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Life Experience and Demographic Influences on Cognitive Function in Older Adults

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Abstract

Objective—We examined the influence of a broad spectrum of life experiences on longitudinal cognitive trajectories in a demographically diverse sample of older adults.

Method—Participants were 333 educationally, ethnically, and cognitively diverse older adults enrolled in a longitudinal aging study. Mixed-effects regression was used to measure baseline status in episodic memory, executive functioning, and semantic memory and change in a global cognition factor defined by change in these three domain-specific measures. We examined effects of life experience variables (literacy, childhood socioeconomic status, morphometric measures of physical development, life course physical and recreational activity) on longitudinal cognitive trajectories, covarying for age, APOE genotype and demographics (education, ethnicity, language).

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Results—Non-Latino whites had higher baseline cognition, but life experience variables attenuated ethnic differences in cognitive scores. Age, literacy, childhood socioeconomic status and physical activity significantly influenced baseline cognition. Age, APOE ε4 and decline in intellectually and socially stimulating recreational activity from mid to late life were independently associated with increased late life cognitive decline. Higher literacy and late life recreational activity were associated with less decline. Literacy had similar effects for English and Spanish readers/speakers. Bilingual English and Spanish speakers did not differ from English Speakers in cognitive performance.

Conclusions—Life experience variables, especially literacy level, were strongly related to baseline cognition and substantially attenuated effects of race/ethnicity and education. Cognitive change was best explained by age, APOE ε4, literacy, and current recreational activities. Literacy had robust associations with baseline cognition and cognitive change in both English and Spanish speakers.

Keywords

Aging; cognitive change; individual differences; recreational activity; minority and diverse populations

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A life course epidemiology perspective suggests that early and mid-life circumstances may modify late-life cognitive outcomes, in part, by influencing lifestyle patterns and social and economic trajectories (Glymour & Manly, 2008). Stimulating environmental and educational opportunities are known to shape intellectual development early in life and may continue to exert important influences on cognitive function as people age. However, many important aspects of the relationship between various lifetime exposures/experiences and late-life cognition are not well understood because of their confounding nature. For example, demographic factors that tend to be associated with late life cognition, including education and ethnicity, are complex variables that are interwoven with socioeconomic status (SES) and a host of associated differences in childhood and adult life experiences. An improved understanding of factors throughout the lifespan that influence cognitive aging has potential implications for intervening to reduce risk for cognitive decline. This study examines how a broad group of variables that summarize different aspects of experience across the life span are uniquely associated with late life cognition.

Socioeconomic status in childhood is an indicator of early life circumstances that has been investigated in relation to cognitive aging. Positive associations have been documented between late life cognition and various indicators of childhood SES, including county literacy rate (Wilson, Scherr, Hoganson, et al., 2005), urban versus rural upbringing (Zhang, Gu, & Hayward, 2008), parental education and occupation (Everson-Rose, Mendes de Leon, Bienias, Wilson, & Evans, 2003), and self-reported childhood SES and household size (Wilson, Scherr, Bienias, et al., 2005). There is substantial covariation between education and childhood SES (e.g., Everson-Rose, et al., 2003) but some studies have suggested they each make unique contributions to cross-sectional performance on measures of late life cognition (e.g., Zeki Al Hazzouri, Haan, Osypuk, Abdou, Hinton & Aiello, 2011). However, many of the same studies reported no influence of childhood SES on cognitive *change* (Everson-Rose, et al., 2003; Wilson, Scherr, Bienias, et al., 2005), particularly when taking into account other correlated variables (Zeki Al Hazzouri, Haan, Osypuk, Abdou, Hinton & Aiello, 2011).

Similarly, years of education shares robust positive associations with cross sectional measures of cognition in older adults (e.g., Cagney & Lauderdale, 2002). These associations tend to be weaker in minority populations, which has been attributed to discrepancies between the duration and quality of education available to minorities (Glymour & Manly, 2008; Manly, Jacobs, Touradji, Small, & Stern, 2002). Single word reading/level of literacy, as a measure of quality of education, shares a stronger association with cognition in ethnically diverse populations (Manly, Byrd, Touradji, & Stern, 2004; Manly, Touradji, Tang, & Stern, 2003). Despite its generally strong effects on baseline cognition, education shares only a tenuous association with cognitive change. Some studies have found a protective effect of education on trajectories of cognitive change in nondemented older adults (e.g., Alley, Suthers, & Crimmins, 2007), while others have not (e.g., Zahodne et al., 2011, Early et al. 2013). Independent of education, higher levels of literacy/single word reading at midlife are associated with less ten-year change in episodic memory and processing speed (Richards, Shipley, Fuhrer, & Wadsworth, 2004).

Another set of variables related to early life environment that have been examined in association with late life cognition are indicators of physical growth, presumed to also reflect brain development. Disease and malnourishment, particularly vitamin, mineral and protein intake, have been identified as probable mechanisms of action due to their effects on childhood growth velocity, with as much as 20% of variation in adult height estimated to be due to environmental factors (Silventoinen, 2003). A relationship between growth indices measured in adulthood (e.g. head circumference, height, etc.) and late life cognition has been demonstrated in a variety of regions and ethnic groups. The majority of these studies have been cross-sectional, and suggest that shorter stature (e.g., Abbott et al., 1998; Maurer, 2010) and smaller head circumference (e.g., de Rooij, Wouters, Yonker, Painter, & Roseboom; Reynolds, Johnston, Dodge, DeKosky, & Ganguli, 1999) are associated with lower baseline cognition in older adulthood. Some studies, but not all (Mak, Kim, & Stewart, 2006), have further demonstrated that morphometric variables predict longitudinal change in memory (Gale, Walton, & Martyn, 2003) and global cognition (Lee, Eom, Cheong, Oh, & Hong, 2010).

Finally, engagement in cognitively stimulating and physically demanding activity in late life has been associated with better cognitive function in many prospective cohort studies (Lindwall et al., 2012; Mitchell et al., 2012). Recreational and physical activities are associated with physical health, childhood SES and educational attainment (He & Baker, 2005). Cognitive and physical activity both have been shown to yield associations with baseline cognition and attenuated cognitive decline (Herrera et al., 2011; Jefferson, et al., 2011; Marquine, Segawa, Wilson, Bennett, & Barnes, 2012; Wilbur et al., 2012). However, not all studies have found protective effects of recreational activity on longitudinal cognitive change (e.g. Mitchell, et al., 2012). Evidence of correlated change in leisure activity and cognition suggests that associations between recreational activity and cognition may be best characterized longitudinally (Lindwall, et al., 2012; Mitchell, et al., 2012).

To date, there is little research attempting to comprehensively examine the unique influence of multiple demographic factors, indicators of early life SES, physical growth/nutritional status, quality of education/literacy and cognitive/physical activity engagement throughout the lifespan in relation to late life cognition. This is particularly true with respect to the influence of these variables on longitudinal cognitive change. This study will build upon previous studies by our group wherein we independently examined the influence of select demographic factors, namely education and ethnicity (Early, 2013), and early live environment (Melrose, in press) on cognitive change. In the former study, education and ethnicity were both associated with robust differences in baseline cognition, but not with longitudinal change. Ethnicity reflects a mixture of racial, place of origin, and language characteristics. While a poor marker for genetic relatedness (Barnholtz-Sloan, Chakraborty, Sellers, & Schwartz, 2005; Suarez-Kurtz, Perini, Bastos-Rodrigues, Pena, & Struchiner, 2007; Suarez-Kurtz, Vargens, Struchiner, Bastos-Rodrigues, & Pena, 2007), ethnicity is associated with substantial average differences in educational opportunity and attainment (Conley & Yeung, 2005), early life experiences, health (Gortmaker & Wise, 1997); (Hummer & Benjamins, 2004), quality of education and SES (Glymour & Manly, 2008). In the latter study we observed that lower physical development/growth and lower childhood SES were associated with increased rate of late-life cognitive decline. The purpose of this study was to evaluate the unique contribution of basic demographic variables (e.g. age, ethnicity, primary language (English or Spanish), and years of education), select early-life environmental factors (early life SES, growth indicators, and literacy/quality of education), and cognitive and physical activity engagement during the lifespan to late life cognitive function and longitudinal cognitive trajectories. Because the presence of ApoE status, and the presence of the ε4 allele in particular, has also been associated with increased risk of late life cognitive decline, we included this variable as an additional predictor. Our basic hypothesis was that early life environmental factors and cognitive/physical activity engagement throughout life would be more important predictors of late life cognitive trajectories than basic demographic factors.

Methods

Design and Participants

Data are from the UC Davis Aging Diversity Cohort (UCD ADC), a longitudinal study of cognitive aging in an educationally and ethnically diverse sample of older adults. The goal in developing this cohort was to approximate the diverse racial, ethnic, and socioeconomic composition of a six-county catchment area in the central Sacramento/San Joaquin valley and east San Francisco Bay area of Northern California. The objectives of the UCD ADC were to: (a) create a cognitively heterogeneous sample for longitudinal follow-up that was 1/3 Latino, 1/3 African American, and 1/3 non-Latino White, (b) enhance the sample so that the widest variability possible in educational achievement was obtained, and (c) achieve a spectrum of cognitive function from normal to mildly impaired to demented in response to the scientific aims of our overall research program that sought to understand risk factors that influence onset and trajectories of cognitive impairment. These objectives were based on substantial evidence that SES, use of a second language, educational achievement and vascular risk factors may be important modifiers of cognitive health.

A community based recruitment protocol was used to develop a racially/ethnically and cognitively diverse cohort (Hinton et al., 2010). Briefly, recruitment strategies included presentations at senior social and recreation centers, churches, healthcare settings, and residential centers, and also utilized word of mouth to take advantage of social networks of recruited participants. A large group of individuals (>1300) received detailed cognitive testing and stratified sampling methods then were used to select individuals for recruitment into the longitudinal research cohort. Sampling characteristics are described in Hinton et al (2010). Enrollment began in 2001 and a rolling enrollment design was used to build the cohort with substantial enrollment continuing through 2010. Characteristics of the longitudinal cohort matched 2000 Census estimates closely (Hinton et al., 2010).

All participants received multidisciplinary diagnostic evaluations through the UCD ADC at baseline and at approximately annual intervals following the baseline evaluation. Details of these evaluations are described in Mungas et al 2010). Neuropsychological outcome measures were administered at each assessment occasion independent of diagnostic evaluation. Data collection is ongoing, with an average of four evaluations per participant to date. Annual loss to follow-up is approximately 7% and attrition due to death is 3%. There are no significant ethnic group differences in number of evaluations, loss to follow-up or attrition due to death.

Eligibility criteria included age 60 or older at baseline, ability to speak English or Spanish, and completion of at least two evaluations. Exclusion criteria included unstable major medical illness, major primary psychiatric disorder, and substance abuse or dependence in the last five years. This study included only participants who described themselves as Caucasian, African American or Hispanic; 16 individuals from other ethnic groups were not included. All participants signed informed consent, and all human subject involvement was overseen by institutional review boards at University of California at Davis, the Veterans Administration Northern California Health Care System and San Joaquin General Hospital in Stockton, California.

Cognitive Assessment

The cognitive outcomes in this study were composite measures of episodic memory, semantic memory, and executive function derived from the Spanish and English Neuropsychological Assessment Scales (SENAS). The SENAS has undergone extensive development as a battery of cognitive tests relevant to cognitive aging that allow for valid comparisons across race/ethnic groups (Mungas, Reed, Crane, Haan, & Gonzalez, 2004; Mungas, Reed, Haan, & Gonzalez, 2005; Mungas, Reed, Marshall, & Gonzalez, 2000; Mungas, Reed, Tomaszewski Farias, & DeCarli, 2005). The episodic memory composite score is derived from a multitrial word-list-learning test (Mungas, Reed, Crane, Haan, & Gonzalez, 2004). The semantic memory composite is derived from highly correlated verbal (object-naming) and nonverbal (picture association) tasks. The executive function composite is constructed from component tasks of category fluency, phonemic (letter) fluency, and working memory (digit-span backward, visual-span backward, list sorting). These measures were administered at all evaluations. Language of test administration was determined by an algorithm that combined information regarding each participant's language preference in several specific contexts (e.g., conversing at home, listening to radio or television, conversing outside the home, preferred language for reading). Administration procedures, measure development and psychometric characteristics of the SENAS battery are described at greater length elsewhere (Mungas, Reed, Crane, Haan, & Gonzalez, 2004).

Measurement of Life Experiences

Participants were administered the Life Experiences and Activities Form (LEAF). The LEAF is an interview-based instrument used to characterize experience across the participant's life span. It was developed drawing on similar measures in the literature (Wilson, Barnes, & Bennett, 2003; Wilson et al., 1999). We used a number of variables derived from the LEAF as independent variables to explain cognitive trajectories. These included frequency of current physical and recreational activity and of physical and recreational activity at age 40. LEAF physical and recreational variables are measured using a five-point frequency rating scale with a higher score indicating greater activity (1 = never to 5 = almost every day). Physical activities include light and heavy physical activities associated with work related demands, house or yard work, and exercise. Recreational activities include reading, writing, complex cooking, taking classes, performance arts, games or puzzles, cultural events, arts or crafts, socializing, and attending meetings or religious activities. Summary measures for light physical activity, heavy physical activity, and recreational activities were created by summing relevant items for age 40 and for the current evaluation, yielding three summary scores for each age epoch.

Language

Language of test administration or monolingual/bilingual status were included as independent variables. Language of test administration was assigned based on language usage in daily life as described elsewhere (Mungas, et al., 2004; Mungas, et al., 2000). Bilingualism was defined by participant self-rating of proficiency in English and Spanish. Monolingual English speakers spoke English well or very well, and spoke Spanish not at all or not well. The opposite pattern defined monolingual Spanish speakers. Bilinguals spoke both languages well or very well.

Literacy/Quality of Education

The American version of the National Adult Reading Test (Grober & Sliwinski, 1991) was used to measure single word reading in English. A Spanish language counterpart, the Word Accentuation Test (Del Ser, Gonzalez-Montalvo, Martinez-Espinosa, Delgado-Villapalos, & Bermejo, 1997) was used for Spanish speakers. These measures were combined into a single reading measure using previously described methods (Cosentino, Manly, & Mungas, 2007). This combined measure essentially merges Z scores based on cognitively normal English and Spanish samples into a single measure.

Morphometrics

Physical measurements of head circumference, knee height, and femur length were obtained using a standardized protocol (National Center for Health Statistics, 1988). These measurements are commonly used to examine associations between growth and cognitive aging (see Bornstein, Copenhaver, & Mortimer 2006 for a review). Head circumference was measured by placing a measuring tape over the eyebrows and passing it around the head to fit over the most posterior protuberance of the occiput. Knee height was measured while the participant was in a seated position by placing a measuring tape at the top of the patellar bone, a flat edge was then extended out and the distance from the top of the height of the patella to the floor was measured. Femur length was also measured while the participant was in a seated position by placing a measuring tape at the crease of the hip to the start of the patellar bone.

APOE Genotyping

Apolipoprotein E (APOE) genotyping was carried out using the LightCycler ApoE mutation detection kit (Roche Diagnostics, Indianapolis, IN).

Childhood SES

Indicators of SES were collected retrospectively via a structured interview with the research participant and informant. Indicators included father and mother's education in years, complexity of the father's occupation (Roos & Treiman, 1980), number of siblings, and number of sibling who died during childhood.

Data Analysis

SENAS measures of Episodic Memory, Semantic Memory, and Executive Function were standardized using means and standard deviations from the full baseline sample. Analysis of variance (ANOVAs) and the chi-square test were used to examine baseline characteristics of study participants. Mixed effects regression analyses were used to estimate parallel process growth models to characterize cognitive trajectories and to assess the impact of demographic and life experience variables on baseline cognitive scores and rate of change.

Confirmatory factor analysis (CFA) was applied to LEAF indicators of early life SES and morphometric measures to develop factor based measures of early life SES and growth/ physical development. SES was modeled as a formative factor, in effect an optimized linear combination of father and mother's education, complexity of the father's occupation (Roos & Treiman, 1980), number of siblings, and number of sibling who died during childhood. Growth was modeled as a reflective factor accounting for covariance of head circumference, knee height, femur length, and height, and was residualized for gender. Indicators of formative factors are selected on the basis of their construct validity, without regard to the correlations among indicators. In the present analyses, indicators of childhood SES obtained from the LEAF were selected based on prior research supporting the association between each indicator and late-life cognition. Weights associated with formative factors are comparable to beta weights in regression, in that they reflect the relative contribution of each indicator to the factor.

A 2-factor model of childhood SES and growth/physical development fit well, and favorable socioeconomic circumstances during early life were positively associated with growth (standardized beta = 0.21). Non-linear effects of growth and childhood SES on cognition were found previously that supported recoding these variables so that they were categorical variables grouped by quintiles (Melrose in press). These grouped variables were used in this study.

Mixed effects longitudinal analyses were performed using MPlus version 7.0 multilevel modeling (Muthen & Muthen, 2010). Complete data was not available on all variables, and the missing data analysis option of Mplus was used. Mplus uses full information maximum likelihood estimation, which provides unbiased parameter estimates in the context of missing at random (Newman, 2003). Missing data was primarily missing by design, which meets requirements for missing at random (Bollen & Curran, 2005). Analyses took advantage of the complete sample to estimate baseline and change random effects for the three cognitive outcomes and to estimate how basic demographic variables and APOE ε4 influenced cognitive baseline and change. Missing data was present by design for childhood SES, growth/physical development, and for physical and recreational activity variables. Statistical power for these effects is reduced by missing data, but parameter estimates should be unbiased.

Mixed effects models for longitudinal data provide estimates of the baseline value and rate of change in the outcomes of interest. They also estimate how differences in the baseline level of the outcome and its rate of change over time relate to variables of interest (fixed effects) that differ between subjects (e.g., ethnicity, childhood SES). The inclusion of random effects accounts for individual variation not measured by the variables included in the model. Mixed effects models allow for heterogeneity in the number of assessment time points and in the lags between assessments across persons.

Model building proceeded in steps. Step 1 developed a base model to estimate intercept and slope random effects for all three outcomes, and included within-subjects terms to account for practice and form effects. The episodic memory measure included in SENAS consisted of three forms that were alternated across measurement occasions to control for practice effects. Previous studies (Early et al., 2013; Mungas et al., 2010) involving this longitudinal cohort identified significant form differences for the episodic memory measure, showed a beneficial effect of previous exposure for Semantic Memory, and showed that previous exposure to the episodic memory task differentially benefitted individuals tested in Spanish. These effects were explicitly modeled in this study so that estimates of longitudinal change would be adjusted for these potential sources of bias. A time-varying covariate coded for the episodic memory form administered at each evaluation. For each of the three cognitive outcome measures, a variable coding for previous exposure was created and included as a time-varying fixed effect. A Spanish language by previous exposure interaction term was included for Episodic Memory.

The initial model allowed the six random effects latent variables (intercept and slope random effects for each of the three outcomes) to freely correlate, but we then estimated second order latent variables (one with intercepts as indicators, one with slopes) that explained the correlations among the random effects. This step was taken to determine whether baseline cognition and cognitive change in our sample was best characterized by the three SENAS composite measures of Episodic Memory, Semantic Memory, and Executive Function separately, or by a second-order latent variable that provides an estimate of “global cognition" by reflecting the covariance among the three SENAS measures. We compared fit of models with 0, 1, and 2 second order factors using the Sample Size Adjusted Bayesian Information Criterion (SA-BIC). The SA-BIC weights model parsimony and model fit and has been shown in simulation studies to be useful for comparing model fit (Enders & Tofighi, 2008; Tofighi & Enders, 2007).

In step 2, we added APOE genotype and basic demographic variables age (years, centered at 70), gender, education (years, centered at 12), language and ethnicity as fixed effect independent variables to explain cognition baseline and change. Ethnicity was dummy coded using two variables: African American (1 = yes, 0 = no) and Latino (1 = yes, 0 = no); non-Latino white was represented by 0's for both. We examined interaction effects involving ethnicity and other covariates and retained significant interaction effects in subsequent models. In Step 3 we added specific life experience independent variables one at a time to the best model from Step 2. Finally, Step 4 generated a multivariate model including the life experience variables that showed significant effects in Step 3.

A secondary analysis substituted bilingual status for language of test administration in the Step 4 model. Bilingualism was dummy coded using two variables: monolingual Spanish (1 if monolingual Spanish, 0 otherwise), bilingual (1 if bilingual, 0 otherwise). Monolingual English was indicated by 0s on both variables.

Mixed model regression analyses are sensitive to assumptions of linearity, normality, and constant variance. These assumptions were examined using graphical and statistical diagnostics. Residuals and random effects were examined to assure that they were normally distributed, and plots of residuals against predicted values and effects were examined to verify that non-linear trends in the data or non-constant variances were not present. Additional diagnostics included evaluation of variance components related to random effects and within subject error variance to address adequacy of statistical estimation procedures associated with the random effects modeling.

Results

Sample characteristics

Characteristics of the study sample are presented by ethnic group in Table 1. Latinos were significantly younger and had less education than non-Latino white and African American participants. Latinos also had lower scores on measures of childhood SES, growth, and recreational activity. The non-Latino white subgroup included more male participants, had higher scores on single word reading, and was followed for a slightly shorter duration than African American and Latino samples. The African American sample had the highest proportion of APOE ε4 allele carriers and included the largest proportion of female participants. Forty seven percent of the Latino sample and one African American participant were Spanish monolingual. Forty two percent of Latinos and 3% of the non-Latino white sample was English/Spanish bilingual. At the baseline evaluation, 31% of African American participants met study criteria for MCI, compared with18% of Latino participants and 25% of non-Latino whites.

Effects of basic demographic factors and genetic status on baseline and change in cognition

The best base longitudinal model included a second order latent variable to account for intercorrelations of slopes of the three outcomes, but individual first order intercepts (SA-BIC was 5418.2 for the model with a 2nd order "global slope" factor, 5422.1 for a model with 2nd order "global intercept" and "global slope" factors, and 5427.9 for the model with no second order factors). This model examines episodic memory, semantic memory and executive functioning separately at baseline, but examines cognitive change as a second-order "global" factor that explains highly correlated change in the three measures. Basic demographic variables (age, gender, ethnicity, language) and APOE ε4 were then added to this model, and terms for interactions of ethnicity with other independent variables were tested. Significant education-by-ethnicity interactions were found for Executive Function and these effects were retained in subsequent models. Tables 2 and 3 present results of the model that included these significant interaction effects. Table 2 shows effects on baseline cognitive scores. Spanish language of test administration and age were negatively associated with baseline scores for all three cognitive outcomes. Higher education was positively related to Episodic Memory and Semantic Memory. There was a significant education-by-ethnicity interaction for Executive Function such that education effects were stronger in non-Latino whites. However, simple main effects of education in African Americans and Latinos still were significant. Males had lower baseline scores on Episodic Memory and Executive Function but higher Semantic Memory scores. African Americans and Latinos had lower average Semantic Memory and Executive Function scores in comparison with non-Latino whites. Presence of an APOE ε4 allele was associated with lower Episodic Memory. Table 3 shows effects on the global slope estimate. Older age and APOE ε4 were associated with greater cognitive decline, and African Americans declined less in comparison with non-Latino whites.

Effects of environmental and experiential factors on baseline and change in cognition

Summary statistics for the environment and experience variables that were used to explain cognitive trajectories are presented in Table 1. Growth/physical development and childhood SES differed substantially across ethnicity groups. Recreational activity variables differed across groups, though effect sizes were quite small, and physical activities did not differ across groups. Correlations among environment and experience variables were small to moderate. Correlations exceeding 0.30 were observed for: Reading with Current Recreational Activities (0.36), Recreational Activities at 40 with Current Recreational Activities (0.46) and Light Physical Activity at 40 (0.48), Current Light Physical Activities with Current Recreational Activities (0.40) and Current Heavy Physical Activities (0.41), and Childhood SES with Growth/Physical Development (0.53).

Specific life experience variables were added one at a time to the model with demographics and APOE ε4 to determine if these variables added explanatory power. Effects on baseline scores are shown in Table 4. Single word reading was positively associated with baseline scores for all three outcomes. When single word reading was added as an independent variable, education effects were no longer significant for Episodic Memory and Semantic Memory and were not significant for Executive Function for African Americans and Latinos in this model (not shown). Race/ethnicity group differences also were attenuated in this model and differences were no longer significant for Executive Function (not shown). The lowest quintile of childhood SES had lower Semantic Memory in comparison with the highest quintile, and the next to highest quintile had lower Executive function in comparison with the highest. Heavy current physical activity was associated with better Episodic Memory and Executive Function, and heavy physical activity at age 40 was related to better Semantic Memory and Executive Function, with a positive trend for Episodic Memory. Higher current recreational activity was related to better Executive Function, and recreational activity at age 40 was associated with better Semantic Memory. Results for annual cognitive change estimates are shown in Table 5. Higher single word reading and current recreational activity were associated with less global decline. The highest quintile of childhood SES had less decline than the first, third, and fourth quintiles, and the difference for the second quintile approached significance.

The final multivariate model included basic demographics, APOE ε4 and all of the life experience variables except growth and light physical activities, which were not significantly related to baseline cognition or cognitive change in the previous analyses. This is a complex model that simultaneously estimated independent contributions of all variables in the model. Results for baseline cognitive scores are presented in Table 6. Spanish language and older age continued to be negatively associated with baseline values of all three outcomes. African Americans and Latinos had lower baseline Semantic Memory, but Executive Function differences across ethnic groups were no longer significant. Education did not have an independent relation with Episodic Memory or Semantic Memory and was related to Executive Function only in non-Latino whites. Males continued to have lower scores on Episodic Memory and Executive Function and higher Semantic Memory. Presence of an APOE ε4 allele was negatively associated with Episodic Memory. Single word reading was strongly related to all three cognitive variables. Heavy physical activity at age 40 was associated with better Semantic Memory and Executive Function. The lowest quintile of childhood SES and the fourth quintile continued to have lower Semantic Memory and Executive Function, respectively, in comparison with the fifth quintile.

Multivariate effects on global cognitive decline from the final model are shown in Table 7. Older age and APOE ε4 predicted greater decline, while better single word reading was associated with slower decline. African Americans declined less on average than non-Latino whites. Higher current recreational activity was associated with less decline, but higher recreational activities at age 40 was associated with faster cognitive decline in later life in this multivariate model. This pattern of results most likely reflects effects of change in recreational activities from mid to late life. Higher recreational activities at age 40 in comparison with current levels were associated with greater cognitive decline, whereas recreational activities that are stable or increase from age 40 to present were associated with less decline. Stated in different terms, decline in recreational activities from mid to late life is associated with late life cognitive decline. Figure 1 provides a graphical representation of this explanation for the observed recreational activity effects on cognitive change. It is based on results from the final multivariate model and shows two model predicted longitudinal trajectories for episodic memory, one for a hypothetical individual who was at the median in recreational activities at age 40 and was at this same level in late life, and a second who was at the median at age 40 but whose current recreational activity level was one standard deviation lower. Results show stable cognitive function for the first, but declining cognition for the second. It is noteworthy that these lines start at the same baseline level but subsequently diverge.

A secondary analysis examined effects of bilingual status (monolingual Spanish, bilingual, monolingual English) in the multivariate model. Language of test administration was replaced by the dummy variables coding monolingual Spanish and bilingual (in comparison to monolingual English) in this model. Monolingual Spanish was associated with lower baseline scores in comparison with monolingual English for Semantic Memory (β=-0.952, S.E.= 0.213, $p<0.001$), and Executive Function (β=-0.643, S.E.= 0.221, $p<0.004$), and results approached significance for Episodic Memory (β=-0.417, S.E.= 0.225, $p<0.064$). Bilingual and monolingual English did not significantly differ (*p*'s = 0.14, 0.58, 0.85). Bilingual status was not related to global cognitive change.

An additional secondary analysis tested whether effects of English reading, measured by the AmNART, differed from effects of Spanish reading, measured by the Word Accentuation Test. An interaction term for Spanish test administration by single word reading was added. None of these interaction effects were significant (p's>0.16) indicating that reading effects did not differ by language. English reading effects on all three baseline scores continued to be strong (Episodic Memory: β= 0.252, S.E.= 0.052, $p<0.001$; Semantic Memory: β=0.302, S.E.= 0.051, $p<0.001$; and Executive Function: β=0.459, S.E.= 0.054, $p<0.001$). Spanish reading also was strongly related to baseline scores (Episodic Memory: β=0.870, S.E.= 0.068, $p<0.001$; Semantic Memory: β=0.334, S.E.= 0.0670, $p<0.001$; and Executive Function: β=0.533, S.E.=0.069, $p<0.001$). The effect of reading on cognitive change was significant both for English speakers (β=0.017, S.E.= 0.009, p=0.042) and Spanish speakers (β=0.039, S.E.= 0.017, $p<0.02$).

Results Summary

In the final multivariate model, older age and APOE ε4 genotype were associated with more rapid global cognitive decline and higher single word reading was associated with slower global cognitive decline. Current recreational activities were associated with slower global cognitive decline, but recreational activities at age 40 were associated with faster decline after controlling for current recreational activities and all other variables in the multivariate model. These results suggest that decline in recreational activities from mid life to late life is associated with declining cognition in late life. More favorable childhood SES was associated with less global cognitive decline in a model that adjusted for demographic variables, age, and APOE, but this effect was not significant in the final model that included other life experience variables.

African Americans and Latinos had baseline Semantic Memory scores that were 0.50-0.60 standard deviations (s.d.) lower than non-Latino whites and Executive Function scores that were 0.30-0.40 s.d. lower in the model with demographics and APOE ε4. Controlling for life experience variables attenuated ethnicity effects, especially for Executive Function where ethnicity differences no longer were significant. For Semantic Memory, the African American difference declined to about 0.50 s.d. and Latino difference to about 0.40 s.d.

Addition of life experience variables substantially attenuated education effects: by 97% for Episodic Memory and by 71% for Semantic Memory. For Executive Function, education effects were attenuated by 49% for whites, but by 98% for African Americans and 77% for Latinos. African Americans declined less on average than non-Latino whites, and there was a trend for slower decline in Latinos in comparison with whites.

Spanish language was associated with lower baseline scores, and effects of Spanish language were greater in the final model that included life experience variables. Bilinguals did not differ from monolingual English speakers in either baseline scores or longitudinal change. Single word reading had strong effects on cognition baseline in both English speakers and Spanish speakers. Age and single word reading had robust effects on baseline scores of all three cognitive outcomes, and heavy physical activity at age 40 was associated with better Semantic Memory and Executive Function.

Discussion

Declining cognitive function in older adults is a major personal and public health problem. But not all older people lose cognitive function, and understanding the remarkable variability in cognitive trajectories as people age is of critical importance for prevention, treatment, and planning to promote successful cognitive aging and minimize problems associated with cognitive decline. This study addressed a broad range of life experience variables that contribute to development of cognitive skills over the lifespan. These variables potentially influence not only the baseline level of cognitive function that is the reference point for subsequent maintenance or decline of cognitive abilities, but also might affect whether individuals decline from this baseline level. We utilized an ethnically and demographically diverse sample to examine how a broad spectrum of life experience variables relate to late life cognitive trajectories, and specifically tested incremental effects of these variables after accounting for basic demographic variables, age, and APOE genotype. The diversity of our sample, the breadth of predictors of cognitive trajectories, and the simultaneous assessment of their effects on baseline cognitive test scores and longitudinal change provide a unique opportunity for clarifying determinants of successful and unsuccessful cognitive aging in demographically diverse older populations.

We were especially interested in effects of life experience variables on cognitive change. Demographic variables like ethnicity and education have been shown to have robust effects on cross-sectional or baseline cognitive test scores, but associations with cognitive decline are not so well established. This may be because baseline test scores reflect the sum total of life experiences that contribute to development of cognitive skills and knowledge, and to familiarity with and skills for taking cognitive tests, while in contrast, longitudinal change is more dependent on late life diseases that impact the brain systems and mechanisms that subserve cognition. Identifying life experience variables that impact late life cognitive decline is especially important because this might have public health, prevention, and treatment implications for minimizing the adverse impacts of diseases of aging and maximizing the potential for successful aging.

The strongest predictors of cognitive decline in this study were age at the baseline evaluation, APOE genotype, and single word reading ability. APOE ε4 and age previously have been shown to impact the slope of cognitive change in older adulthood (e.g. Schiepers et al., 2012). Age and APOE are likely to exert their effects on cognitive decline via well-known associations with diseases of aging like Alzheimer's disease and cerebrovascular disease. Single word reading, on the other hand, has often been considered a measure of quality of educational experience (Manly, et al., 2002; Manly, Touradji, Tang, & Stern, 2003), and so, might be a strong indicator of life experience that impacts cognitive aging. An important and novel aspect of this study was that we showed similar effects of single word reading for English and Spanish language readers/speakers. We also identified other life experience variables that were related to cognitive change, notably childhood SES and intellectually stimulating recreational activities.

We found that higher levels of current recreational activities were associated with less cognitive decline. Late life recreational activities are known to relate to cognitive decline (Hultsch, Hertzog, Small, & Dixon, 1999; Wilson et al., 2003; Wilson, Segawa, Boyle, & Bennett, 2012). There are a number of potential explanations for these associations. Late life activity might be a consequence of earlier life experiences that build resilience to diseases that cause cognitive decline (Hultsch, et al., 1999). Alternatively, decreased recreational activities and declining cognition may both result from age related diseases, with no causal relationship. Wilson et al. (Wilson, et al., 2012) evaluated this hypothesis by testing time-lagged correlations of recreational activities and cognition, and found specific protective effects of activity variables. Reed et al. (Reed et al., 2011) similarly reported that recreational activity in mid-life and late life were independently associated with greater cognitive reserve in late life. Together, these findings support the importance of exploring the potential role of interventions that engage disparate populations in cognitive activities for addressing disparities in cognitive aging (Lachman, Agrigoroaei, Murphy, & Tun, 2010; Marquine, et al., 2012).

Higher current recreational activities were associated with less cognitive decline, but higher recreational activities at age 40 were associated with greater decline in models that simultaneously estimated effects of current recreational activities. Current recreational activities and recreational activities at age 40 were moderately correlated ($r = 0.46$) but not collinear. This pattern of results suggests that cognitive decline is greater when recreational activity at age 40 is high in relation to current activity, that is, when recreational activity has declined from mid life levels. Recreational activity scores at age 40 may represent a "premorbid" level of functioning, and decline from this level has negative implications for cognitive trajectories. To our knowledge this finding has not been reported elsewhere, but associations between correlated change in physically and cognitively demanding recreational activity and cognition have been documented previously (e.g. Lindwall, et al., 2012; Mitchell, et al., 2012). Replication of our finding in an independent sample is warranted.

Consistent with our previous study (Melrose in press) early-life SES was associated with cognitive change independent of basic demographic variables, age, and APOE. However, this effect was not significant after adjusting for other life experience variables, notably single word reading and recreational activities. These results are consistent with the notion that early life experience affects late-life cognition indirectly through education, literacy, and late-life recreational activities (Jefferson, et al., 2011). Richards & Sacker (2003) found that paternal occupation, a measure of childhood SES, yielded only an indirect association with adult literacy that was mediated through the effects of educational attainment and childhood cognition. Consistent with social trajectory models, (Richards & Sacker (2003) noted that paternal occupation plays a strong determining factor in educational attainment and childhood cognition, but that its association with late-life outcomes is largely an artifact of its strong association with childhood cognition and education. Thus, accounting for late-life variables such as recreational activity and adult literacy removes the association between early life experience and late-life cognitive change. While we previously observed that low growth predicted greater rate of cognitive decline (Melrose in press) this finding was not replicated here when using a different model with additional demographic covariates. This also supports the interpretation that experiences throughout the lifespan attenuate the impact of early life deprivation on risk of cognitive decline.

We also examined how the life experience and demographic variables in this study were related to baseline cognitive function. Language, race/ethnicity, and education effects on cognition in cross-sectional studies are well documented (Manly et al., 1998; Manly et al., 2002). In this study, independent effects of education and racial/ethnic group on cognition were substantially reduced when single word reading/literacy, a proxy for quality of education, was included. These results are consistent with broader literature showing that single word reading is useful for estimating “premorbid ability” and differentiating cognitive impairment from stable adulthood performance. We also examined effects of language and bilingualism. Monolingual Spanish speakers in this study had substantially lower baseline scores, and these differences actually were greater in the final multivariate model. Perhaps the most accurate characterization of this effect is that Spanish monolinguals had lower test scores; differences between English speaking bilinguals and monolinguals were not significant. Bilingualism per se was not associated with better baseline performance or with slower cognitive decline. These findings highlight the importance of developing group specific norms for monolingual Spanish speakers when using cross-sectional cognitive test results to make clinical decisions about the presence of cognitive impairment.

There remained a relatively small but significant effect of ethnicity on cognitive change in the final multivariate model. Although African Americans had lower cognitive functioning at baseline, they demonstrated slower decline than non-Latino whites. A recent study by Barnes et al. (2012) found that early life adversity (food deprivation and being thinner) had a protective effect on cognitive decline in older African Americans but not whites. Our findings may reflect resilience or reserve capacity in ethnic groups that have survived inordinate challenges throughout their life-course. However, other interpretations are possible, including sampling bias (Barnes, et al., 2012). It is possible that Africans Americans with better cognitive health differentially agreed to participate in this study.

Heavy physical activity at age 40 also was associated with better baseline cognition in the final multivariate model, which is consistent with prior findings showing that leisure physical activity during midlife is associated with reduced risk of dementia, (Andel et al., 2008; Chang et al., 2010; Rovio et al., 2005), Alzheimer's disease (Rovio, et al., 2005) and vascular dementia (Gelber et al., 2012), as well as better processing speed, memory and executive function (Chang, et al., 2010). Our results are intriguing in that mid-life physical activity was related to cognition independent of many other variables that affect test scores. If these results are broadly replicated, they might suggest that heavy physical work and exercise promote cardiovascular and brain health and support the maintenance of cognitive skills and knowledge in old age.

This study has several methodological strengths. First, the sample was ethnically diverse and also heterogeneous in terms of demographic characteristics, baseline cognition, and cognitive decline. Second, the measures of cognition have been shown to be appropriate for use with English and Spanish speakers, and the racial ethnic groups included in this study (Mungas, et al., 2004; Mungas, Reed, Haan, et al., 2005; Mungas, Widaman, Reed, & Tomaszewski Farias, 2011). Third, information collected from participants regarding life experiences was extensive. Finally, there was a relatively high follow-up rate of individuals enrolled in this study.

There also are important limitations to this study. First and foremost, the sample size was relatively small for detecting effects of distal life experiences on late life cognition. Sample size and resulting limits of statistical power are particularly relevant for interpreting negative results. Also due to limited power, an alpha level of 0.05 was used in this study and no adjustments were made for multiple comparisons. Second, the length of follow-up of this sample was relatively short; while our sample was followed for about 4 years on average, cognitive trajectories in late life likely develop over decades. This is especially true for cognitive change that follows a slow and gradual transition from mid to late life. In consideration of the relatively small sample size and short length of follow-up, we strongly recommend replication of our findings in a larger sample with more extensive follow-up. Third, measures of life experience variables involved retrospective self-report, which can introduce systematic biases and unreliability of measurement. Finally, many other variables not included in this study might contribute to observed differences and obscure differences that were not found in this study. Unmeasured health disparities specifically might have important effects.

This study used comprehensive measures of demographic and life experience variables to explain late life cognitive trajectories in a unique, ethnically, demographically, and cognitively diverse longitudinal community based cohort. Replication of our findings with larger representative samples will be important to advance understanding of how different experiences across the life span contribute to or protect against cognitive decline in late life.

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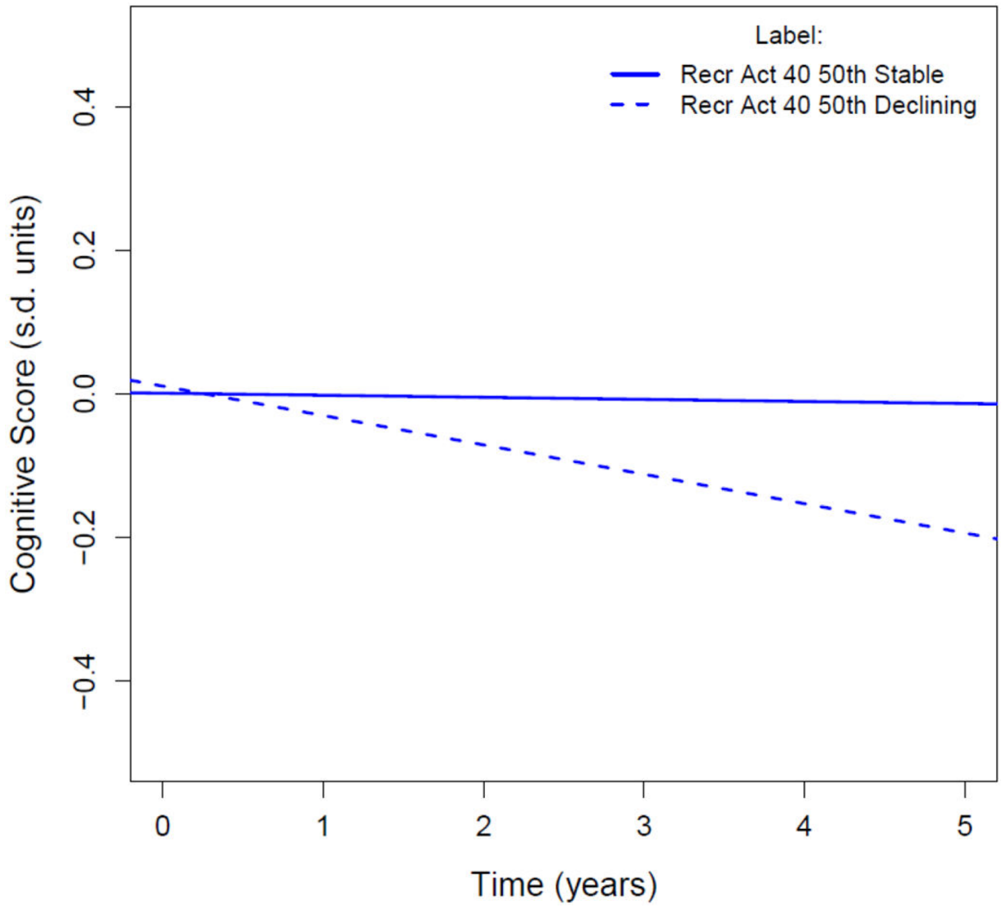

Figure 1.
Expected linear trajectories for stable versus declining recreational activities from age 40 to the present. The graphed lines are model predicted linear trajectories for two hypothetical cases; one having a median recreational activity total score at age 40 and remaining at this same level at the time of assessment of current recreational activities, and the second having the same median recreational activity level at age 40 but a current level one standard deviation lower.

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Table 1

Characteristics of study sample at baseline assessment by ethnicity.

Variable	African American	Latino	Non-Latino White	*Effect Size*[a]
Sample Size	**n=120**	**n=109**	**n=104**	
Number of assessments	4.24 (1.74)	4.50 (1.86)	4.05 (1.96)	0.009
Years in study - Mean (SD)	4.27 (2.13)	4.57 (2.25)	3.77 (2.28)	0.022 *
Episodic Memory – Mean (SD)	0.16 (0.86)	-0.34 (0.93)	0.17 (1.13)	0.035 ***
Semantic Memory – Mean (SD)	-0.05 (0.74)	-0.61 (1.00)	0.69 (0.83)	0.370 ***
Executive Function – Mean (SD)	0.01 (0.83)	-0.43 (0.97)	0.43(1.03)	0.134 ***
Age - Mean (SD)	74.43 (7.08)	71.47 (6.46)	74.93 (6.76)	0.050 ***
Years of education - Mean (SD)	13.54 (3.03)	8.39 (5.48)	14.40 (3.05)	0.435 ***
Gender - % Female	73	66	58	0.135 *
APOE ε4 - % positive (n)	45 (49)	20 (20)	35 (32)	0.217 ***
Monolingual English - % (n)	99 (119)	11 (12)	97 (101)	0.890 ***
Monolingual Spanish - % (n)	1 (1)	47 (51)	0 (0)	0.599 ***
Bilingual - % (n)	0 (0)	42 (46)	3 (3)	0.542 ***
Normal Cognition - % (n)	62 (73)	72 (75)	64 (65)	0.090
Mild Cognitive Impairment - % (n)	31 (36)	18 (19)	25 (26)	0.119
Dementia - % (n)	7 (8)	10 (10)	11 (11)	0.059
Single word reading - Mean (SD, n)	-0.24 (0.93, 106)	-0.30 (1.11, 74)	0.39 (0.90, 67)	0.092 ***
Growth/Physical Development – Mean (SD, n)	0.30 (0.73, 93)	-0.78 (0.73, 89)	0.32 (0.80, 78)	0.480 ***
Childhood SES - Mean (SD, n)	0.14 (0.69, 62)	-0.91 (1.02, 62)	0.44 (0.62, 46)	0.404 ***
Current physical activity (light) – Mean (SD, n)	12.09 (2.64, 56)	11.39 (3.22, 61)	12.48 (2.49, 43)	0.026
Light physical activity at age 40 – Mean (SD, n)	11.96 (2.23, 56)	11.21 (2.45, 61)	11.58 (2.35, 41)	0.019
Current physical activity (heavy) - Mean (SD, n)	6.70 (2.17, 56)	6.51 (2.37, 61)	7.04 (2.54, 43)	0.008
Heavy physical activity at age 40 - Mean (SD, n)	8.36 (2.66, 56)	8.31 (3.16, 61)	7.95 (2.68, 41)	0.004
Current recreational activities - Mean (SD, n)	30.00 (4.70, 56)	27.00 (5.30, 61)	29.51 (5.72, 43)	0.070 **
Recreational activities at age 40 – Mean (SD, n)	30.82 (6.10, 56)	27.64 (6.32, 61)	29.49 (5.76, 41)	0.052 *

Note. Cognitive status was missing from 10 participants.

[a] Cohen's f^2 for Continuous variables, Cramer's *V* for categorical variables

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

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Table 2

Effects of demographic variables and APOE ε4 on baseline cognition. Significant effects are shown in bold font.

	Episodic Memory			Semantic Memory			Executive Function		
Independent Variable	**Parameter Estimate**	**Standard Error**	**p**	**Parameter Estimate**	**Standard Error**	**p**	**Parameter Estimate**	**Standard Error**	**p**
African American	-0.131	0.100	0.187	**-0.624**	0.101	0.001	**-0.370**	0.123	0.003
Latino	-0.163	0.139	0.242	**-0.532**	0.122	0.001	**-0.355**	0.142	0.012
Spanish	**-0.566**	0.150	0.001	**-0.966**	0.150	0.001	**-0.355**	0.159	0.026
Male	**-0.450**	0.085	0.001	**0.181**	0.091	0.047	**-0.309**	0.096	0.001
Age	**-0.046**	0.006	0.001	**-0.029**	0.005	0.001	**-0.045**	0.007	0.001
APOE ε4	**-0.232**	0.094	0.014	-0.107	0.088	0.223	-0.123	0.096	0.199
Education (non-Latino white)	**0.038**	0.010	0.001	**0.055**	0.011	0.001	**0.117**[*]	0.021	0.001
Education (African American)							**0.060**[*]	0.020	0.002
Education (Latino)							**0.066**[*]	0.014	0.001

[*] simple main effects

Table 3

Effects of demographic variables and APOE ε4 on global cognitive decline. Significant effects are shown in bold font.

Independent variable	Parameter Estimate	Standard Error	*p-value*
African American	**0.039**	0.019	0.042
Latino	0.029	0.023	0.201
Spanish	-0.005	0.021	0.828
Male	0.005	0.015	0.731
Age	**-0.004**	0.001	0.000
APOE ε4	**-0.041**	0.016	0.012
Education	0.002	0.002	0.169

Table 4

Effects of individual, specific life history variables on baseline cognition. Significant effects are shown in bold font. Demographic variables and APOE were included as covariates (effects not shown).

	Episodic Memory			Semantic Memory			Executive Function		
Independent Variable	**Parameter Estimate**	**Standard Error**	**p**	**Parameter Estimate**	**Standard Error**	**p**	**Parameter Estimate**	**Standard Error**	**p**
Growth – Q1 vs. Q5	-0.087	0.235	0.709	-0.331	0.235	0.159	-0.327	0.245	0.183
Growth – Q2 vs. Q5	0.053	0.199	0.790	-0.105	0.186	0.571	-0.192	0.182	0.293
Growth – Q3 vs. Q5	-0.035	0.185	0.851	-0.209	0.176	0.235	-0.286	0.174	0.101
Growth – Q4 vs. Q5	-0.090	0.184	0.624	-0.198	0.173	0.253	-0.232	0.182	0.203
Childhood SES – Q1 vs. Q5	-0.195	0.184	0.291	**-0.474**	0.192	0.013	-0.133	0.159	0.402
Childhood SES – Q2 vs. Q5	-0.254	0.191	0.184	-0.022	0.197	0.912	-0.177	0.172	0.304
Childhood SES – Q3 vs. Q5	-0.208	0.177	0.240	-0.305	0.171	0.075	-0.283	0.157	0.070
Childhood SES – Q4 vs. Q5	-0.295	0.182	0.106	-0.055	0.164	0.739	**-0.328**	0.165	0.046
Single Word Reading	**0.237**	0.047	0.000	**0.336**	0.048	0.000	**0.454**	0.050	0.000
Heavy Physical Activity - Current	**0.073**	0.027	0.008	0.017	0.026	0.511	**0.059**	0.029	0.040
Heavy Physical Activity - Age 40	0.038	0.022	0.086	**0.056**	0.022	0.011	**0.060**	0.025	0.017
Light Physical Activity - Current	0.013	0.023	0.578	-0.005	0.024	0.830	-0.008	0.023	0.736
Light Physical Activity - Age 40	0.007	0.028	0.803	0.036	0.030	0.227	0.024	0.030	0.410
Recreational Activities - Current	0.018	0.012	0.148	0.016	0.012	0.157	**0.032**	0.011	0.005
Recreational Activities - Age 40	0.009	0.011	0.393	**0.024**	0.010	0.022	0.016	0.011	0.152

Table 5

Effects of individual, specific life history variables on global cognitive decline. Significant effects are shown in bold font. Demographic variables and APOE were included as covariates (effects not shown).

Independent variable	Parameter Estimate	Standard Error	*p*-value
Growth – Q1 vs. Q5	-0.091	0.061	0.136
Growth – Q2 vs. Q5	-0.083	0.058	0.152
Growth – Q3 vs. Q5	-0.041	0.051	0.423
Growth – Q4 vs. Q5	-0.029	0.047	0.542
Childhood SES – Q1 vs. Q5	**-0.074**	0.033	0.024
Childhood SES – Q2 vs. Q5	-0.053	0.031	0.087
Childhood SES – Q3 vs. Q5	**-0.060**	0.026	0.021
Childhood SES – Q4 vs. Q5	**-0.071**	0.029	0.015
Single Word Reading	**0.025**	0.009	0.008
Heavy Physical Activity - Current	0.007	0.005	0.206
Heavy Physical Activity - Age 40	0.003	0.004	0.498
Light Physical Activity - Current	0.003	0.003	0.406
Light Physical Activity - Age 40	-0.008	0.006	0.184
Recreational Activities - Current	**0.007**	0.002	0.001
Recreational Activities - Age 40	-0.001	0.002	0.804

Table 6

Multivariate effects of demographic variables, APOE ε4, and specific life history variables on baseline cognition. Significant effects are shown in bold font.

	Episodic Memory			Semantic Memory			Executive Function		
Independent Variable	**Parameter Estimate**	**Standard Error**	***p*-value**	**Parameter Estimate**	**Standard Error**	***p*-value**	**Parameter Estimate**	**Standard Error**	***p*-value**
African American	-0.017	0.097	0.861	**-0.492**	0.092	0.000	-0.188	0.110	0.090
Latino	-0.056	0.139	0.686	**-0.380**	0.129	0.003	-0.240	0.132	0.070
Spanish	**-0.748**	0.155	0.000	**-1.199**	0.145	0.000	**-0.686**	0.144	0.000
Male	**-0.386**	0.088	0.000	**0.251**	0.081	0.002	**-0.172**	0.086	0.046
Age	**-0.043**	0.006	0.000	**-0.027**	0.005	0.000	**-0.043**	0.006	0.000
APOE ε4	**-0.178**	0.090	0.049	-0.095	0.079	0.233	-0.037	0.081	0.649
Education	0.008	0.011	0.477	0.016	0.011	0.125	**0.060***	0.020	0.003
Education-by-African American							0.001*	0.019	0.964
Education- by- Latino							0.015*	0.012	0.217
Childhood SES – Q1 vs. Q5	-0.255	0.192	0.183	**-0.540**	0.190	0.004	-0.103	0.175	0.557
Childhood SES – Q2 vs. Q5	-0.320	0.182	0.080	-0.121	0.191	0.526	-0.204	0.159	0.200
Childhood SES – Q3 vs. Q5	-0.216	0.185	0.244	-0.319	0.184	0.083	-0.221	0.162	0.173
Childhood SES – Q4 vs. Q5	**-0.356**	0.174	0.041	-0.167	0.167	0.318	**-0.381**	0.158	0.016
Single Word Reading	**0.253**	0.047	0.000	**0.324**	0.047	0.000	**0.460**	0.048	0.000
Heavy Physical Activity - Current	0.054	0.029	0.062	-0.001	0.024	0.980	0.020	0.029	0.496
Heavy Physical Activity - Age 40	0.024	0.022	0.293	**0.049**	0.021	0.023	**0.053**	0.023	0.023
Recreational Activities - Current	-0.002	0.016	0.907	-0.010	0.011	0.396	0.015	0.012	0.230
Recreational Activities - Age 40	-0.002	0.012	0.896	0.013	0.009	0.140	-0.001	0.011	0.894

*simple main effects

Table 7

Effects of individual, specific life history variables on global cognitive decline. Significant effects are shown in bold font.

Independent variable	Parameter Estimate	Standard Error	*p*-value
African American	**0.045**	0.018	0.010
Latino	0.040	0.025	0.119
Spanish	-0.019	0.023	0.400
Male	0.008	0.016	0.605
Age	**-0.004**	0.001	0.000
APOE ε4	**-0.030**	0.014	0.038
Education	0.000	0.002	0.877
Childhood SES – Q1 vs. Q5	-0.047	0.039	0.229
Childhood SES – Q2 vs. Q5	-0.030	0.036	0.402
Childhood SES – Q3 vs. Q5	-0.042	0.028	0.129
Childhood SES – Q4 vs. Q5	-0.052	0.036	0.148
Single Word Reading	**0.020**	0.008	0.012
Heavy Physical Activity - Current	-0.001	0.005	0.872
Heavy Physical Activity - Age 40	0.004	0.004	0.285
Recreational Activities - Current	**0.006**	0.002	0.002
Recreational Activities - Age 40	**-0.004**	0.002	0.013