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The Illinois Institute for Rural Affairs (IIRA) works to improve the quality of life for rural residents by partnering with public and private agencies on local development and enhancement efforts.

Cognitive Functioning in Later-Life, Older than 65 Years: Insights from the Health and Retirement Panel Study, 2010-2020

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Abstract

The concept 'cognitive functioning' refers to mental abilities; it includes thinking, learning, and decision making. Age-related cognitive decline includes slowness in thinking and holding information in the mind. This research explores the correlates of cognitive reserve among the later-life segment in the nation using panel data from the Health and Retirement Study. Results of data analysis indicate that one's level of education contributes to one's cognitive reserve; physical inactivity contributes to cognitive decline.

Introduction

The lexical definition of cognition is the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses[2]. Age-related cognitive decline includes slowness in thinking and holding information in the mind; the median correlation between age and memory performance is -.33 and the typical correlation between age and measures of reasoning effectiveness is -.35[3]. Normal age-related cognitive change doesn't impair one's performance of day-to-day activities, for example, bathing. However, normal aging could impact negatively, albeit subtly, performance of complex activities such as driving[4]; this is one reason why commercial airline pilots have a mandatory retirement

[1] Professor, Illinois Institute for Rural Affairs, Western Illinois University.
[2] https://www.merriam-webster.com/dictionary/cognition.
[3] Merriam, S. B., & Baumgartner, L. M. (2020). *Learning in adulthood: A comprehensive guide*. John Wiley & Sons.
[4] Anstey KJ., and Wood J. (2011). Chronological age and age-related cognitive deficits are associated with an increase in multiple types of driving errors in late life. *Neuropsychology*, 25, 613–21.

age of 65[5]. While variability in age-related cognitive changes is mostly genetics[6], medical illness, sensory shortcomings in vision and hearing, and psychological factors also explain a substantial portion of variability.

This research explores the correlates of cognitive reserve[7] among the later-life segment in the nation using panel data from the Health and Retirement Study (HRS). Research questions that guided data analysis include:

(i) Can cognitive changes among the later-life members of the population be ascertained from the HRS?

If the answer to the above question is "yes",

(ii) Is cognitive change more evident among certain sub-segments of the later-life population, for example, minorities?

(iii) What are the determinants of cognitive reserve among the later-life segment of the population?

Concepts and their Relations

Cognitive functioning is defined as one's mental abilities, including thinking, learning, and decision making[8]. The lifestyle cognition hypothesis states that an active lifestyle will prevent age-related cognitive decline and dementia[9]; examples of active lifestyle include 'intellectually engaging activities', for example, puzzles and playing boardgames; 'physical activities' such as gardening; and social engagement such as travel and cultural events.

Another explanation of age-related cognitive decline is the cognitive reserve hypothesis; it is predicated on the assumption that higher levels of education, higher socioeconomic status, and baseline intelligence protect against clinical manifestation of brain disease[10].

Finally, there is the 'retraining' hypothesis, that cognitive training will minimize functional decline with advancing age[11]. Empirical support for this assertion can be gleaned from a meta-analysis on the topic[12]; it showed that cognitive training produces improvements in safer driving performance.

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[5] https://www.faa.gov/faq/what-maximum-age-pilot-can-fly-airplane.

[6] McClearn, GE., Johansson B., and Berg S, et al. (1997). Substantial genetic influence on cognitive abilities in twins 80 or more years old. *Science*, 276, 1560–1563.

[7] The terms 'cognitive reserve' and 'cognitive functioning' are used interchangeably in this paper.

[8] Park, D. C. (2000). The basic mechanisms accounting for age-related decline in cognitive function. In D. C. Park & N. Schwarz (Eds.), *Cognitive aging: A primer.* New York, NY: Routledge.

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Table 1 lists the predictors of cognitive reserve from the conceptual frameworks discussed above and shows the directions of the association or correlation of the criterion with the predictors.

Table 1: The Criterion, Cognitive Reserve, and their Correlates

HRS Variable (*X* ranges from 2010-2020)	Expected Direction of Association with the Criterion, Cognitive Reserve
R*X*MAP: Difficult to use a map	Negative
R*X*MONEY: Difficult to manage money	Negative
R*X*JOG: Difficult to jog 1 mile	Negative
R*X*WALK: Difficult to walk one block	Negative
RAEDYRS: Years of education	Positive
R*X*EARN: Income	Positive
R*X*RETSAT: Retirement satisfaction	Positive
R*X*LBEXT: Extroversion	Positive
R*X*LBLONELY3: Loneliness	Negative

Methodology

Panel data from the HRS were sourced to address the research questions. It is a survey of individuals over age 50 and their spouses and consists of the following cohorts: “children of depression” cohort, born 1924 to 1930; “initial HRS” cohort, born 1931 to 1941; “war baby” cohort, born 1942 to 1947; “early baby boomer” cohort, born 1948 to 1953; “mid baby boomer” cohort, born 1954 to 1959; and “late baby boomer” cohort, born 1960 to 1965.

The surveys[13] contain information on a range of topics including demographics, income, assets, health, and cognition[14]. Table 2 lists the number of records obtained from the HRS for each of the six cohorts. Since the research focus is on the later-life segments as at 2020, only cohorts 1-4 were included in data analysis. Table 3 provides operational definitions of both the predictive or explanatory variables and the criterion variable, ‘cognitive functioning’.

[13] The survey is administered every two years; data are available for 2010, 2012, 2014, 2016, 2018, and 2020 time periods.
[14] See, https://hrsdata.isr.umich.edu/data-products/rand-hrs-longitudinal-file-2020

Table 2: Dataset, Cohorts and their Frequencies

Cohorts and their Date of Birth	Percent in the Database	N
Cohort 1: 1924-30	8%	2,016
Cohort 2: 1931-41	15%	3,667
Cohort 3: 1942-47	17%	4,043
Cohort 4: 1948-53	19%	4,569
Cohort 5: 1954-59	21%	5,186
Cohort 6: 1960-65	20%	4,865

Table 3: Operational Definitions of Variables (*X* ranges from 2010 – 2020)

HRS Variable	Definition
R*X*COGTOT	Total cognition score; ranges from 0-35.
RAGENDER	Sex of the respondent; Male = 1; Female = 2.
RARACEM	Race of the respondent. White = 1; Black = 2; Other = 3.
RAEDYRS	Years of education: 1-16 and 17+ years
R*X*IEARN	Individual income; ratio measure.
R*X*MAP	Difficulty using a map; 1 = No; 2 = Yes
R*X*MONEY	Difficulty in managing money. 1 = No; 2 = Yes
R*X*JOG	Difficulty in jogging 1 mile. 1 = No; 2 = Yes
R*X*WALK	Difficulty in walking 1 block. 1 = No; 2 = Yes
R*X*RETSAT	Is retirement satisfying? 3 = Very; 2 = Moderately; 1 = Not at all.
R*X*LBEXT	Extroversion; does it describe the respondent? 4 = A lot; 3 = Some; 2 = Little; 1 = Not at all
R*X*LBLONELY3	How much of the time the respondent felt loneliness; 3 = Often; 2 = Some of the time; 1 = Never

An econometric model of the form,

$$y_{it} = \beta_0 + \beta_x X_{it} + \beta_z Z_t + v_t + \varepsilon_{it}$$

was estimated[15], where, *i* indicates the individual and *t* the time periods, 2010 – 2020. The criterion variable, y_{it}, is the cognition score of the respondent. The predictors, *Z* variables do not vary with time; these include the gender of the respondent, her race, and years of education. The *X* variables differ over time, for example, difficulty in walking one block. The v_t are individual effects, and ε_{it} are stochastic errors.

Findings

<u>Profile of the Respondents</u>

A typical respondent is a 76-year old White female with high school education (Table 4). Most respondents were from the "South" Census region. Of the 15,453 respondents to the 2010 survey, 8,566 or 55% responded to the 2020 survey. A majority (68%) self-reported their health as "same" compared to the previous interview", but typically had an elevated, unhealthy BMI of 28.5 [16].

Table 4: Demographics of the Respondents, Typical Values

Variable	**%**
Gender:	
- Female	58% (Mode)
Year of Birth	1944 (Median)
Race	White (Mode)
Body Mass Index (BMI)	28.5 (Median)
Years of education	12 (Median)
Census region	South (Mode)
Number of respondents (unweighted)	8261

[15] The random-effects model was calibrated; it assumes that v_t is stochastic.

[16] According to CDC, a BMI of 25 – 29.9 falls within the "overweight" range; see https://www.cdc.gov/healthyweight/assessing/index.html.

Cognitive Change

In HRS, 'total cognition' was an index of eight components: immediate recall (score = 0-10), delayed recall (0-10), serial 7s (0-5), backwards count from 20 (0-2), object naming (scissors & cactus; 0-2), President naming (0-1), Vice President naming (0-1), and date naming (month, day, year, day of week; 0-4); thus, the index had scores in the range of 0-35.

The construct validity of the total cognition index can be gleaned from its correlation with cognitive functioning measures such as "difficulty in managing money" and "difficulty using a map"; the expectation is that the index, total cognition, will correlate negatively with the cognitive functioning measures (Table 1).

Table 5 shows the zero-order correlations between total cognition and the time-varying variables listed in Table 3; see the discussion on the econometric model for a listing of time-varying variables. The correlation coefficients provide empirical support for the argument that the total cognition measure is valid.

Table 5: Construct Validity of the 'Total Cognition' Measure: Correlation Coefficients and Central Tendencies

	Total. Cognition	***p***
Map	-0.02	<.1
Money	-0.08	<.05
Jog	-.02	<.1
Walk	-.12	<.05
Ret. Sat	.12	<.05
Extroversion	.11	<.05
Lonely	-.12	<.05
Mean, total cognition score	21.61	
Median, total cognition score	22.00	
Std. Deviation, total cognition score	5.30	
Interquartile range, total cognition score	7.00	

Cognitive Changes, Gender and Race

The 'total cognition' scores for 2020 were subtracted from the 2010 scores to obtain change scores, 'cognition change'. The variability in the change scores were assessed using ANOVA with gender, race, and their interaction specified as "effect" variables. The mean of the 'cognition change' variable is -1.41; it suggests that cognitive decline is expected of an ageing population.

Table 6 shows the sources of variation in the dependent variable, 'cognition change'. The model sum of squares, 5940, is small compared to the error sum of squares; the conclusion: race, but not gender, explains significant variability in the dependent variable.

Further multiple-comparison analysis of the race means show that Whites suffer more cognitive decline than Blacks. The "other" races such as Asians are the least impacted, suffer little cognitive decline (Figure 1).

Table 6: Unbalanced Two-Way Analysis of Variance

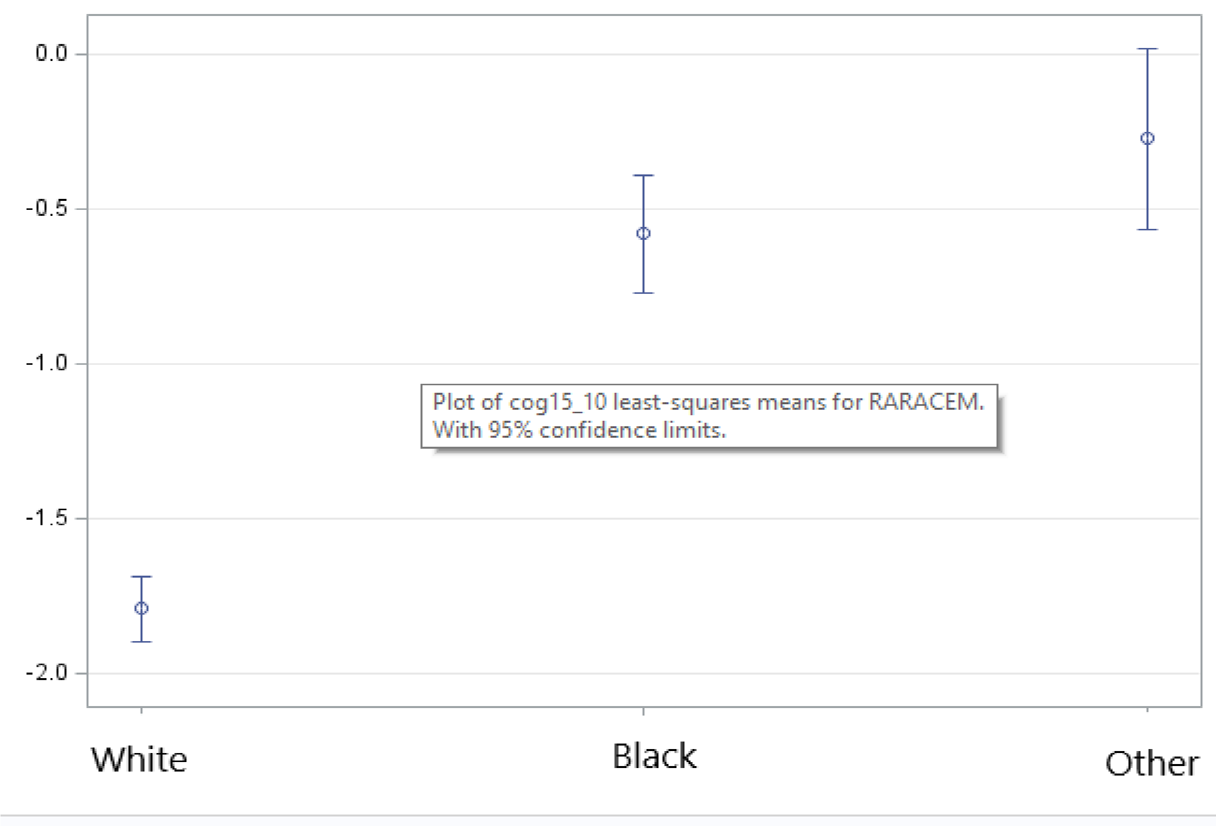
Dependent Variable = Cognition Change; $\hat{\mu}$ = -1.41

Source	DF	Sum of Squares	Mean Square	*F* Value	*P*
Model	5	5940.13	1188.03	51.71	<.01
Error	12302	282623.47	22.97		
Corrected Total	12307	288563.59			
R^2	$\frac{5940}{288563}=2\%$				

Type III Sum of Squares: Measures the differences between predicted race means over a balanced race x gender population (Least-squares means)

Source	DF	Sum of Squares	Mean Square	*F* Value	*P*
Race	2	4289.27	2144.63	93.35	<.01
Gender	1	0.103232	0.103232	0.00	0.946
Race x Gender	2	716.63	358.31	15.60	<.01

Figure 1: LS-Means for Race, with 95% Confidence Limits



<u>Predictors of Cognitive Reserve</u>

The panel data contain repeated measurements on subjects, so generalized estimation equations methods[17] were used to calibrate the econometric model,

$$y_{it} = \beta_0 + \beta_x X_{it} + \beta_z Z_t + v_t + \varepsilon_{it}.$$

Table 7 shows the results of the model run. Only two variables, “education” and “difficulty in walking one block” were statistically significant. One’s education contributes to one’s cognitive reserve. Physical inactivity contributes to cognitive decline.

[17] The GENMOD procedure in SAS was implemented to estimate parameters.

Table 7: Results of Model Estimation

Parameter	Estimate	Standard Error	Z	Pr > |Z|
Intercept	10.0794	9.2533	1.09	0.276
Gender	2.0932	1.4534	1.44	0.1498
Race	-0.0125	1.1722	-0.01	0.9915
Education	0.2628	0.1589	1.65	0.0983
Difficult to read Map	-0.1709	1.2167	-0.14	0.8883
Difficult to manage money	5.5463	3.375	1.64	0.1003
Difficult to jog 1 mile	0	0	.	.
Difficult to walk one block	-5.3484	1.4415	-3.71	0.0002
Retirement satisfaction	-0.941	0.7901	-1.19	0.2336
Extroversion	-0.1655	1.1441	-0.14	0.885
Lonely	0.2894	0.9024	0.32	0.7484

Summary and Conclusion

This paper addressed a set of research questions using panel data from the Health and Retirement Study (HRS). Salient findings include:

(i) The mean or average 'cognition change' among the later-life segment of the population is -1.41; the statistic suggests that cognitive decline is expected of an aging population.

(ii) One's race, but not gender, explains significant variability in one's cognitive reserve; and

(iii) Determinants of cognitive change include "years of education" and "physical activity"; specifically, one's education contributes to one's cognitive reserve. Physical inactivity contributes to cognitive decline.

Statistical significance is largely a function of sample size. Although panel data were used in data analysis, a large number of missing observations of the predictor variables makes it difficult to deduce substantive policy implications. The National Institute on Aging lists age-related cognitive research as a priority[18], so it is time that we assembled 'quality' data sets from the HRS that would permit more probing and fine-grained analyses of cognitive change among the population.

[18] https://www.nia.nih.gov/research/dn/research-areas.

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