assess for differences in longitudinal performance among the literacy groups. The GEE analyses used literacy groups split on the median WRAT-3 score. The primary variables of interest in these analyses were literacy group (high vs low), time, and the interaction term literacy group \times time.

We evaluated age (67-78 vs >79 years), ethnicity (white, black, and Hispanic), gender, and years of education (high vs low, split at the median of 12 years) for inclusion as covariates, as well as the interactions of each of these variables with time. For each GEE analysis, we first included all covariates in the model and then trimmed back the model, retaining only those covariates that significantly contributed to prediction of memory test score.

Regression coefficients from these GEE analyses represent associations between a neuropsychological score and variables included in the model. A significant literacy group effect indicates a significant difference between the 2 groups at the baseline or any subsequent evaluation, with a positive regression coefficient indicating that the

group with high literacy obtained higher scores than the low literacy group. A significant literacy \times time regression coefficient indicates that there is a difference in the rate of change of test scores between the 2 groups.

RESULTS

Sample Characteristics

The composition of the current sample is provided in Figure 1. After subjects were removed from the baseline cohort for not meeting language and/or race/ethnicity criteria, 27% of the remaining sample were eliminated at baseline because they had prevalent stroke, Parkinson's disease, or cognitive or functional impairment on examination. Of those remaining, 18% were not seen for at least 1 follow-up evaluation because they refused, died, or were lost to follow-up. Of those remaining, 10% could not be included because they were missing data on key variables needed to address the study aims. In addition, *t* tests revealed that those missing the literacy test were not different from those included in the analysis in terms of age, $t(1, 072) = 0.3, P > .05$; years of education, $t(1, 076) = 0.3, P > .05$; or baseline memory factor scores, $t(1, 055) = 1.5, P > .05$. A total of 1002 participants met criteria for inclusion in the study.

Participants were stratified into 2 literacy groups based on the median performance of the group on the WRAT-3 reading test (median = 47). Table 1 presents the demographics of the 2 groups. As expected, the low literacy group had fewer years of education, and low literacy participants were more likely to be ethnic minorities than were the high literacy participants. The groups did not differ from each other on age or gender composition. Follow-up duration was somewhat longer in the low literacy group.

To determine differences in change in memory function between the 2 literacy groups, GEE analyses were performed. The final model, shown in Table 2, included 4 significant covariates, indicating that age and education had main effects memory score in the expected directions. Men attained lower scores than did women on the memory measures. There was a significant literacy group effect and a significant time effect. There was also a significant positive literacy \times time interaction, indicating that the low literacy group had a steeper decline in memory scores compared with the high literacy group. These results are also presented graphically in Figure 2. There was no significant effect of race/ethnicity or the interactions of race/ethnicity, age, or years of education with time; however, there was a significant interaction of gender and time, such that women experienced less decline over time than did men. Using the executive function factor score as the dependent variable in a GEE analysis showed similar results and that the interaction term of interest, literacy \times time, was significant. Finally, we found that

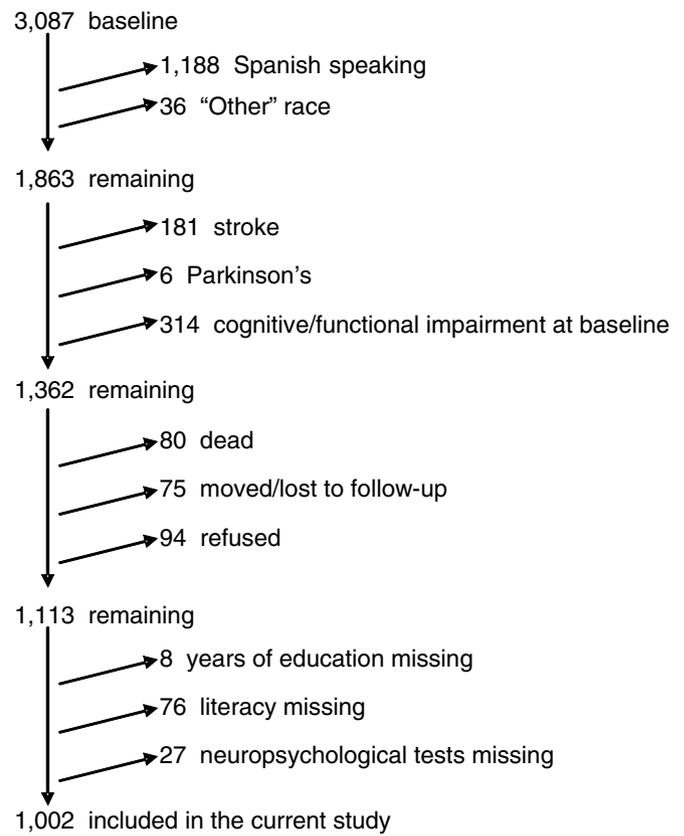


Figure 1. Cohort for the current study.

Table 1. Demographics, Reading Level, and Years Follow-up Among Low and High Literacy Groups

Reading Level	High	Low
n	532	470
Age at baseline (SD)	75.5 (6.2)	75.9 (5.9)
Female, %	67.1	69.8
White, %	73.6	26.4*
Years of education (SD)	14.0 (3.1)	11.1 (3.4)*
Reading level (SD)	51.0 (2.3)	40.7 (7.0)*
Years follow-up (SD)	3.2 (1.7)	3.6 (1.8)*

* $P < .001$.

elders with low literacy also have a significant but small increase in the rate of decline of language skills over time.

CONCLUSION

The current study demonstrates that literacy is a crucial predictor of cognitive decline among an ethnically diverse cohort of English-speaking elders. Along with our previous work,^{19,27,28} this study shows that not only does literacy influence the specificity of neuropsychological measures but it is also a consistently stronger factor in determining rate of decline in memory, executive function, and language than is years of education. Based on the results of

Table 2. Beta Weights and P Values for Generalized Estimated Equations Models Predicting Cognitive Factor Scores

	Memory		Executive		Language	
	β	P	β	P	β	P
Age	-14.9	.000	-2.7	.000	-0.4	.000
Gender	7.0	.002				
Education	12.4	.000	8.4	.000	0.5	.000
Black race			-4.5	.000	0.4	.001
Hispanic ethnicity						
Literacy	15.9	.000	11.6	.000	1.2	.000
Time	-5.2	.000	-0.9	.000	-0.2	.000
Gender \times literacy	0.6	.000				
Time \times literacy	3.2	.002	1.0	.002	0.2	.000

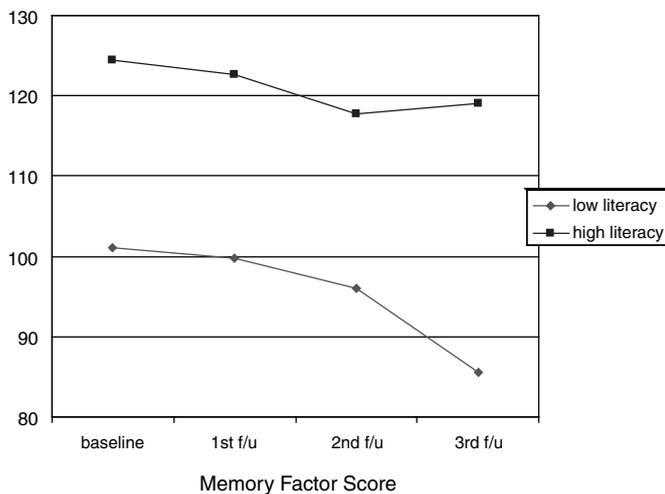


Figure 2. Effect of literacy on change in memory factor score over time.

this work, we propose that regardless of race/ethnicity, literacy measures reflect educational experience more accurately than do years of education and, thus, are a superior assessment of the knowledge, strategy, and skills needed to perform well on traditional neuropsychological tasks. Test scores adjusted for reading level can be used to predict performance more accurately than if only years of education and racial/ethnic classifications are used.

In the United States there is a great deal of discordance between years of education and reading level; this discordance is especially true among African Americans. Previous studies revealed that elderly African Americans have reading skills that are significantly below their self-reported education level.^{29,30} The unequal distribution of funds to African American schools, and the subsequent lower quality of education, has been studied as the source of this discordance between years of education and achievement.³¹⁻³⁴

The relevance of this study to children of people with AD is 2-fold. First, assessment and research of families of people with AD, especially ethnic minorities, should include literacy level, as this study suggests it is an impor-

tant indicator of cognitive reserve. Literacy level could be a more accurate reflection of native ability because it does not assume that all persons get the same amount of learning from a certain grade level; the fact that some excel more than others or seek learning outside of school will be reflected in measurements of reading level. It is possible that literacy level could be a more sensitive proxy for cognitive reserve than years of education because it more accurately reflects the quality of the educational experience provided to ethnic minority elders. Second, as our nation becomes more culturally and linguistically diverse, we must find efficient and meaningful ways to inform ourselves about premorbid experiences that will impact willingness to participate in research, the assessment and diagnostic process, the interactions of genes with environment on disease, and possibly resistance to cognitive decline.

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