Cognitive Activity in Older Persons From a Geographically Defined Population

Robert S. Wilson,1,2,4 David A. Bennett,1,2 Laurel A. Beckett,1,3 Martha C. Morris,1,3 David W. Gilley,1,2,4
Julia L. Bienias,1,3 Paul A. Scherr,5 and Denis A. Evans1,2,3

1Rush Alzheimer’s Disease Center and Rush Institute for Healthy Aging, Chicago, Illinois.
2Department of Neurological Sciences, 3Medicine, and 4Psychology, Rush-Presbyterian-St. Luke’s Medical Center, Chicago, Illinois.
3Health Care and Aging Studies Branch, Center for Disease Control and Prevention, Atlanta, Georgia.

Patterns of cognitive activity, and their relation to cognitive function, were examined in a geographically defined, biracial population of persons aged 65 years and older. Persons (N = 6,162) were given cognitive performance tests and interviewed about their participation in common cognitive activities, like reading a newspaper. Overall, more frequent participation in cognitive activities was associated with younger age, more education, higher family income, female gender, and White race; participation in activities judged to be more cognitively intense was not strongly related to age, but was associated with more education, higher family income, male gender, and White race. Substantial heterogeneity in activity patterns remained after accounting for demographic factors, however. In an analysis controlling for demographic variables, level of cognitive function on performance tests was positively related to composite measures of the frequency and intensity of cognitive activity. Longitudinal studies are needed to assess the relation of cognitive activity patterns to stability and change in cognitive function in older persons.

Engagement in cognitively demanding activities has long been considered a potential modifier of cognitive change in older persons. Cross-sectional studies suggest that cognitive activity is positively related to cognitive function (Arbuckle, Gold, & Andres, 1986; Arbuckle, Gold, Andres, Schwartzman, & Chaikelson, 1992; Arbuckle, Gold, Chaikelson, & Lapidus, 1994; Christensen & Mackinnon, 1993; Cockburn & Smith, 1991; Crabtree, Antrim, & Klenke, 1990; DeCarlo, 1974; Hultsch, Hammer, & Small, 1993; Rice & Meyer, 1986), but its relation to age has been inconsistent. In some studies, older persons reported spending more time in cognitive activities than younger persons (Pfeiffer & Davis, 1971; Salthouse, 1993; Surber, Kowalski, & Pena-Paez, 1984), but other studies found either the opposite association (Baltes & Lang, 1997; Christensen & Mackinnon, 1993; Hultsch et al., 1993), or mixed results (Ratner, Schell, Crimmins, Mittleman, & Baldinelli, 1987; Rice, 1986; Rice & Meyer, 1986). These inconsistencies may reflect several issues. First, prior studies have been conducted on selected groups rather than in defined populations, possibly biasing findings—especially because volunteering for a research study may be considered a form of cognitive activity. Second, because daily occupation strongly influences activity patterns (Rice, 1986), it is difficult to compare younger persons, most of whom work or are in school, with older persons, many of whom are retired. In addition, cognitive activity has been defined and measured in a variety of ways. Studies differ, for example, in the nature and number of activities examined, how information about activity participation was ascertained and quantified, and how summary measures were derived.

In the present study, we sought to describe participation in common cognitive activities among persons aged 65 years and older, from a geographically defined, biracial community of Chicago. An activity was considered cognitive if information processing was central to it, and if physical demands and social requirements were minimal. Participants were asked how often they usually engaged in the activity, and which subform of the activity they most frequently pursued. Summary measures of cognitive activity were developed from this information. We then examined the association of cognitive activity with age; we also evaluated its relation to education, family income, gender, and race, and whether these variables could account for any age-associated differences in cognitive activity. Finally, the association of cognitive activity with cognitive test performance was examined in analyses that controlled for age, education, family income, gender, and race.

Methods

Participants

The study took place in a geographically defined community on the south side of Chicago made up of three adjacent neighborhoods: Morgan Park, Washington Heights, and Beverly. As part of the Chicago Health and Aging Project, from October 1993 to April 1997 all households in this community were censused, and all persons aged 65 years and older were asked to participate in an in-home interview. The interview took an average of 85 minutes and included questions about demographic variables, health problems, and current functioning, as well as physical measurements and cognitive and physical performance tests. Race was assessed with U.S. Census questions; education with years of formal schooling; and income by asking participants to select one of ten levels of total annual family income using the “show-card” method from the Established Populations for Epidemiologic Studies of the Elderly (Cornoni-Huntley, Brock, Ostfeld, Taylor, & Wallace, 1986). Interviewers were recruited from the community. They underwent an average of three weeks of training, and were certified on interview procedures using performance-based criteria. Data were collected on
laptop computers, with forms programmed in Blaise (Central Bureau of Statistics, the Netherlands), a Pascal-based data entry program. Data quality was monitored with range and logic checks and periodic review of selected indices for outliers.

Of 8,501 age-eligible persons identified in the census, 439 died and 249 moved before being asked to participate in the interview; of the remaining 7,813 persons, 6,162 participated in the interview (78.9% overall; 81.4% of Blacks, 75.1% of Whites). The mean age of participants was 75.0 years (SD = 7.2); 3,605 persons were aged 65 to 74 years; 1,869 were aged 75 to 84 years; and 688 were aged 85 years and older. The mean educational level was 11.8 years (SD = 3.7). The participants were 60.7% female; 59.1% were Black, 40.2% were White, and 0.2% belonged to other racial groups. The study was approved by the Human Investigation Committee of Rush-Presbyterian-St. Luke’s Medical Center.

Measurement of Cognitive Activity

The interview included questions about time typically spent in seven basic activities: viewing television; listening to radio; reading newspapers; reading magazines; reading books; playing games such as cards, checkers, crosswords, or other puzzles; and going to museums. Participants were asked to rate on a 5-point scale how often they typically engaged in each activity as follows: (5) every day or about every day; (4) several times a week; (3) several times a month; (2) several times a year; (1) once a year or less. For viewing television and listening to radio, persons indicating daily activity were asked to estimate average daily hours.

For six of these basic activities (excluding “going to museum”) people were questioned about participation in activity subtypes. All persons were asked to designate the type of television program (12 types; e.g., game shows, soap operas, educational programs) and radio show (9 types; e.g., sports, news, jazz) most frequently listened to or watched. Persons indicating activity frequency of at least several times a year were asked to indicate the most frequently read newspaper section (11 sections; e.g., advertisements, business pages, comics) and book type (6 types; e.g., fiction, hobbies, religious), and to name the three magazines most often read and the three games most often played. Magazines were subsequently sorted into six types (e.g., news and opinion, informational, popular culture), and games into six types (e.g., chance, strategy, word/information retrieval).

A panel of raters was formed to estimate the level of “cognitive intensity” involved in each activity (e.g., viewing television) and activity subtype (e.g., viewing soap opera on television) on a 5-point scale, with higher numbers indicating an activity requiring effortful, demanding cognitive function. The panel consisted of 10 doctoral psychologists (5 female; 9 White, 1 Hispanic) and 20 lay persons (10 female; 10 White, 10 Black). One person whose ratings were consistently very different from the others, as indicated by being beyond the range of the whiskers on standard box plots of the distributions of the ratings (Tukey, 1977), was removed from the panel. A repeated-measures ANOVA found no differences between lay and expert raters (for the effect of group, \( F[1,27] = 1.85, p = 0.19 \); for the interaction between rating and group, \( F[61,1647] = 1.17, p = 0.18 \). The lay group included subgroups of Black and White, male and female raters. A repeated-measures ANOVA found no differences among the four lay subgroups (for the effect of group, \( F[3,15] = 0.67, p = 0.59 \); for the interaction between rating and group, \( F[183,915] = 0.81, p = 0.97 \). Because there were no strong effects of expertise, gender, or race, the mean rating of each item by all 29 panel members was used as a measure of the intensity of the cognitive functioning involved in the activity.

Measurement of Cognitive Function

The population interview also included three performance measures of cognitive function: immediate and delayed recall of 12 ideas contained in a brief, orally presented story (Albert et al., 1991; Scherr et al., 1988); a modified form of the oral version of the Symbol Digit Modalities Test (Smith, 1984), a symbol substitution procedure which measures perceptual speed; and the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975), a 30-item test of mental status that is widely used to measure cognitive functioning in older persons. In a principal components analysis, all tests had loadings of .79 or more on a single factor that accounted for about 74% of the variance. Therefore, a summary measure was constructed. Scores on each of the four tests were converted to z scores and then averaged to yield a single, global measure of cognitive function scaled in standard units, with positive scores indicating higher performance.

Data Analysis

Descriptive summaries of the measures of cognitive activity and function included frequency tables, means, standard deviations, and graphical displays (box plots and stem-and-leaf displays). The relations among the cognitive activity items were examined using pairwise correlations, item-total correlations, and smoothed scatter plots, to determine the extent to which summary measures could be formed that would capture substantial fractions of the variation in activity across participants. Pairwise correlations, smoothed scatter plots, and generalized additive models (Venables & Ripley, 1994) were used to examine the relations of the summary measures with demographic variables, and of cognitive function with summary activity and demographic variables. In all regression models, predictor variables were entered simultaneously; models were evaluated for nonlinearity, interactions, and collinearity using standard diagnostic and graphic procedures.

Results

The frequency of participation in the seven basic cognitive activities is shown in Table 1. The television and museum questions yielded especially skewed distributions, with most participants indicating daily television viewing and one or fewer museum trips per year. Those indicating daily television viewing (90.5%) estimated an average of 3.8 hours per day (SD = 2.9). Those reporting daily radio listening (54.2%) indicated an average of 1.9 hours per day (SD = 2.9). Correlations among these items and of each item with the adjusted item total are shown in Table 2. Inter-item correlations were positive and modest in size with a median correlation of .17. Each item was positively related with total score for the other six items. Inter-item correlations were lowest for viewing television, and highest for reading newspapers and magazines.

On the basis of these data, four measures of cognitive activity were constructed. Given evidence of shared item variance, responses to all seven items were averaged to yield a composite
COGNITIVE ACTIVITY AND AGE

P157

measure of cognitive activity frequency. This measure had a mean of 3.05 ($SD = 0.71$), and its distribution was approximately normal (Figure 1). Responses to the three reading items were averaged to form a reading frequency measure ($M = 3.13$; $SD = 1.12$). Measures of television frequency ($M = 7.61$; $SD = 3.20$) and radio frequency ($M = 4.63$; $SD = 3.97$) were created by combining the activity frequency rating with estimated hours of activity per day. This was done by adding daily hours minus one to the frequency category, with daily hour estimates of 13 to 24 (given by 1.8% for television and 2.4% for radio) treated as 13. Thus, a person estimating 4 hours of daily television viewing would receive a score of 8 (i.e., $[4-1] + 5$).

The mean of the panel’s ratings served as the cognitive intensity score for each activity. Intensity scores for the seven basic activities are shown in Table 1; viewing television had the lowest intensity score, and reading a book had the highest. Scores for activity subtypes ranged as follows: television, 1.4 (advertisement/shopping program) to 3.6 (educational program); radio, 1.7 (folk music or program) to 2.8 (news); newspaper, 1.8 (advertisements) to 3.4 (business pages, crossword/other game); magazine, 1.9 (shopping catalog) to 3.4 (news and opinion, idea-oriented); books, 2.2 (children’s) to 4.2 (health/medical); game, 2.0 (chance) to 4.4 (strategy).

The cognitive intensity scores were used to form secondary measures. First, the frequency of each basic activity was multiplied by its intensity score, and these products were averaged. A second measure was formed by multiplying basic activity subtype, and averaging the products. Both frequency-by-intensity measures of cognitive activity were highly correlated with the composite measure of cognitive activity frequency ($r \geq .95$ for both measures), and so were not used in subsequent analyses. Third, correlations among cognitive intensity scores for the six activity subtypes were examined. These correlations were generally low, and in some cases negative. A composite measure of cognitive intensity was constructed by averaging scores for three items (television, newspaper, magazine) with significant positive intercorrelations (median $r = .16$, all $p < .001$). This measure had a small positive correlation with the composite measure of cognitive activity frequency ($r = .23$, $p < .001$).

The association of cognitive activity with age and other demographic variables was examined with linear regression models. In an initial analysis, the composite measure of cognitive activity frequency was inversely related to age ($F[1,6114] = 343.9$, $p < .001$), with an adjusted $R^2$ of .05. Next, education, family income, gender, and race were added to the model (Table 3). Activity frequency continued to be inversely correlated with age; more frequent cognitive activity was also associated with more years of education, higher family income, female gender, and White race. Together, these demographic factors accounted for over one fourth of the variance in the composite measure of cognitive activity frequency (adjusted $R^2 = .27$).

These multiple regression analyses were repeated for the measures of reading, television, and radio frequency. The re-
sults for the reading measure were similar to those for the composite frequency measure. Reading activity was inversely related to age and positively related to education and family income; women and White persons reported reading more than men and Black persons did, respectively (adjusted \( R^2 = .22 \)). The regression models accounted for relatively little variance in television viewing and radio listening (adjusted \( R^2 = .03 \) for both models). Both activities were inversely related to age. Television viewing was inversely related to education and family income; radio listening was positively related to those variables. There were no gender differences in either activity. Black persons reported more television viewing and less radio listening than did White persons.

Because the scaling of the television and radio measures may not have been optimal, alternative scores for these activities were computed by converting data on frequency and daily hours to \( z \) scores, which were averaged. The results of regression analyses using these alternate measures of television viewing and radio listening essentially were unchanged from the primary analyses.

The regression analyses were repeated for the composite measure of cognitive activity intensity. With age alone in the model, there was a significant (\( p < .001 \)) but very small (adjusted \( R^2 = .004 \)) positive association between age and intensity. With all five demographic variables in the model (Table 4), substantially more variance was explained (adjusted \( R^2 = .23 \)); age still showed a small, positive association with intensity, and higher intensity was also associated with more education, higher family income, male gender, and White race. In a secondary analysis, a composite intensity measure based on all six items produced similar results, except that the age effect was reduced to a trend.

Family income data were unavailable for 14% of the population. To see if exclusion of these persons affected results, each of the regression analyses was repeated without family income. The results of these analyses were comparable to those obtained in primary analyses, except that women reported somewhat less television viewing than men (\( F[1,6084] = 4.4, p = .04 \)).

Because previous studies have shown a relation between cognitive activity and cognitive function, we examined the correlations of the activity measures with the global performance-based measure of cognitive function. Each activity measure was positively related to cognitive function (all \( p \leq .001 \)), with composite frequency (\( r = .54 \)) and reading (\( r = .47 \)) showing higher correlations, and composite intensity (\( r = .23 \)), radio (\( r = .20 \)), and television (\( r = .04 \)) showing lower correlations. The smoothed function for the association (general additive model) between the composite frequency and cognitive function measures, with 95% pointwise confidence intervals for the relationship, is shown in Figure 2. To further examine the association, a series of linear regression analyses was performed. In an initial analysis, cognitive function was positively related to composite frequency and composite intensity measures (both \( p < .001 \); adjusted \( R^2 = .17 \)). In another analysis, cognitive function was related to age, education, family income, gender, and race (\( p < .001 \) for each term, adjusted \( R^2 = .34 \)). In a third analysis, the cognitive function measure was regressed on the two activity, and five demographic variables. Both activity measures were significant (for frequency, \( F[1,4502] = 170.2, p < .001 \); for intensity, \( F[1,4502] = 17.0, p < .001 \)) as was each demographic variable (all \( p < .001 \); adjusted \( R^2 = .37 \)). When the analysis was repeated without the family income term, thereby increasing the number of persons available for analysis, results were unchanged (all \( p < .001 \); adjusted \( R^2 = .36 \)). To see if the results depended on a subset of persons with very poor cognitive function, the analysis was repeated excluding persons with global cognitive scores at or below the tenth percentile. Comparable results were obtained (all \( p < .001 \); adjusted \( R^2 \) of .35).

**DISCUSSION**

In this biracial, urban population of persons aged 65 years and older, participation in common cognitive activities varied substantially. Overall, more frequent participation in cognitive activities was associated with younger age, more education, higher family income, female gender, and White race. Together, these demographic variables accounted for about one fourth of the variance in a composite measure of activity frequency, with age alone accounting for about 5%. The tendency to engage in activity subtypes judged to be relatively more cognitively intense or demanding was associated with older age, more education, higher family income, male gender, and White race. Age accounted for less than 1% of the variance in this composite in-

---

**Table 4. Summary of Regression of Composite Measure of Cognitive Activity Intensity on Demographic Variables.**

<table>
<thead>
<tr>
<th>Model Term</th>
<th>Parameter Estimate*</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.003</td>
<td>0.001</td>
</tr>
<tr>
<td>Education</td>
<td>0.022</td>
<td>0.002</td>
</tr>
<tr>
<td>Family Income</td>
<td>0.016</td>
<td>0.002</td>
</tr>
<tr>
<td>Gendera</td>
<td>0.087</td>
<td>0.010</td>
</tr>
<tr>
<td>Raceb</td>
<td>-0.186</td>
<td>0.011</td>
</tr>
</tbody>
</table>

*Parameter estimates are unstandardized; \( p < .001 \) for each

*aMale = 1; Female = 0

*bBlack = 1; White = 0

---

**Figure 2.** Smoothed association between composite measure of cognitive activity frequency and global, performance-based measure of cognitive function derived from generalized additive model. Higher scores indicate more frequent activity and better performance. The dashed lines are approximate 95% confidence intervals.
tensity measure, however, and was not significantly correlated with a secondary measure of intensity. In an analysis that controlled for demographic variables, level of cognitive function on performance tests was positively related to composite measures of the frequency and intensity of cognitive activity.

Prior research on the association of age with cognitive activity has yielded mixed results, as noted earlier. However, because most of the studies have included both younger and older persons, age ranges have differed substantially from the range in the present study (65 to 108 years), making it difficult to compare findings. Another important consideration is that previous studies have been conducted on selected groups, making it difficult to estimate securely the association of activity with age and other demographic variables. In contrast, participants in the present study were identified in a census of a geographically defined area of Chicago; all persons aged 65 years and older were asked to participate and over 6,000 (78.9% of those eligible) did so, thereby substantially reducing the likelihood of selection bias and increasing the likelihood that a broad spectrum of cognitive activity patterns, demographic variables, and cognitive function would be represented.

Assessment of cognitive activity poses several challenges. Most activities are cognitive to some degree; how best to quantify that degree and characterize individual differences, especially among persons from diverse cultural backgrounds, socioeconomic levels, and birth cohorts is unclear. Our approach was to define cognitive activities as those in which information processing was central, and to focus on activities believed to make relatively minimal physical or social demands and to be relatively common in this population. Because economic factors can limit opportunities to participate in these activities, and because income was related to frequency of participation, a term for income was included in analyses.

The best way to summarize activity information is uncertain, so several measures were formed. The construct validity of these measures can be indirectly assessed by examining their correlations with education and the performance-based measure of cognitive function. The composite measures of frequency and intensity had near-unity correlations with measures based on frequency alone; Arbuckle and associates (1994) reported a similar result with a more diverse set of activities. On the other hand, a composite measure of cognitive intensity, which reflected a tendency to opt for more or less demanding subforms of several activities, did contribute to the prediction of cognitive function independently of frequency information.

Knowledge about the relation of cognitive activity with gender or race is limited. In this urban population, women reported more overall cognitive activity and reading, equivalent television viewing and radio listening, and engaged in somewhat less cognitively demanding activities, when compared with men. White persons reported more overall cognitive activity, reading, and radio listening, less television viewing, and engaged in somewhat more cognitively demanding activities, when compared with Black persons. In future studies, it will be important to determine whether these subgroup differences are observed in other populations, with other measures of cognitive activity, and whether they contribute to different patterns of aging.

Among persons in this population, individual differences in level of cognitive function were related to both the frequency and intensity of cognitive activity. Other studies have also reported positive correlations between measures of cognitive activity and cognitive function, but the basis of this association is uncertain. There is substantial evidence that in children (Ceci & Williams, 1997; Gottfried, 1984) and in some middle-aged adults (Kohn & Schooler, 1978; Miller, Slomczynski, & Kohn, 1985; Owen, 1966) exposure to complex, intellectually demanding environments in the home, school, or workplace is associated with enhanced cognitive functioning. Little is known, however, about the relation of cognitive activity to change in cognitive function in older persons. More longitudinal studies are needed to understand whether and how current and lifetime levels of cognitive activity are related to person-specific change in cognitive function in older people.