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The Urban Neighborhood and Cognitive Functioning in Late Middle Age

Carol S. Aneshensel[1], **Michelle J. Ko**[1], **Joshua Chodosh**[1,2], and **Richard G. Wight**[1]

[1]University of California, Los Angeles

[2]Veterans Administration Greater Los Angeles Healthcare System

Abstract

This study examines the association of cognitive functioning with urban neighborhood socioeconomic disadvantage and racial/ethnic segregation for a U.S. national sample of persons in late middle age, a time in the life course when cognitive deficits begin to emerge. The key hypothesis is that effects of neighborhood on cognitive functioning are not uniform but are most pronounced among subgroups of the population defined by socioeconomic status and race/ethnicity. Data are from the third wave of the Health and Retirement Survey for the birth cohort of 1931 to 1941, which was 55 to 65 years of age in 1996 (analytic N = 4,525), and the 1990 U.S. Census. Neighborhood socioeconomic disadvantage has an especially large negative impact on cognitive functioning among persons who are themselves poor, an instance of compound disadvantage. These findings have policy implications supporting "upstream" interventions to enhance cognitive functioning, especially among those most adversely affected by neighborhood socioeconomic disadvantage.

Keywords

cognition; ecological model; multilevel model; neighborhood

Although research into the health effects of neighborhood characteristics, especially socioeconomic disadvantage, has increased exponentially in the past decade, cognitive functioning has received scant attention. Our concern with cognitive functioning is driven by the aging of American society because the prevalence of age-related declines in cognitive functioning is expected to increase enormously in the future (Bruner 2005). These declines command our attention because mild impairment can be a precursor to Alzheimer's disease and other severe dementias (Mitchell and Shiri-Feshki 2009). These conditions, in turn, (1) are major sources of impairment in activities in daily living (ADLs) (Sauvaget et al. 2002), (2) typically require considerable informal caregiving—generating health-compromising burdens for caregivers (Aneshensel et al. 1995)—and (3) are major contributors to costly institutionalized care for the aged (Banaszak-Holl et al. 2004). Linking poor cognitive functioning to neighborhood conditions would direct policy attention to "upstream" interventions, that is, interventions that focus on the "real" or underlying determinants of the social patterning of disease (McKinlay and Marceau 2000), that have the capacity to reach large numbers of at-risk persons and, hence, reduce disparities in cognitive functioning. This study examines this linkage for a U.S. national sample of persons in late middle age, a stage in the life course when cognitive deficits begin to emerge (Dickerson et al. 2007; Salthouse

Corresponding Author: Carol S. Aneshensel, Department of Community Health Sciences, University of California, Los Angeles, School of Public Health, Box 951772, 650 Young Drive South, Los Angeles, CA 90095-1772, anshnsl@ucla.edu.

2009), focusing on the extent to which urban neighborhood effects are manifest uniformly, or are more pronounced among some social strata defined by socioeconomic status (SES) and race/ethnicity.

INTRODUCTION

A handful of existing studies support the idea that neighborhood characteristics are associated with cognitive functioning among elderly persons. For example, a recent study of Mexican Americans found that "barrio" residents (i.e., low-income, almost exclusively Mexican American neighborhoods) have an elevated risk of cognitive impairment compared to "transitional" and "suburban" residents, but this study is limited to a single subgroup of the population and a single region of the U.S., the Southwest, limiting generalizability (Espino et al. 2001). In contrast, Sheffield and Peek (2009) recently found that for older Mexican Americans, the proportion of neighborhood residents who are Mexican American is related to a slower rate of cognitive decline, a potential "ethnic enclave" effect; they also found that neighborhood socioeconomic disadvantage is related to a greater rate of decline over time.[1] However, this study also has limited generalizability for the same reasons as the earlier one. For a national sample of older persons in England, cognitive functioning was found to be inversely correlated with neighborhood socioeconomic deprivation (Lang et al. 2008); although this study has good external validity, it did not use multilevel modeling, the preferred method of analysis when individuals are nested within neighborhoods. Wight and colleagues (2006), in the only multilevel analysis of a U.S. national sample, found that cognitive functioning among adults age 70 or older varied inversely with the average educational attainment within the neighborhood, especially among persons whose own educational attainment was limited. The study was based on the Assets and Health Dynamics Among the Oldest Old (AHEAD) cohort of the Health and Retirement Study (HRS). It constitutes the most definitive study to date on neighborhood and cognition among elderly persons because it used appropriate statistical methods and multilevel modeling with a large nationally representative sample of older persons, generating excellent external validity.

The current study is unique because it is the first to focus on neighborhood and cognition in late middle age, a time of life when cognitive deficits begin to emerge (Dickerson et al. 2007; Salthouse 2009). It is imperative to ascertain the correlates of early and mild cognitive deficits because such deficits are implicated in more severe impairment later in life (Werner, Stein-Shvachman, and Korczyn 2009). This is particularly true for social etiological factors that might be changed through intervention and thereby inhibit the development of more profound cognitive deficits later in life.

Alwin (2008) observes that the role of the social environment in affecting cognition potentially changes over the life span. We test this possibility for neighborhood influences on cognitive functioning by comparing our findings for late middle age to those of Wight and colleagues (2006) for elderly persons. In addition to providing comparative data, however, the current study goes beyond the earlier study, employing a much broader conceptualization of neighborhood socioeconomic disadvantage. Also, we consider the impact of the racial/ethnic segregation of neighborhoods because we posit that segregation may be harmful to cognitive functioning and because there is mixed evidence concerning potential ethnic enclave effects for elderly persons as described above.

[1]These discrepant findings may be due to methodological differences: Espino et al. (2001) contrast three neighborhoods, for which the classification of "barrio" is completely confounded with socioeconomic status (SES), whereas Sheffield and Peek (2009) use a multilevel model and separate measures of ethnic composition and socioeconomic disadvantage.

Neighborhood Socioeconomic Disadvantage and Cognitive Functioning

We contend that impoverished neighborhoods foster poor cognitive functioning because such neighborhoods restrict opportunities for socially derived cognitive stimulation. Existing evidence suggests that social engagement, or participation in socially meaningful or productive activity, is protective against cognitive decline (Barnes, Cagney, and Mendes De Leon 2008; Ertel, Glymour, and Berkman 2008). Barnes and colleagues (2008) note that social capital may influence health by bridging the social resources to which people have access through individual-level social interactions (e.g., an actual exchange of social support) and the totality of community-level resources that exist among people in a community. Similarly, Alwin (2008) points out that cognition occurs within a configuration of opportunities and constraints linked to social roles, institutional arrangements, and interpersonal relationships.

We draw on the work of Massey and Denton (1993), who describe a mutually reinforcing relationship between social decay and social withdrawal in hypersegregated, underclass urban communities, conditions we posit are harmful to cognitive functioning. When residents experience public deviance—such as the presence of delinquency, vandalism, and unsupervised youth—they tend to retreat socially and psychologically from their communities; they stay away from certain sites, avoid strangers, remain indoors, and generally keep to themselves, interacting with a small set of relatively homogeneous close friends and relatives (Massey and Denton 1993). As a result, social interactions may offer less than optimal cognitive stimulation, lacking the heterogeneity that would be provided by interacting with people of diverse backgrounds, situations, and characteristics. Social isolation also limits social support, which translates into poor cognitive functioning (Crooks et al. 2008; Ertel et al. 2008). In addition, the threatening conditions that lead residents to withdraw are experienced as stressful and generate psychological distress (Aneshensel and Sucoff 1996; Ross 2000). Both of these states independently impede cognitive functioning (Chodosh et al. 2004; Karlamangla et al. 2005; Wight, Aneshensel, and Seeman 2002; Wilson et al. 2007).

Our thinking here also is influenced by Rankin and Quane (2000), who remind us that communities influence patterns of social relations by virtue of the types of people encountered in their social environment. Summarizing literature on poor neighborhoods and social isolation, Rankin and Quane observe that within communities where one class predominates, people tend to have friends from that class, regardless of their own class, so residents of poor neighborhoods are unlikely to have contact with neighbors who are better off financially. Thus, residents of poor neighborhoods are likely to interact with neighbors whose ability to offer a full complement of cognitive stimulation may be suppressed by their own poverty as well as their limited educational attainments because these attributes are associated with lower levels of cognitive functioning (Cagney and Lauderdale 2002; Wight et al. 2002). In contrast, socioeconomically advantaged neighborhoods expose affluent residents to other affluent residents. These neighbors should offer extensive cognitive stimulation that comes from instant access to the world of knowledge. Thus, we hypothesize that (hypothesis 1) there is a negative association between neighborhood socioeconomic disadvantage and cognitive functioning.

However, the cognitive consequences of living in disadvantaged neighborhoods may accrue to everyone who resides in the neighborhood, or they may selectively apply to some residents more than others. This idea flows from the ecological framework principle, that the same environment has systematically different effects on people depending upon their personal characteristics and situations (Bronfenbrenner 1979). Thus, our next hypothesis is that the cognitive impact of neighborhood socioeconomic disadvantage is conditional upon the individual's own SES rather than being uniform across persons of differing SES. On the basis of findings of Wight and colleagues (2006), we specifically posit that (hypothesis 2) the effect of neighborhood socioeconomic disadvantage varies inversely with personal SES, such that the most disadvantaged persons living within disadvantaged neighborhoods have exceptionally poor cognitive functioning, an instance of "compound disadvantage" (Wheaton and Clarke 2003), that is, a synergistic or more than additive influence of neighborhood- and individual-level socioeconomic disadvantage.

Neighborhood Segregation and Cognitive Functioning

The current study uniquely adds to the literature on neighborhood and cognitive functioning by considering the impact of racial/ethnic segregation, contrasting the effects of racial segregation of African Americans on the one hand with ethnic enclave effects for Latinos on the other. Racial segregation has created distinctive ecological environments for African Americans in that most poor African Americans reside in neighborhoods of concentrated poverty (Williams and Collins 2001); neighborhood poverty, we contend, is linked to poor cognitive functioning, as described above. In addition, racial segregation reinforces racial differences in opportunity structures and access to resources, and increases exposure to discrimination (Robert and Ruel 2006), factors that are likely to elevate stress and psychological distress, which in turn interfere with cognitive functioning (Chodosh et al. 2004; Karlamangla et al. 2005; Wight et al. 2002; Wilson et al. 2007). Thus, we hypothesize that (hypothesis 3) the proportion of neighborhood residents who are African American is negatively associated with cognitive functioning (hypothesis 4), especially among African Americans (Gee et al. 2006). We also posit a conditional relationship with the individual's own SES, such that (hypothesis 5) the harmful effect of racial segregation varies according to the person's own SES, being exacerbated among those of low SES and being offset among those of more ample means.

A decidedly different theoretical perspective is that of ethnic enclaves (Ostir et al. 2003; Shaw and McKay 1969), which predicts a beneficial effect of living within a neighborhood characterized by a high concentration of co-ethnics through the creation of social networks and the diffusion of positive cultural practices (Aneshensel and Sucoff 1996; Eschbach et al. 2004; Lee and Ferraro 2007; Patel et al. 2003). However, any cognitive benefits of living among persons like oneself may be overridden by the adverse effects of factors associated with segregation (e.g., discrimination) and accompanying socioeconomic disadvantage. Given the mixed evidence on ethnic enclave effects for cognitive functioning among elderly persons (Espino et al. 2001; Sheffield and Peek 2009), we additionally test the idea that (hypothesis 6) living in a neighborhood with a high concentration of Hispanics will be associated with better cognitive functioning and that (hypothesis 7) this effect will be most pronounced for Hispanics living in predominantly Hispanic neighborhoods.[2] We also posit a cross-level interaction such that (hypothesis 8) the beneficial effect of living in a predominantly Hispanic neighborhood depends upon the person's own SES.

Urban Neighborhoods

The theory presented above assumes an urban context insofar as it has as a cornerstone the adverse consequences of living within hypersegregated underclass urban areas. Galea, Freudenberg, and Vlahov (2005) recently have described urban social structures and living conditions as unique determinants of health. In particular, they single out the close proximity of areas with high concentrations of impoverished people, ethnic minorities, and recent immigrants on the one hand and very wealthy, typically non-Hispanic white persons on the other. The very juxtaposition of these disparate populations may exacerbate the adverse

[2]We use the term *Hispanic* rather than *Latino* because this is the term used in the Health and Retirement Study (HRS) data and the 1990 Census.

health consequences of poverty or segregation. These considerations lead us to believe that investigations that are limited to urban environments are more meaningful than those that also encompass rural areas and simply control for a main effect of living in an urban or nonurban area.

METHOD

The data for this project are from the HRS linked to the 1990 U.S. Census, which is our operationalization of neighborhood. The HRS is a biennial, longitudinal, multicohort study of large, nationally representative samples of persons ages 50 and older. The original HRS cohort (HRS1), which commenced in 1992, was designed to follow adults (born 1931 to 1941) as they made the transition from active worker into retirement. It was joined in 1993 by the companion cohort, AHEAD, consisting of persons ages 70 and older (born before 1924), designed to examine the postretirement and end-of-life period. Our analysis utilizes HRS1. Findings are then compared to those previously reported for the AHEAD cohort (Wight et al. 2006).

The target population for the HRS cohorts included all adults in the contiguous United States born during the birth cohort years who resided in households. The HRS samples were selected under a multistage area probability sample design based on the 84-strata national sample frame of the University of Michigan, Institute for Social Research, Survey Research Center, with oversamples of blacks, Hispanics, and residents of Florida. Sample weights adjust for differential selection probabilities, and statistical procedures adjust for the complex sample design. Housing units (HU), the observational unit, were included if they contained at least one age-eligible member from the birth year cohort: (1) a single unmarried age-eligible person, (2) a married couple in which both persons are age eligible, or (3) a married couple in which only one spouse is age eligible. If the HU contained more than one unrelated age-eligible person, one person was randomly selected. If an age-eligible person had a spouse, he or she was automatically selected irrespective of age.

Baseline interviews were conducted face-to-face. Follow-up interviews were conducted by telephone. Interviews were conducted in English or Spanish. Main survey topics include demographic background and family structure; health status; religion; housing; income and assets; employment, retirement, and job history; and future plans. Analysis is based on the RAND HRS data set (RAND HRS Data 2007).[3]

Analytic Sample Derivation

We focus on late middle age because it is during this time that age-related cognitive deficits first manifest. Thus, we utilize the original HRS1 birth cohort of 1931 to 1941, which was 51 to 61 years of age at the 1992 baseline survey. We analyze the sample as constituted at the third interview in 1996 because this is the first full assessment of cognitive functioning; previous waves used abbreviated measures. Participants then were ages 55 to 65. Of the data collections with a full assessment of cognition, this one is closest to the 1990 Census, which is desirable because neighborhood effects may dissipate over time or neighborhoods may change. Although the survey that coincides with the 2000 Census is more recent, we use the earlier data to minimize the effects of sample attrition.

At Time 3, the sample size was 10,964 individuals, with 424 not surveyed due to reassignment to other HRS cohorts, 504 deceased, 1,463 nonresponders known to be alive,

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[3]The RAND HRS Data (2007) file is an easy-to-use longitudinal data set based on the HRS data. It was developed at RAND with funding from the National Institute on Aging and the Social Security Administration. It is can be accessed at http://www.rand.org/labor/aging/dataprod/.

28 dropped from the sample, and 51 of unknown status (RAND HRS Data 2007). For these analyses, the following were sequentially removed from the analytic sample: 2,505 age-ineligible spouses; 520 proxy interviews, which are missing on the dependent variable; and 479 with other missing or invalid data. An additional 2,935 persons were removed because they did not reside in an urbanized area as defined by the Census. Urban was operationalized as tracts within which at least 75 percent of the population lived in an urbanized area; the arbitrary cut point was selected to ensure the inclusion of predominantly urban tracts. The final analytic sample size is 4,525.[4]

Weights adjust for variation in the probabilities of selection and attrition between baseline and Time 3. Thus, the analytic sample is nationally representative of persons ages 51 to 61 in 1992 who survived to 1996 without cognitive or physical impairment sufficient enough to require proxy assistance during the interview and who were living in the community in urban areas. The omission of persons who required proxy assistance and the limitation of the sample to community-dwelling persons mean that the sample is somewhat biased toward healthy persons.

Measures

Dependent variable—A multidimensional measure of cognitive functioning was used and was based on the Telephone Interview for Cognitive Status (Brandt, Spencer, and Folstein 1988). First, memory was assessed with immediate and delayed word recall tasks. For immediate recall, the interviewer read a list of 10 short, concrete, high-frequency nouns and asked the respondent to recall as many as possible (scored 0 to 10). Delayed recall of the same 10 nouns occurred after five minutes of asking other questions (scored 0 to 10). Second, working memory, attention, and calculation were assessed by using the serial sevens subtraction test, in which respondents subtracted 7 from 100 for a total of five trials (scored 0 to 5) for the number correct. Third, other dimensions of mental status were measured by correct answers to the following tasks: attention (counting backward for 10 continuous numbers beginning with 20, as quickly as possible; range 0 to 2); orientation to time (date, month, year, day of week; range 0 to 4); language (object naming; range 0 to 2); and knowledge of current affairs (naming the president and vice president; range 0 to 2). The total score (range 0 to 35) has been validated and has a near-normal distribution, reflecting the large verbal memory component, which is sensitive to early cognitive change and less susceptible to ceiling issues (Brandt et al. 1988; Herzog and Wallace 1997; Rodgers, Ofstedal, and Herzog 2003). Respondents with missing values were dropped from the analysis (n = 81).

Individual-level independent variables—We have incorporated as fully as possible known covariates of cognitive functioning as available in the HRS survey data, such as those specifically identified for HRS in the Aging, Demographics, and Memory Study (Langa et al. 2005), because a comprehensive individual-level model is essential to the assertion that any neighborhood-level covariates probably represent contextual effects as distinct from compositional effects. These measures were taken from the RAND HRS data set (see note 3). Measures of sociodemographic characteristics include educational attainment (coded as the highest grade of school completed), household wealth (the sum of all wealth components, e.g., value of primary residence and savings minus all debt, in thousands of dollars; a constant was added to eliminate negative values prior to taking the log to improve the skew), household income (e.g., individual’s and spouse’s earnings, pensions, social

[4]The sample includes 2,805 respondents who are the only respondent in the household and 1,720 respondents from households with two respondents because age-eligible spouses are included. Although the presence of spouses introduces another level of clustering, we do not have hypotheses about households and therefore do not model the household level of clustering. However, the non-independence of observations within households is taken into consideration with the robust standard errors.

security, in thousands of dollars; logged to improve the skew), gender, age, race/ethnicity (non- Hispanic white, African American, Hispanic, other), marital status (married, widowed, separated/divorced, never married), and employment status (employed full- or part-time, unemployed, retired, disabled, other).[5] Social integration counts volunteer activity (1 = at least one hour in the past year; else = 0); contact with parents and with children (1 = weekly or more contact by phone, by mail, or in person; else = 0); and getting together with neighbors to chat or for a social visit (1 = weekly or more; else = 0); range = 0 to 4 (Ertel et al. 2008).[6]

Health conditions that may interfere with cognitive functioning fall into five categories. The first is activities of daily living (ADL), a count (0 to 6) of self-reported functional limitations with personal care tasks (e.g., walking across a room, dressing). The second is a count (0 to 6) of physician-identified major chronic conditions (e.g., diabetes, hypertension, heart disease), along with a separate indicator for diabetes because it was statistically significant in preliminary analysis beyond its contribution with the count variable. The third is depressive symptoms according to the Center for Epidemiologic Studies–Depression Scale (Radloff 1977) and is scored 1 for yes and 0 for no for the probe of whether respondents had experienced “much of the time in the past week” (Steffick 2000; Turvey, Wallace, and Herzog 1999) for eight symptoms (e.g., felt depressed, felt that everything I did was an effort). Positively worded items are reverse coded and items summed. Self-rated health was assessed with categories ranging from 1 to 5 for *excellent*, *very good*, *good*, *fair*, and *poor*; although sometimes dichotomized, we use its original scoring to avoid losing information and statistical power. Two health behaviors—smoking (former, current, or never) and drinking (0, 1, or 2 or more per day)—also were considered. However, these variables were not statistically significant ($p > .05$) in preliminary models and therefore are not included in the final models reported below.

Although there is growing evidence that early-life conditions influence cognitive functioning in late life (e.g., Fors, Lennartsson, and Lundberg 2009), the following variables were not statistically significant ($p > .05$) in preliminary analysis and therefore are not included in the final models presented below: parental education and childhood health (rated the same as self-rated health).

Neighborhood-level independent variables—Neighborhood-level variables are taken from the 1990 Census as compiled by Geolytics and the Urban Institute (2007). Socioeconomic disadvantage is a principal component comprising the proportion of residents ages 25 or older without a high school degree, households receiving public assistance income, residents living below the poverty level, and residents ages 16 or older who are unemployed. Racial/ethnic segregation is operationalized as the proportion of residents who are African American and proportion of residents who are Hispanic, respectively. These are proxy measures of segregation, which typically is applied to larger areas than neighborhoods, such as cities, and assessed with measures such as a dissimilarity index, but this operationalization is the norm in neighborhood research using Census tracts. Due to its skew, we also tested the final models with the log-transformed proportion African

[5]We use a composite variable in the RAND HRS data set (RAND HRS Data 2007) that combines responses to a set of non–mutually exclusive questions. Persons who mention both retirement and working are recoded to working, as were part-time workers. The other category includes those who are not in the labor force. This operationalization of employment status sacrifices some detail but is sufficient as a control variable.

[6]Ertel, Glymour, and Berkman (2008) used a five-item version of this measure that also included being married, which we treat separately as a category of marital status. Also, they treated persons without the potential source of integration as missing, whereas we score such persons as zero. The item pertaining to children was recorded for either spouse having contact, meaning that it is not specific to the respondent but instead reflects the social integration of the couple.

American, but results were the same, so we present the original scoring, as this is the usual practice.

Analysis

Descriptive statistics are calculated with the Stata SVY procedure. Hierarchical linear regression models are estimated with robust standard errors using HLM 6.04. Variables are grand-mean centered.

First we estimated a null model containing only a random intercept to ascertain the gross amount of between-neighborhood variation in cognitive functioning. Then we added individual-level variables to the model to ascertain how much of this variation remains after taking into consideration compositional effects (model 1 in Table 2). The next step added the main effects of the three neighborhood-level variables: socioeconomic disadvantage, proportion African American, and proportion Hispanic (hypotheses 1, 3, 6; model 2 in Table 2). To minimize the possibility of making a Type I error, we compared the fit of model 2 to an identical model that also contained all of the interaction terms, testing the null hypothesis that all of the coefficients for the interactions terms equal 0; we failed to reject this hypothesis, meaning that at least one of the terms probably is statistically significant ($\chi^2 = 62.81$, $df = 26$, $p < .001$).[7] Consequently, we proceeded to test each of the cross-level interactions derived from our conceptual model individually to avoid problems of multicollinearity: neighborhood-level socioeconomic disadvantage, proportion African American, and proportion Latino conditional upon individual-level SES as indexed by education, income, and wealth (hypotheses 2, 5, and 8, respectively); and neighborhood-level proportion African American and Hispanic conditional on individual-level race/ethnicity (hypotheses 4 and 7, respectively). Statistically significant ($p < .05$) terms were combined into a composite model, and terms that became nonsignificant were trimmed from the final model (model 3 in Table 2).

RESULTS

Sample Characteristics

Characteristics of the analytic sample appear in Table 1. There are somewhat more women than men, which reflects the fact that the average age is almost 60 years, when the greater longevity of women has begun to be apparent. Almost three out of four participants are married, followed in size by those who are separated or divorced. One in 12 respondents is widowed. Almost two-thirds of the sample is employed, with another quarter being retired. The sizeable numbers of widowed and retired persons indicate that major transitions in life course trajectories are underway among this sample.

The sample is well educated, household income is above the national median ($35,172), and there is substantial wealth as well. However, there is considerable variation in these socioeconomic indicators, meaning that the sample also encompasses those of very low SES. Three out of four participants are non-Hispanic white in background, with specific other groups present at much lower rates. The average participant reports approximately two of the four sources of social integration: parents, children, neighbors, volunteer activities.

Table 1 validates the earlier description of the sample as being somewhat biased toward healthy persons. Although ADLs are low, on average, 6 percent need assistance with two or

[7]The degrees of freedom for this test are the number of variables required to operationalize the interactions, which are larger than the number of conceptual interactions for two reasons. First, three components of SES are tested: education, income, and wealth. Second, for education, the individual-level interactions by race/ethnicity are modeled in the cross-level interactions as well as the cross-level interaction for education itself.

more activities. Depressive symptoms also are quite variable: Whereas 37 percent report no symptoms whatsoever, 22 percent endorsed three or more of the eight items. The self-rated health mean is equivalent to a response midway between *very good* and *good*.

For the dependent variable, the mean cognition score equates to an average of 72.2 percent correct. The full range of scores was observed. Only 0.62 percent received a perfect score, alleviating concerns about a ceiling effect. Although the omission of proxy interviews effectively screened out persons with severe cognitive impairment, some very low scores were observed. Applying the cut point value of 12 (Freund and Szinovacz 2002) yields 1.10 percent (weighted) of the sample as impaired. In summary, the sample is in general cognitively well functioning but encompasses persons with marked deficits.

Of particular note with regard to characteristics of the Census tracts included in this study is the amount of variability. The principal component entry is uninformative because it is a standardized score, so for descriptive purposes, it is more useful to look at its components, as shown in italics in Table 1. The minimum and maximum values for all of these variables (not shown) demonstrate that these neighborhoods encompass extreme socioeconomic disadvantage through affluence and are hypersegregated to diverse communities.

Overall Neighborhood Variation in Cognitive Functioning

Preliminary analysis estimated an intercept-only or null model containing only a random intercept, which reveals statistically significant between-neighborhood variation in cognitive functioning across Census tracts ($\tau = 3.708$, $p < .001$). The intraclass correlation, which is the ratio of between tract variation to total variation, however, is moderate in size ($\rho = .19$), indicating that most of the variation in cognitive functioning is at the individual level. This finding is to be expected, given the influence of genetic and other biological factors on cognitive functioning as well as the unique life course experiences of each individual that shape cognitive functioning.

Preliminary Model of Cognitive Functioning

As a prelude to examining neighborhood-level variables, cognitive functioning was regressed on the individual's sociodemographic characteristics and health status, as shown in model 1 of Table 2. Women score more than a point higher than men (on a 35-point scale), net of other variables in the model. Age is associated with lower scores: The 10-year age span of participants equates to less than a 1-point difference on the measure. Employed persons score higher on the cognition measure than those who are retired or those not working because of a disability.

The beneficial impact of formal education on cognitive functioning varies significantly by race, with the advantage conferred by each year of education being substantially greater among African Americans than non-Hispanic whites. Among persons with an eighth-grade education, non-Hispanic whites score 3.6 points higher than African Americans, on average, a difference that is reduced substantially to 2.1 points among high school graduates and is only 0.5 points at college graduation, ceteris paribus. In contrast, persons of Hispanic or other backgrounds accrue approximately the same cognitive benefits from formal education as do non-Hispanic whites, and these groups have, on average, approximately the same level of cognitive functioning as non-Hispanic whites, other things being equal. Although household wealth is independently associated with better cognitive functioning, income is not. The extent of the person's social integration is positively associated with his or her cognitive functioning.

Three of the five health status indicators are statistically significant ($p < .05$): depressive symptoms, diabetes, and self-rated health.

As also shown for model 1, statistically significant residual variation between neighborhoods in cognitive functioning remains when individual-level attributes are taken into consideration. Compared to the null model, the addition of individual-level attributes produces an 81.6 percent reduction in between-neighborhood variation, which represents the impact of taking into account compositional effects.

Multilevel Models of Cognitive Functioning

Model 2 in Table 2 adds the main effects on cognitive functioning of the three neighborhood-level variables. Model 1 is nested within model 2, meaning that the difference in their deviation scores tests the null hypothesis that the coefficients for the additional variables all equal 0, a hypothesis we marginally fail to reject ($\chi^2 = 6.639$, $df = 3$, $p < .10$). As shown, none of the individual regression coefficients is statistically significant. However, when modeled individually, the negative coefficient for socioeconomic disadvantage is statistically significant ($p < .05$; not shown).

The inclusion of the neighborhood-level variables as a set does not appreciably change the coefficients for the individual-level variables, with a few exceptions that pertain to coefficients that remain statistically nonsignificant ($p > .05$). Statistically significant between-neighborhood variation remains after taking into consideration the amount of socioeconomic disadvantage and racial/ethnic composition of neighborhoods. This variation is reduced only slightly (1.4 percent) from model 1.

Model 3 in Table 2 presents the results of the sequential tests for cross-level interactions described in the Method section. The addition of these interactions is a statistically significant improvement compared to model 2 ($\chi^2 = 18.697$, $df = 5$, $p < .01$). The inclusion of these terms produces only a slight reduction in the amount of between-neighborhood variation (4.3 percent). As can be seen, the effects on cognitive functioning of some neighborhood-level characteristics are contingent on characteristics of the person. The first interaction term shown in Table 2, model 3, entails the declining cognitive impact of neighborhood socioeconomic disadvantage as individual wealth increases, as plotted in Figure 1.[8]

As can be seen, neighborhood socioeconomic disadvantage has a strong negative association with cognitive functioning among persons with little personal wealth but is not associated with cognitive functioning among persons of above-average wealth. As a result, personal wealth has no effect on cognitive functioning in well-to-do neighborhoods but exerts a strong protective effect within impoverished neighborhoods. Poor persons living in impoverished neighborhoods exhibit, on average, especially low levels of cognitive functioning.

As also shown in model 3 of Table 2, the cognitive impact of the neighborhood concentration of African Americans depends upon the person’s own educational attainment. Figure 2 illustrates this cross-level interaction.[9] Among persons with little formal education, cognitive performance declines slightly as the proportion of African Americans in the neighborhood increases. However, racial composition of the neighborhood does not matter

[8]This plot is derived by substituting into the equation the mean values for continuous variables, which are equal to zero because the variables are grand-mean centered, and the reference category of zero for categorical variables, with the following exceptions: Race/ethnicity is set to the sample proportions, and wealth and neighborhood socioeconomic disadvantage are plotted at the mean and in increments of half a standard deviation around the mean. Two lines are truncated to reflect data sparseness.

[9]To plot this interaction, values are derived as described in Note 8, except for education, which is plotted at the mean, which is slightly more than a high school education, plus or minus one standard deviation, which approximates college graduation and the 10th grade, respectively, and the proportion African American, which because of its extreme skew is plotted at the 25th percentile (.007), the mean (.212), and the 90th percentile (.857).

to cognitive functioning among persons of average educational attainment. Among persons with higher levels of formal education, cognitive functioning increases as the proportion of African Americans increases. Consequently, the lowest and highest average levels of cognitive functioning both occur in neighborhoods with high concentrations of African Americans. Within each type of neighborhood, cognitive functioning increases as education increases.

In general, the inclusion of these interactions does not appreciably alter the coefficients for individual-level covariates, except insofar as these covariates are parts of the interaction terms. The exceptions are the coefficients for the individual-level interaction of education by race, which decreases substantially. Additional analysis (not shown) indicates that this reduction is due to the inclusion of the cross-level interaction between the proportion of African Americans and education. Thus, some of the extra cognitive benefit that African Americans accrue from formal education appears to be due to the cognitive benefits that come from being highly educated within predominantly African American neighborhoods.

DISCUSSION

Our findings indicate that the impact of neighborhood conditions on cognitive functioning among persons in late middle age is not uniformly manifest across this population in its entirety, but it is instead differentially consequential to select subgroups of the population defined by SES. Although we had hypothesized that each of the three neighborhood attributes considered would be associated with cognitive functioning (hypotheses 1, 3, and 6), when these neighborhood attributes are relevant to cognitive functioning, their effects are conditional, disconfirming these “main effects” hypotheses.

Instead, we find support for the hypothesis that the impact of neighborhood socioeconomic disadvantage is conditional upon personal SES (hypothesis 2). In particular, neighborhood socioeconomic disadvantage is associated with cognitive functioning, but this association varies inversely with the person’s own SES, specifically his or her personal wealth. A person’s cognitive functioning appears to be enhanced by personal *or* neighborhood socioeconomic assets, but one asset does not augment the other. Thus, there may be an upper limit to the cognitive benefit that can be garnered either by being wealthy or by living in a wealthy neighborhood. Although a socioeconomically advantaged neighborhood does not enhance the already high cognitive functioning of wealthy persons, the same cannot be said for residents of average or below-average wealth (although the latter tend not to live in the most advantaged neighborhoods). Their elevated levels of cognitive functioning are consistent with the “advantages of advantaged neighbors” perspective described by Jencks and Mayer (1990); its application to this situation predicts that the greatest cognitive benefits will accrue to those of low SES because they have the greatest capacity to gain from a social environment where they interact with more affluent neighbors.

In sharp contrast, there does not appear to be a limit to the adverse impact of poverty; indeed, being poor in a socioeconomically disadvantaged neighborhood produces compound cognitive deficits. The steep slope of declining cognitive functioning among poor persons signifies their differential vulnerability to neighborhood socioeconomic disadvantage. Others appear to be protected somewhat from the adverse impact of neighborhood socioeconomic disadvantage by their more ample financial assets. A similar pattern of differential vulnerability to neighborhood disadvantage among personally disadvantaged persons recently has been reported for depressive symptoms for this HRS cohort of late-middle-age persons (Wight, Ko, and Aneshensel 2011). In combination, these findings suggest that disadvantaged persons living in disadvantaged neighborhoods may be at exceptionally high risk of multiple poor health outcomes, a pattern that is consistent with the idea of compound disadvantage (Wheaton and Clarke 2003).

We had hypothesized that the racial segregation of African Americans would be associated with poor cognitive functioning (hypothesis 3) and that this effect would be most pronounced for African Americans (hypothesis 4) and would be exacerbated by low personal SES and counterbalanced by high personal SES (hypothesis 5); only the last hypothesis is supported by the data. Specifically, the combination of low education and racial segregation is associated with poor cognitive functioning. In contrast, the highest level of cognitive functioning is among highly educated persons who live in predominantly African American neighborhoods. Only a small number of persons ($n = 38$) fit this profile, however, indicating caution in interpreting this extreme value of the interaction. On average, these persons have attained a college education. They are, as would be expected, disproportionately African American (92.1 percent) and also are disproportionately women (81.6 percent). Although their incomes are on a par with the sample as a whole (mean = $60,767), they have considerably less wealth (mean = $154.989).

In interpreting these data, it is important to recall that this cohort of African Americans received their formal education during the historical period of legally segregated schools, meaning not only that they were educated separately but also that they were educated unequally; that is, the quality of the education they received typically was inferior to that provided to non-Hispanic whites. In addition, African Americans in this cohort attained, on average, much less formal education than non-Hispanic whites (for this sample, 11.88 years vs. 13.21 years, respectively; $t = 8.12$, $p < .001$). Attaining a college education in this context suggests greater ability and motivation, personal characteristics that enabled some African Americans to overcome formidable obstacles—obstacles that hindered the educational attainment of many of their peers and obstacles not faced by as many non-Hispanic whites. These personal characteristics portend continued striving and success in the status attainment process that may have been converted into a lifetime of experiences that enriched opportunities for cognitive stimulation. These personal assets appear to outweigh the cognitive costs of racial segregation that is incurred by persons with little formal education.

In addition, we had hypothesized that cognitive functioning would be enhanced in predominantly Hispanic neighborhoods (hypothesis 6), especially among Hispanics (hypothesis 7), and that these effects would be conditional upon SES (hypothesis 8). None of these hypotheses were supported. One possible explanation is that our categorization of neighborhoods in terms of proportion Hispanic combines dissimilar subgroups living in different regions of the country that counterbalance one another. A more refined analysis that differentiates subgroups, such as Mexican Americans compared to Puerto Ricans, might reveal protective effects for some groups and deleterious effects for other groups, producing overall null findings. We are unable to test this idea because there are too few of any one subgroup to permit estimation of group-specific effects, making this a limitation of the study.

Because this study of late-middle-age persons used methods isomorphic to those used in the AHEAD study of elderly persons (Wight et al. 2006), the two times in the life course can be compared. In both studies, statistically significant between-neighborhood variation remained after rigorous controls for individual-level factors, suggesting the presence of true neighborhood effects between the two cohorts. Both studies found that the effect of neighborhood socioeconomic disadvantage (measured inversely as the proportion with a high school education in the AHEAD study) is contingent upon personal SES (education in the AHEAD study). Specifically, in each case, those most at risk of poor cognitive function are persons of low SES living in low-SES neighborhoods, a combination that is synergistic rather than additive, that is, indicative of compound disadvantage. Thus, the differential cognitive vulnerability of poor persons to neighborhood socioeconomic disadvantage appears to be a feature of late middle age that continues into old age.

The current study presents a still-life image of the connections between urban neighborhood and cognitive functioning, but these connections are likely to evolve over time as neighborhoods and individuals change. Thus, a limitation of our analysis is that it assumes that the effects of neighborhood on cognitive functioning are contemporaneous, whereas these effects may accumulate over time, perhaps a long time, a possibility we are unable to assess with a cross-sectional design. This aspect of the study may lead to an overestimate of the impact of current neighborhood disadvantage to the extent that the impact of past neighborhood disadvantage is transmitted via the impact of current neighborhood disadvantage through neighborhood stability, which may not be the case (Wheaton and Clarke 2003). Similarly, cognitive functioning was examined at only one point in time, meaning that our analysis does not control for prior levels of cognitive functioning when assessing the impact of current neighborhood conditions, nor does this design examine its effects on changes in cognitive functioning as the person ages or capture cognitive decline in younger adults. The cross-sectional design also limits causal inference. In addition, individuals are selected into disadvantaged neighborhoods or fail to select out of such neighborhoods on a variety of characteristics, most of which are unmeasured and therefore uncontrolled; these characteristics may include poor cognitive functioning, making selection an alternative explanation for our findings. To address these issues, future research should employ a more powerful design, for example, examining whether changes in neighborhood conditions are associated with changes in cognitive functioning over time (see Sheffield and Peek, 2009, for an exemplar).

Several other limitations of this study need acknowledgement. Our use of Census tracts to operationalize neighborhoods is somewhat problematic because these official boundaries do not necessarily correspond to neighborhoods as experienced by residents. However, this approach predominates in the field and is justified by the availability of existing data to link with individual-level survey data, making the study possible. In addition, our results are biased toward cognitively well-functioning persons, as noted above. Also, we lack data on the possible causal mechanisms that link neighborhood structural characteristics to individual cognitive functioning; thus, we can only speculate about these processes and cannot speak to the nature of interventions that might alleviate these health disparities. Finally, there necessarily are relatively few people in some of the extreme values of the interaction terms, for example, well-to-do residents of impoverished neighborhoods, so caution is needed in interpreting these values.

This study also has a number of strengths. Most notably, the large national probability sample enhances external validity and generalizability. In addition, the measure of cognition is multifaceted, tapping into both memory capabilities and the general mental state of participants. The variability in cognitive functioning noted within this age cohort indicates that the measured differences reflect functionally important differences. Also, to address selection effects, we control for a range of individual-level characteristics, which reduces the possibility that findings are merely compositional as distinct from contextual.

Our findings have policy implications because they call attention to factors in the neighborhood environment that are consequential to cognitive functioning. Heymann and Fischer (2003) argue that research demonstrating an independent effect of adverse neighborhood conditions on health beyond individual characteristics (1) counters public sentiment that individuals are solely responsible for their health, (2) supports public policy holding society at least partially accountable for improving the health of people living in disadvantaged neighborhoods, and (3) improves the odds that initiatives designed to address neighborhood conditions will be taken seriously. Our findings are consistent with Link and Phelan's (1995) analysis of "fundamental causes," which locates the origin of health disparities in social inequities, in this instance, neighborhood socioeconomic stratification. Although the socioeconomic stratification of neighborhoods is seemingly intractable, some of its consequences are likely to be more malleable (e.g., signs of neighborhood disorder). For example, neighborhood-level revitalization programs can lead to improvements in psychological well-being (Dalgard and Tambs 1997), which could then enhance cognitive functioning. However, additional research is needed to determine the causal mechanisms that link neighborhood socioeconomic disadvantage to poor cognitive functioning in order to identify the appropriate content of such interventions (Aneshensel 2009). Because this structural approach changes the conditions that impinge upon cognitive functioning, as distinct from changing individuals one by one, it has the potential to reach large numbers of people (Gupta et al. 2008) and therefore could produce meaningful improvements in cognitive functioning among disadvantaged persons, thereby reducing health disparities. Our findings regarding the differential vulnerability of poor persons to neighborhood socioeconomic disadvantage suggest not only that interventions occurring "upstream" are appropriate but also that these interventions should be made available especially for those who are most disadvantaged within disadvantaged neighborhoods.

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Biographies

Carol S. Aneshensel, PhD, is Professor in the Department of Community Health Sciences in the School of Public Health, UCLA. Her research primarily addresses the social origins of psychological disorder, for the most part depressive symptoms. It spans the life course from adolescence through old age. Other areas of research include the mental health impact of caregiving for persons with dementia and persons with HIV/AIDS. Her most recent work examines the linkages between the socioeconomic stratification and racial/ethnic segregation of neighborhoods and health. She has received the Leonard I. Pearlin Award for distinguished contributions to the sociological study of mental health and the Leo G. Reeder Award for distinguished contributions to medical sociology.

Michelle J. Ko is a doctoral candidate in the Department of Health Services in the School of Public Health, UCLA. Her research interests include disparities in health and access to care, and the relationship of social context to these outcomes. Her dissertation work examines the impacts of socioeconomic inequality, racial segregation, and social capital on the stability of the healthcare safety net.

Joshua Chodosh, MD, MSHS, is Associate Professor of Medicine in the Division of Geriatrics at UCLA and a physician scientist in the Geriatric Research Education and Clinical Center at the VA Greater Los Angeles Heath System, as well as Assistant Chief of Staff for Patient Safety and Risk Management. Dr. Chodosh's research concerns predictors of dementia, dementia recognition, and quality of care for dementia and other chronic disease conditions. His work also includes psychometric analysis of depression measures as well as epidemiologic studies of late-life depression as a predictor of dementia.

Richard G. Wight is an Associate Researcher in the Department of Community Health Sciences in the School of Public Health, UCLA. His work emphasizes the intersection of individual- and contextual-level factors that affect health across the life course, with a particular emphasis on the midlife and later years. His recent research also examines aging, sexual minority stress, and mental health.

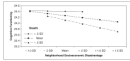

Figure 1.
Cognitive Functioning by Neighborhood Socioeconomic Disadvantage and Individual Wealth

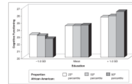

Figure 2.
Cognitive Functioning by Neighborhood Proportion African American and Individual Education

Table 1

Sample Characteristics of U.S. Urban Adults Ages 54 to 65 in 1996

Individual-Level Variables (weighted, *N* = 4,525)	***Percent or Mean***	***SD***
Gender		
Women	55.07	
Men	44.93	
Age (years)	59.35	3.23
Marital status		
Married	71.44	
Widowed	8.01	
Separated/divorced	16.20	
Never married	4.35	
Employment status		
Employed	60.93	
Unemployed	1.60	
Retired	25.42	
Disabled	3.98	
Other employment status	8.07	
Race/ethnicity		
Non-Hispanic white	76.38	
African American	13.21	
Hispanic	8.00	
Other	2.41	
Education (years)	12.74	3.01
Wealth (thousands of dollars)	297.72	593.71
Income (thousands of dollars)	63.14	93.48
Social contact (0–4)	1.89	.99
ADL assistance (0–6)	.24	.80
Depressive symptoms (0–8)	1.21	1.85
Diabetes (yes)	11.81	
Number of chronic conditions (0–6)	.93	1.05
Self-rated health (1–5; 1 = *excellent*)	2.51	1.13
Cognitive functioning (1–35)	25.27	4.37
Census tract–level variables (*n* = 1,596)		
Socioeconomic disadvantage factor	−0.02	1.11
Percent living below federal poverty level	13.88	13.66
Percent ages ≥ 25 years without high school degree	24.91	16.03
Percent unemployed	7.33	5.83
Percent receiving public assistance	8.85	9.73
Percent African American	19.53	30.53
Percent Hispanic	11.52	20.08

Note: ADL = activities of daily living.

Table 2

Multilevel Regression of Cognitive Functioning on Individual-Level and Neighborhood-Level Characteristics

	Model 1		Model 2		Model 3	
Individual-Level Variables	***B***	***(SE)***	***B***	***(SE)***	***B***	***(SE)***
Demographic variables						
Women (/men)	1.128	(.124)***	1.122	(.124)***	1.122	(.124)***
Age (years)	−.059	(.020)**	−.058	(.020)**	−.058	(.020)**
Widowed[a]	−.267	(.241)	−.250	(.242)	−.255	(.241)
Separated/divorced[a]	−.076	(.178)	−.062	(.177)	−.049	(.177)
Never married[a]	.163	(.307)	.184	(.306)	.180	(.303)
Unemployed[b]	−.878	(.515)	−.835	(.510)	−.815	(.509)
Retired[b]	−.358	(.156)*	−.361	(.157)*	−.357	(.156)*
Disabled[b]	−1.219	(.377)**	−1.192	(.376)**	−1.086	(.375)**
Other employment status[b]	−.256	(.249)	−.244	(.249)	−.251	(.248)
African American[c]	−6.935	(.816)***	−6.756	(.823)***	−4.500	(1.146)***
Hispanic[c]	−.693	(.689)	−.191	(.778)	.227	(.763)
Other race/ethnicity[c]	−.304	(2.005)	−.060	(2.004)	.815	(1.935)
Education (years)	.424	(.030)***	.417	(.030)***	.462	(.034)***
Education × African American	.403	(.062)***	.399	(.062)***	.203	(.087)*
Education × Hispanic	−.032	(.061)	−.049	(.062)	−.094	(.062)
Education × Other Race/Ethnicity	−.013	(.134)	−.026	(.135)	−.102	(.135)
Household wealth[d]	1.681	(.826)*	1.609	(.826)	3.596	(1.222)**
Household income[d]	.613	(.708)	.478	(.704)	.559	(.684)
Social integration (0–4)	.278	(.061)***	.278	(.061)***	.272	(.061)***
Health variables						
ADL assistance count (0–6)	−.069	(.101)	−.058	(.101)	−.061	(.100)
Depressive symptoms (0–8)	−.201	(.054)***	−.204	(.054)***	−.199	(.053)***
Diabetes (/no)	−.429	(.208)*	−.421	(.208)*	−.425	(.208)*

Individual-Level Variables	Model 1 B	Model 1 (SE)	Model 2 B	Model 2 (SE)	Model 3 B	Model 3 (SE)
Number of chronic conditions (0–6)	−.024	(.072)	−.025	(.072)	−.019	(.072)
Self–rated health (1–5; 1 = *excellent*)	−.242	(.070)***	−.236	(.070)***	−.238	(.070)***
Census tract–level variables						
Socioeconomic disadvantage			−.135	(.101)	−.044	(.102)
Percent African American			.041	(.395)	−.068	(.413)
Percent Hispanic			−.576	(.605)	.833	(.615)
Cross-level interactions						
Socioeconomic Disadvantage × Wealth					2.560	(1.185)*
Percent African American × Education					.312	(.115)**
Percent African American × Education × African American					.036	(.049)
Percent African American × Education × Hispanic					−.176	(.115)
Percent African American × Education × Other Race/Ethnicity					−.167	(.171)

Intercept and Variance Components	Model 1 B	Model 1 (SE)	Model 2 B	Model 2 (SE)	Model 3 B	Model 3 (SE)
Intercept Variance Components	24.842	(.064)***	24.832	(.064)***	24.877	(.092)***
Between-group intercept (τ)	.681***		.671***		.642***	
Within group (σ^2)	12.916		12.905		12.874	

Note: ADL = activities of daily living.

[a] Reference group = married.

[b] Reference group = employed.

[c] Reference group = Non-Hispanic white.

[d] Thousands of dollars, logged.

* $p \leq .05$.

** $p \leq .01$.

*** $p \leq .001$.