Panel 2: Cognitive Health

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Stanford University Medical Center

THE ROLE OF COGNITIVE DECLINE ON EARLY RETIREMENT: A MENDELIAN APPROACH

Amal Harrati, PhD
Mark R. Cullen, MD

August 4, 2016

Research Aims

Estimate the causal role of cognitive decline on early retirement decisions.

Use an instrumental variable approach called Mendelian Randomization.

Dementia as a population health issue

- More than 35.6 million people living with dementia worldwide, increasing to 65.7 million by 2030 and 115.4 million by 2050.

- Total estimated worldwide costs of dementia are US$604 billion in 2010.

- Important consequences on health care, caregiving, finance and savings, etc.

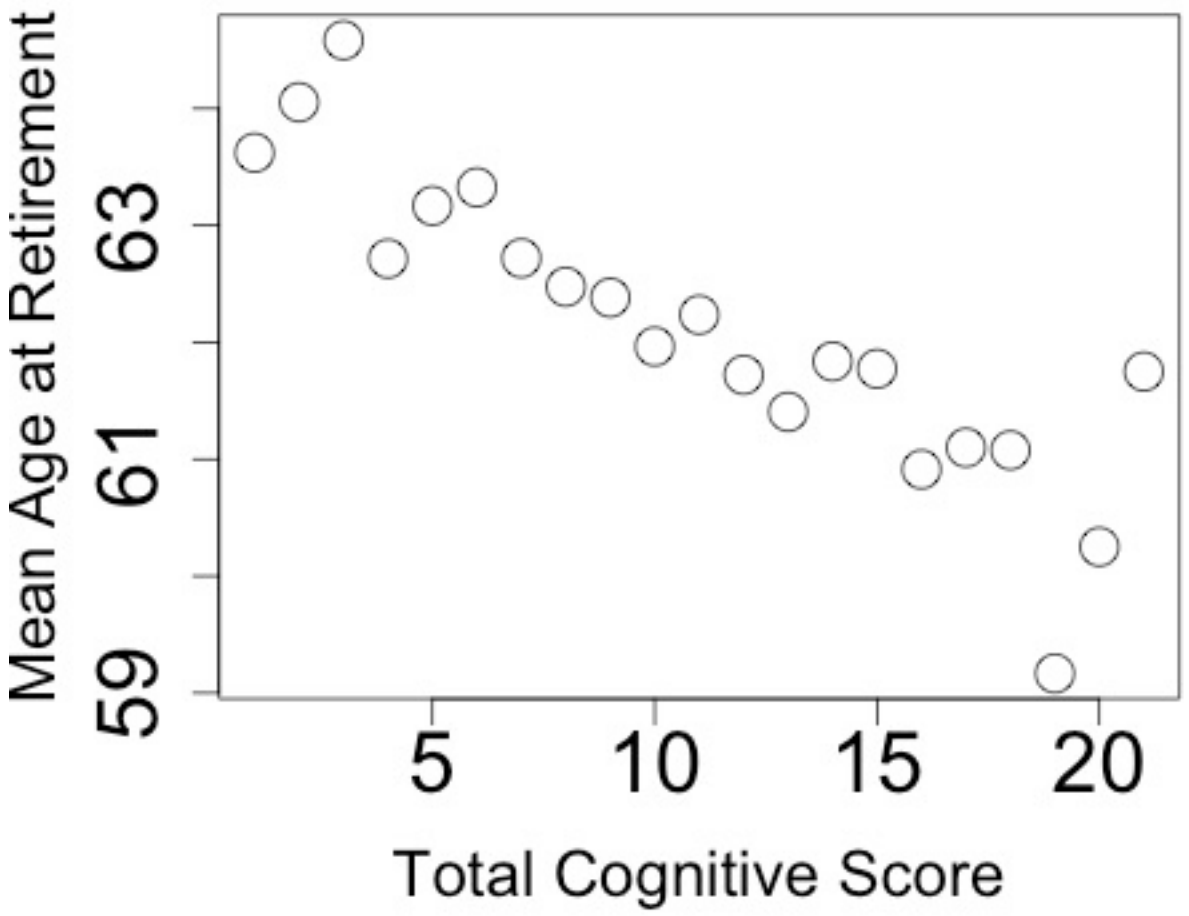
What about earlier forms of cognitive decline?

- Still, what remains relatively understudied is the role of more mild forms of cognitive decline.
- Occurs earlier in the lifecourse and impact a different set of considerations: labor market participation, financial literacy, etc.
- Different biological pathologies may be at play with different trajectories

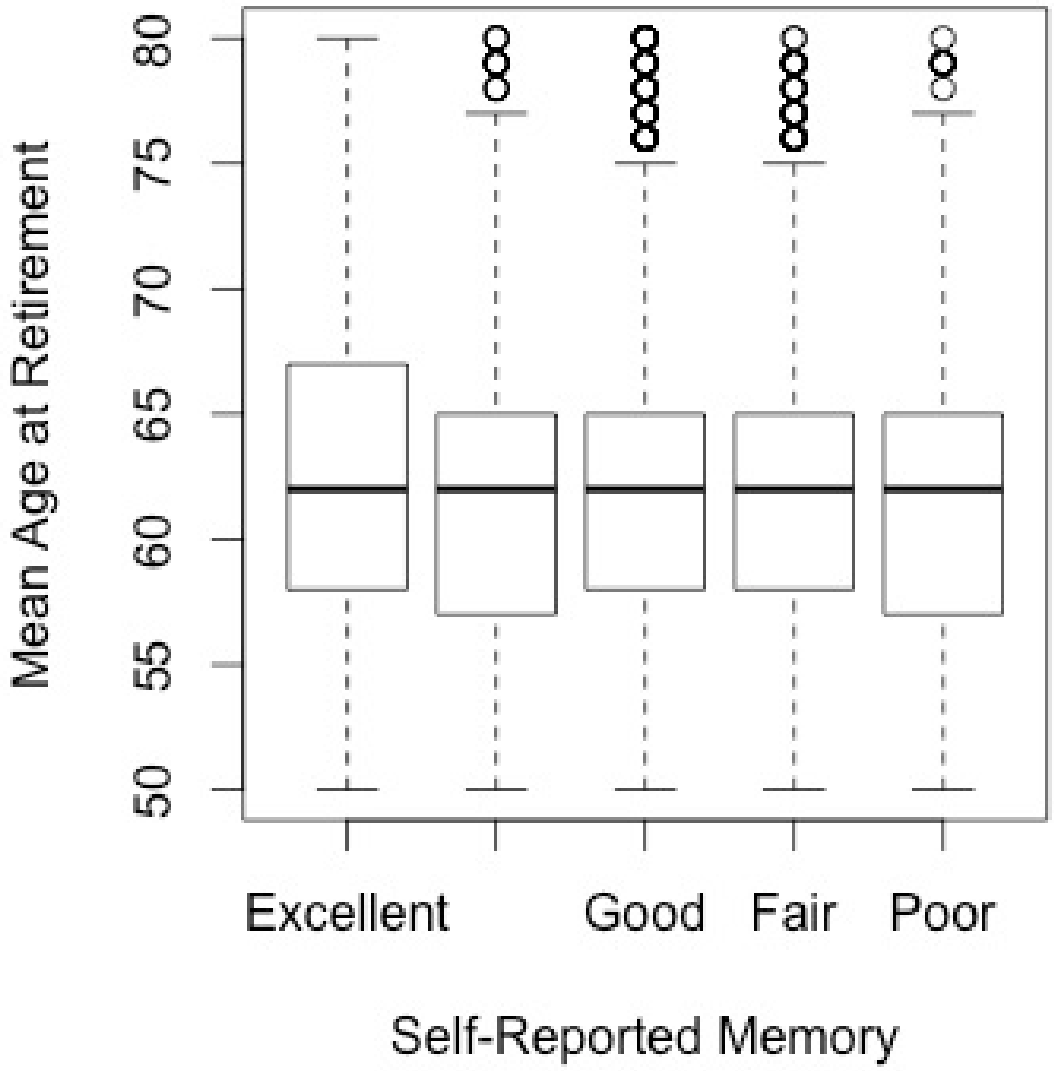
Retirement and Cognitive Decline

- Evidence that physical health impacts early retirement
- Causal evidence that retirement → cognitive decline (Rohwedder and Willis, 2010)
- What about the other direction? This remains an open question
- Endogeneity concerns

Earlier retirement age is associated with lower cognitive scoring



Earlier retirement age is not associated with lower self-rated memory



Mendelian Randomization Approach

- An instrumental variable approach using a genetic instrument
- If assumptions are met, it can calculate an unbiased causal estimate
- 179 + studies in epidemiology (Beof et al. 2015)
- Limited number in economics (Norton and Han, 2008; Ding et al. 2009; Fletcher and Lehrer, 2011)

Instrumental Variables Approaches Using Genetic Instruments

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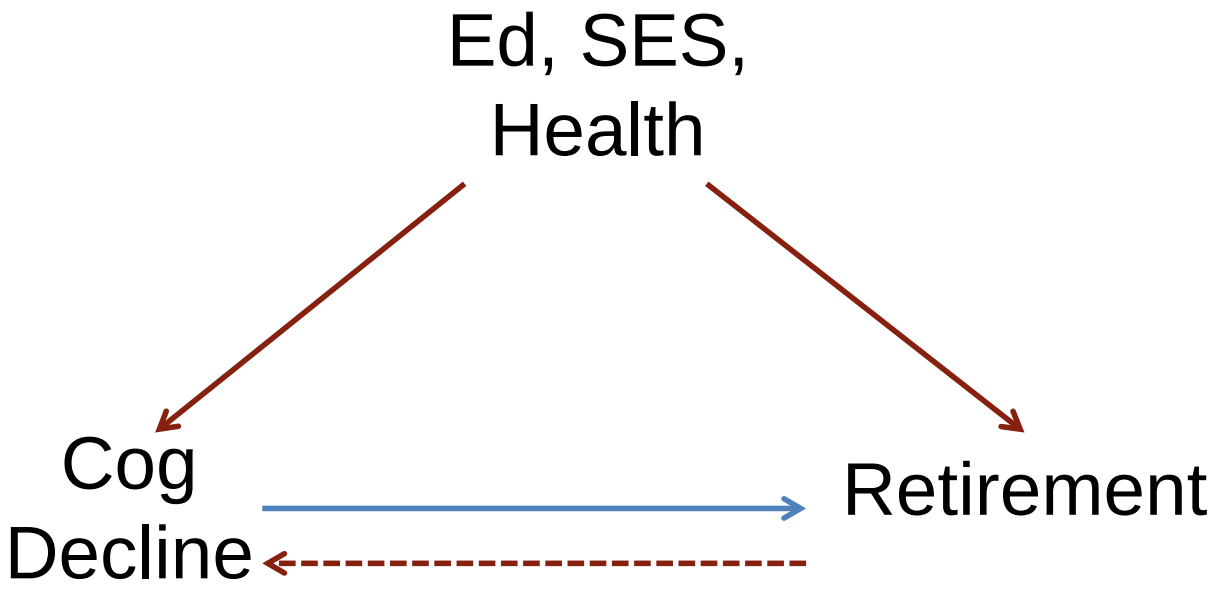
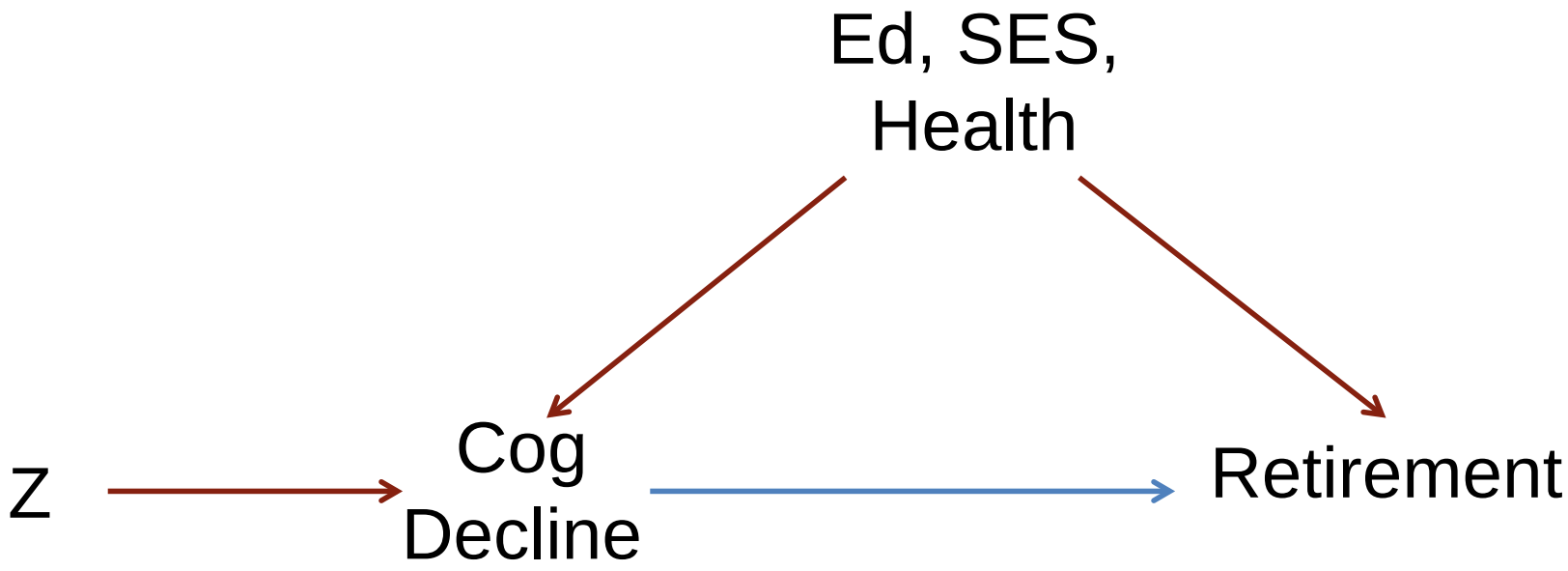
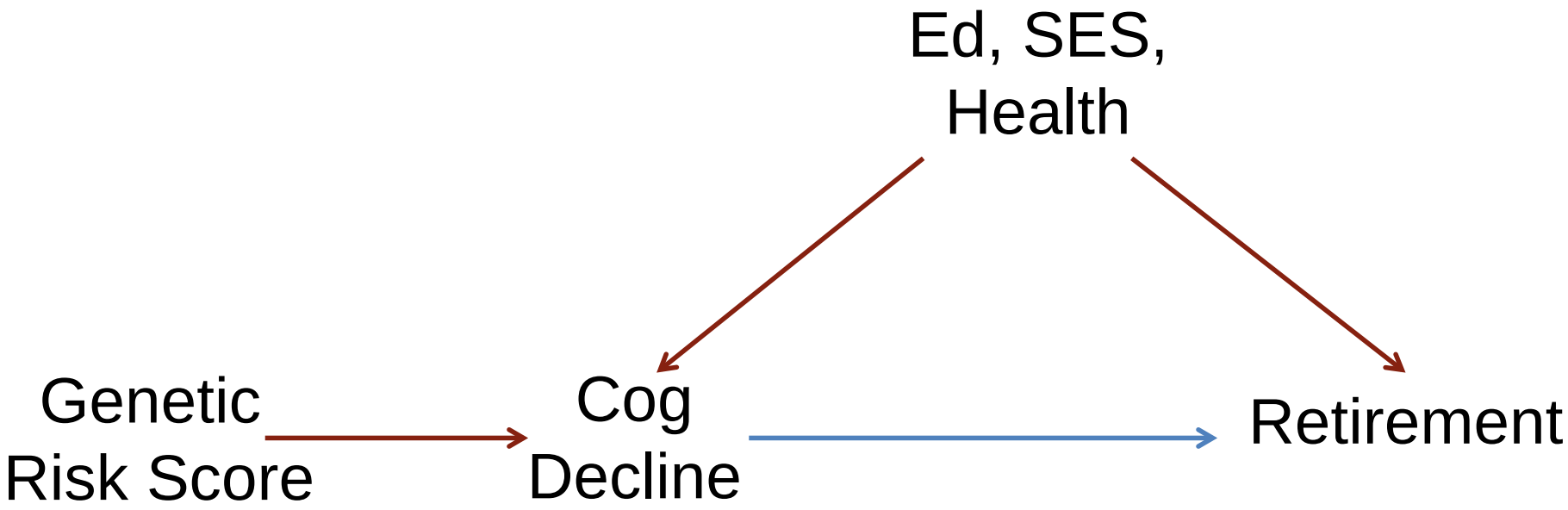


Instrumental Variables Approaches Using Genetic Instruments



Instrumental Variables Approaches Using Genetic Instruments



Data and sample

Health and Retirement Study (HRS)

- Biennial Survey 1992-2014
- Nationally-representative of U.S. 50+
- N= 37,131 respondents;
- 298,536 observations over time

HRS Genetic Data

- 2.5 million Single-Nucleotide Polymorphisms
- 12,595 respondents

Measures

- Cognitive Decline= Cognitive Age Slope between Wave 3 and Wave 10
- Retirement = Age at Full or Partial Retirement
- Instrument= Genetic Risk Score

Sample Restrictions

N= 20,652 with cognitive measures

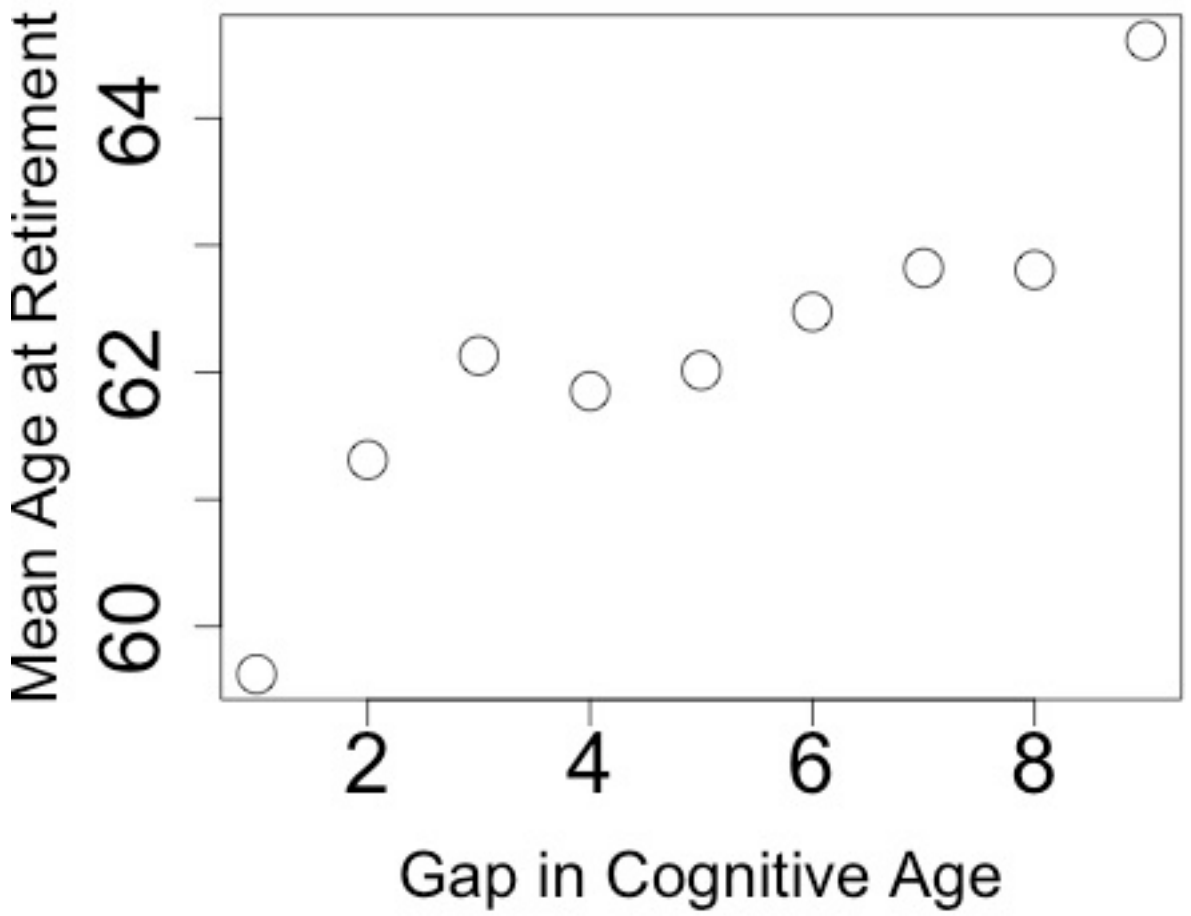
N=12,595 total genotyped

N= 9,218 non-Hispanic whites only

N= 6,836 post-retirement (non-Hispanic whites)

N= 6,438 retired and genotyped

Earlier retirement age is associated with lower cognitive age



Genes as Instruments: Mendelian Randomization

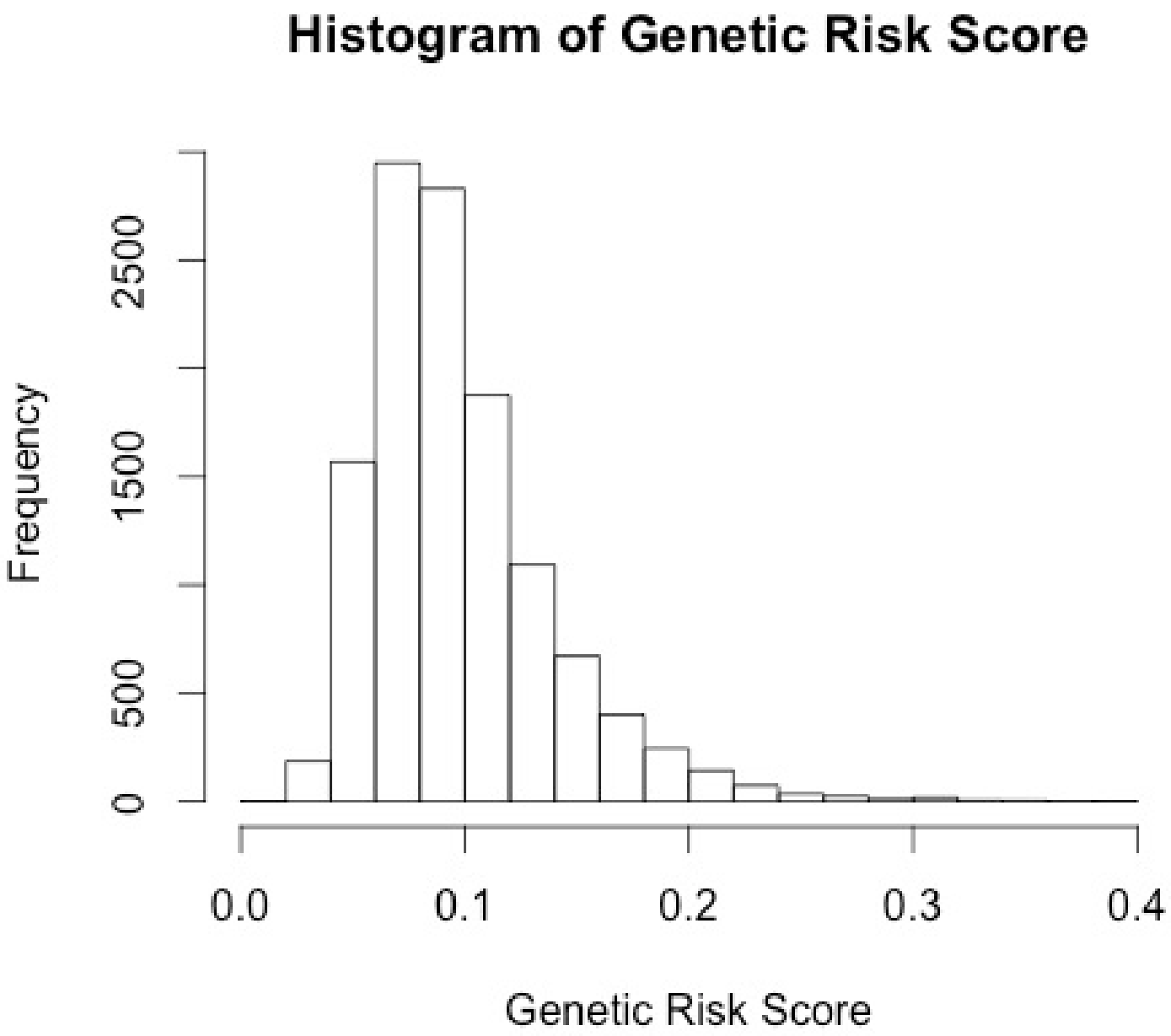
- Mendel's First Law: Genes segregate randomly and independently of environmental factors
- Mendel's Second Law: Genes segregate independently of other traits
- Little individual knowledge of genetic makeup

The Instrument: Genetic Risk Score (GSR)

- Compilation of 19 SNPs that are associated with cognitive decline and memory loss, including APOE.
- Risk Score is created for each individual by creating a weighted sum of risk alleles (Lambert et al., 2013)
- Demonstrated to be associated with memory loss in the HRS population (Marden et al., 2016)

Genes included in instrument (GRS)

- APOE(rs429358 & rs7412)
- BIN1 (rs4663105)
- CLU (rs9331896)
- ABCA7 (rs3764650)
- CR1 (rs6656401)
- PICALM (rs10792832)
- MS4A6A (rs983392)
- CD33 (rs3865444)
- CD2AP (rs10948363)
- EPHA1 (rs11771145)
- HLA-DRB5—HLA-DRB1 (rs111418223)
- PTK2B (rs28834970)
- SORL1 (rs11218343)
- SLC24A4 RIN3 (rs10498633)
- DSG2 (rs8093731)
- INPP5D (rs35349669)
- MEF2C (rs190982)


Histogram of Genetic Risk Score
Frequency
0
500
1500
2500
0.0
0.1
0.2
0.3
0.4
Genetic Risk Score

Assumptions for Mendelian Randomization

Assumption 1 (Non-zero effect of the instrument):

Instrument must be associated with exposure

Assumption 2 (Independence):

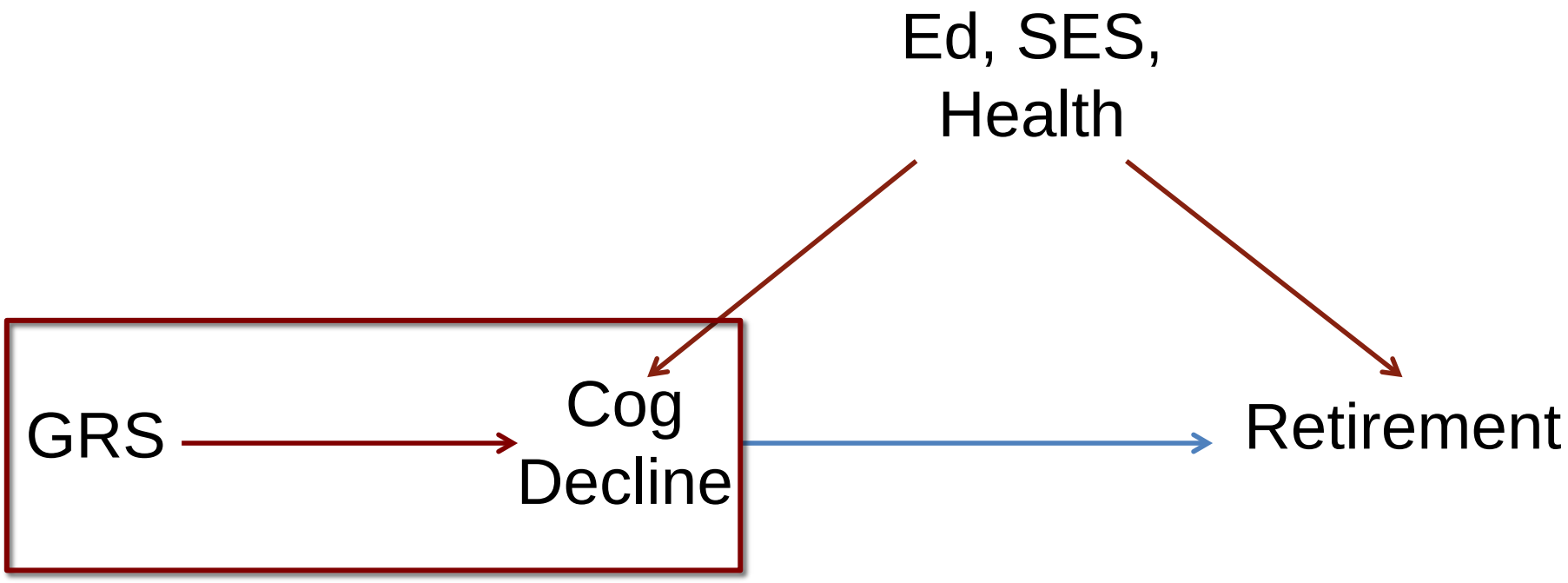
Instrument must not differ systematically with respect to confounders

Assumption 3 (Exclusion):

Instrument not associated with outcome except through exposure

Assumption 4 (:

Assumption 1:
Instrument must be associated with exposure



Satisfying Assumption 1

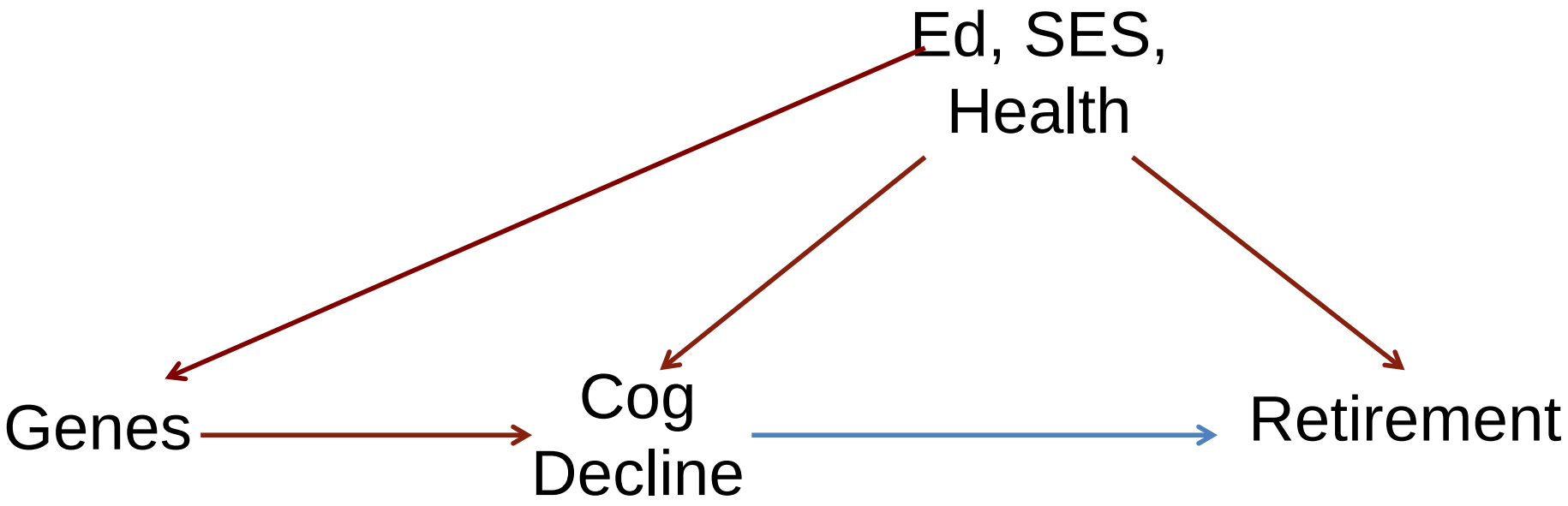
Cognitive Age = b0 + b1 GRS + e

	Estimate	Std. Error	T value	Pr(>|t|)
Intercept	0.41904	.03515	11.922	< 2e-16 ***
Genetic Risk Score	.06378	.01334	-4.78	6.22e-05 ***

F-statistic: 22.85

Controlling for 5 principal components

Assumption 2:
Instrument must not differ systematically with respect to confounders

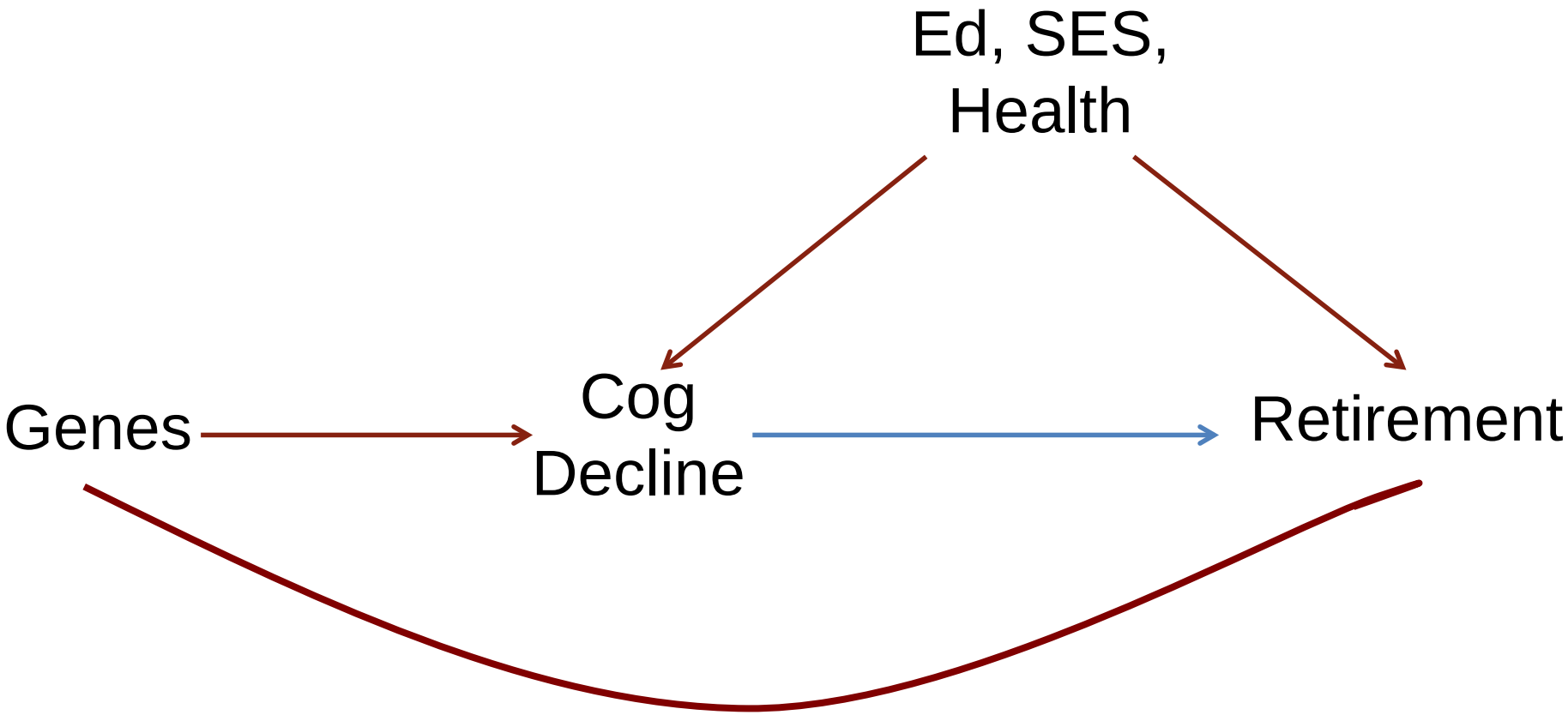


Testing associations with confounders

No systematic differences by genotype with:

- Education
- Age
- Heart Disease
- Stroke
- Blood Pressure
- Income
- Wealth

Assumption 3:
Instrument not associated with outcome



Genetic Pleiotropy

- Genes may act on retirement through other biological pathways
- 19 SNPs are relatively well-documented to have no other biological causes that we can’t account for
- Testing individual biological pathways

Results

Association of Cognitive Age on Retirement Age

	Estimate	Std. Error	Pr(>|t|)
Cognitive Age: Naïve Estimate	0.116	.0284	6.97e-13 ***
Cognitive Age: Genetic Risk Score Instrument	-0.663	3.9091	0.8713

Preliminary Conclusions

- The Genetic Risk Score appears to satisfy the assumptions necessary to be a valid instrument
- Using a Mendelian Randomization method, there is no statistically significant evidence that cognitive decline impacts retirement age
- Consider 2-sample IV to increase power

Thank you!

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RAND LABOR AND POPULATION

CENTER *for* DISABILITY RESEARCH

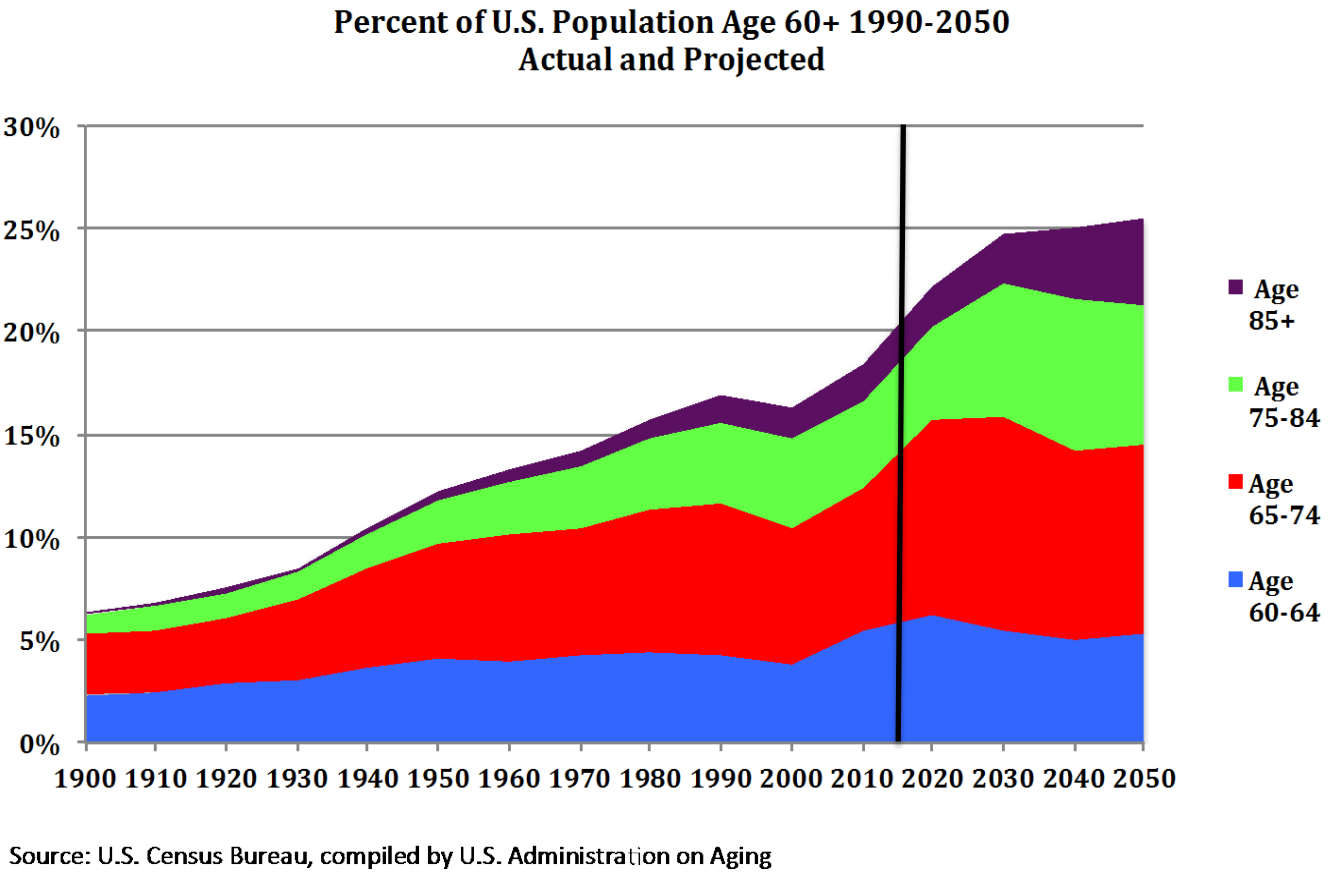
Discussion of "The Role of Cognitive Decline in Retirement Decisions"

Kathleen J. Mullen, RAND

RRC Annual Meeting

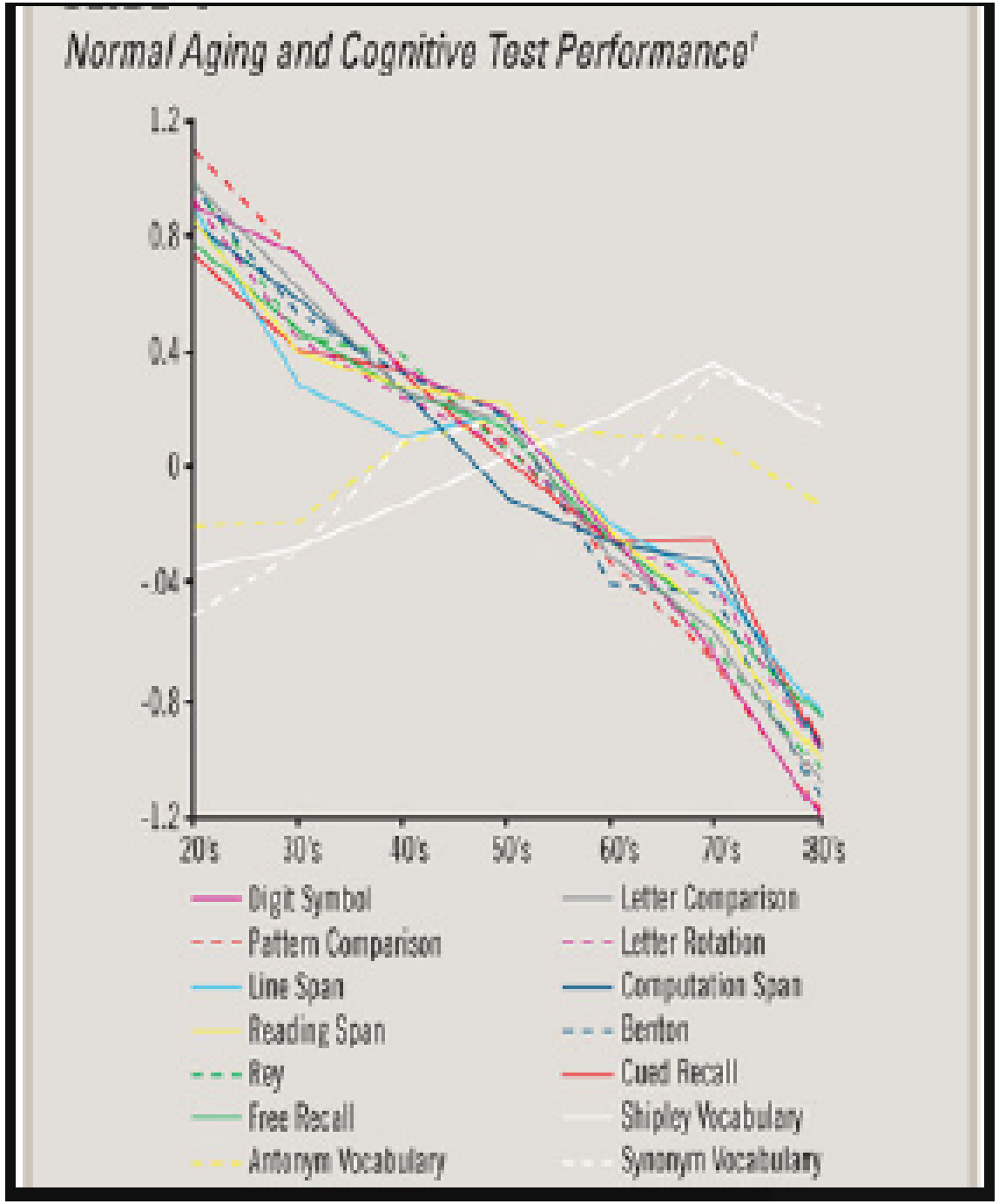
August 2016

Population Aging in the United States



Source: U.S. Census Bureau, compiled by U.S. Administration on Aging

The percent of the U.S. population aged 60+ is projected to increase by 21% between 2010 and 2020, and by 39% between 2010 and 2050.



Decreases in mechanics (speed) may be compensated with increases in other areas (e.g., vocabulary, experience)

Source: Park et al. (2002) from Levenson, 2016, RAND Summer Institute presentation

Three heartening trends

- Decline of cognitive mechanics starting later
- Increases in intellectual functioning across cohorts
  - Dementia prevalence declining across generations (Matthews et al, 2013, Lancet; Wu et al, 2015, Lancet Neurology; Satizabal et al, 2016, NEJM)
- Evidence that “training” interventions can slow decline in mechanics

Source: Staudinger, 2016 RAND Summer Institute presentation

What this paper tries to do

- Goal is to estimate role of cognitive decline on retirement timing
- Problem: people experiencing cognitive declines might have retired earlier anyway
- Authors' solution: find an instrument that exogenously pushes people into earlier cognitive decline and see how that affects retirement
  - IV = Genetic risk score

4 assumptions for validity of IV

- Independence
  - "As good as random" assignment
- Exclusion restriction
  - Single causal channel
- First stage
  - Genetic risk score affects cognitive decline
- Monotonicity
  - Genetic risk score increases cog decline for everyone (need for LATE, i.e., IV = weighted avg of underlying heterogeneous causal effects)

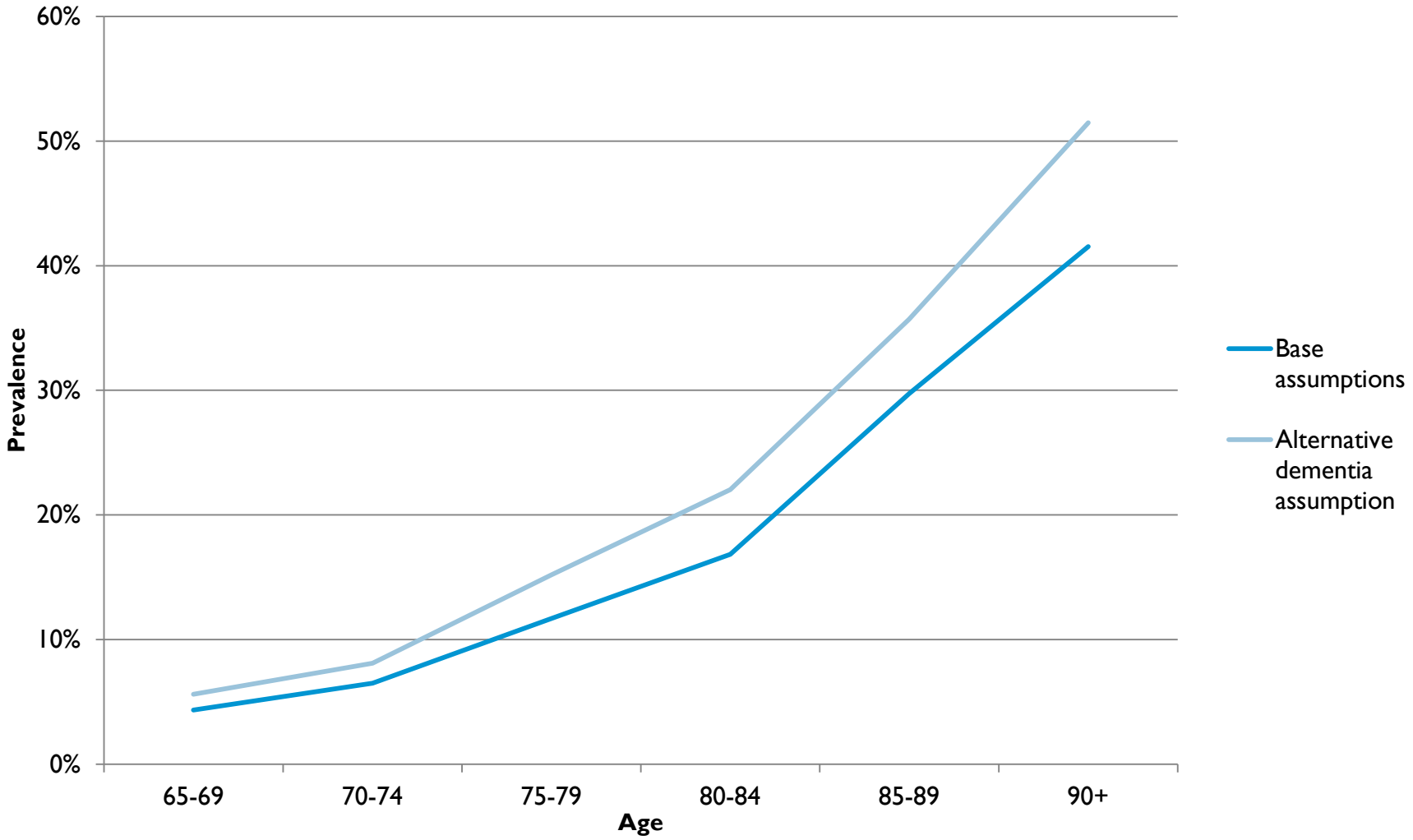
URBAN INSTITUTE · ELEVATE · THE · DEBATE

AUGUST 4, 2016

Melissa M. Favreault and Richard W. Johnson
Urban Institute

Our goals

- Understand late-life disability risk
- Examine how out-of-pocket expenses for health care and long-term services and supports (LTSS) vary by individual characteristics, combinations
- Compare ***stylized***, roughly cost-equivalent policy options that address heavy out-of-pocket cost burdens for people with late-life disability
  - Social Security
  - Medicare cost sharing
  - Medicaid LTSS cost sharing
  - New LTSS insurance options
- Look across program silos on a level-playing



Source: Spillman's tabulations from NHATS.

Our findings

- Out-of-pocket spending burdens fall heavily on those with long-term disabilities
  - Risk of ever experiencing a long-term disability is significant
    - Longer you live, the greater chance you will become disabled
  - For those with long-term disabilities, costs are potentially impoverishing
- Benefits for all the interventions we examine flow disproportionately to older adults with disabilities
  - Targeting differs can be refined with further policy development work

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Context

Costs of late-life disability

- LTSS literature
  - *Risks:* Kemper, Komisar, Alekcih (2005/2006); Stallard (2011); Favreault and Dey (2015); *Policy options:* Rivlin and Wiener (1988), Wiener, Illston, and Hanley (1994); Tumlinson, Hammelman, Stair, and Wiener (2013); Favreault, Gleckman, and Johnson (2015)
- Literature on costs of cognitive impairment
  - Alzheimer's Association (2015), Hurd, Martorell, Delavande, et al. 2013; Yang, Zhang, Lin, et al. (2012); cross-nationally: Wimo, Jönsson, Bond, et al. (2013)
- Literature on out-of-pocket health care risk
  - Fronstin, Salisbury, and VanDerhei (2015); Hatfield, Favreault, Chernew, McGuire (2016); Schoen, Buttorff, Andersen, and Davis (2015); Zuckerman, Shang, and Waidmann (2012)
- Combined financial risks
  - Spillman and Lubitz (2000)

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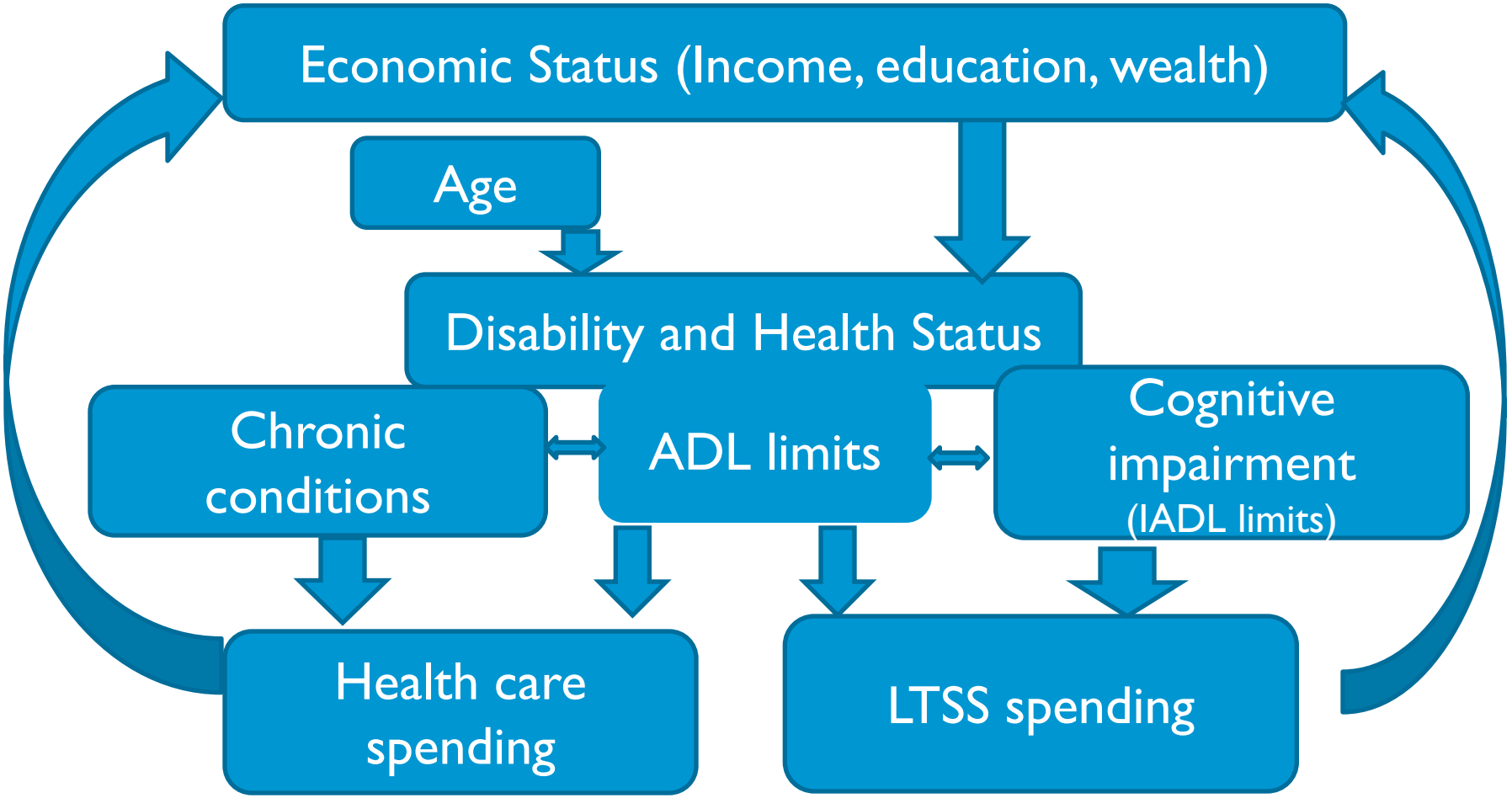
Methods

Our approach

- Take an existing, well-validated model: DYNASIM3
  - SIPP-based starting file
  - Projects for 75 years
- Add in disability, LTSS, and health care spending modules using HRS, MCBS, and NHATS data
  - Prevalence, intensity, costs, payers
- Calibrate to OASDI and HI TR assumptions
- Validate cost and projections against aggregates, academic literature
  - “Black box”/“Nate Silver-ize”
  - Sensitive to projections about the future, especially morbidity improvement and spending growth
    - Use advisory boards to vet assumptions & choices
- Simulate alternatives

Modeling challenges: Interrelationships over the life course



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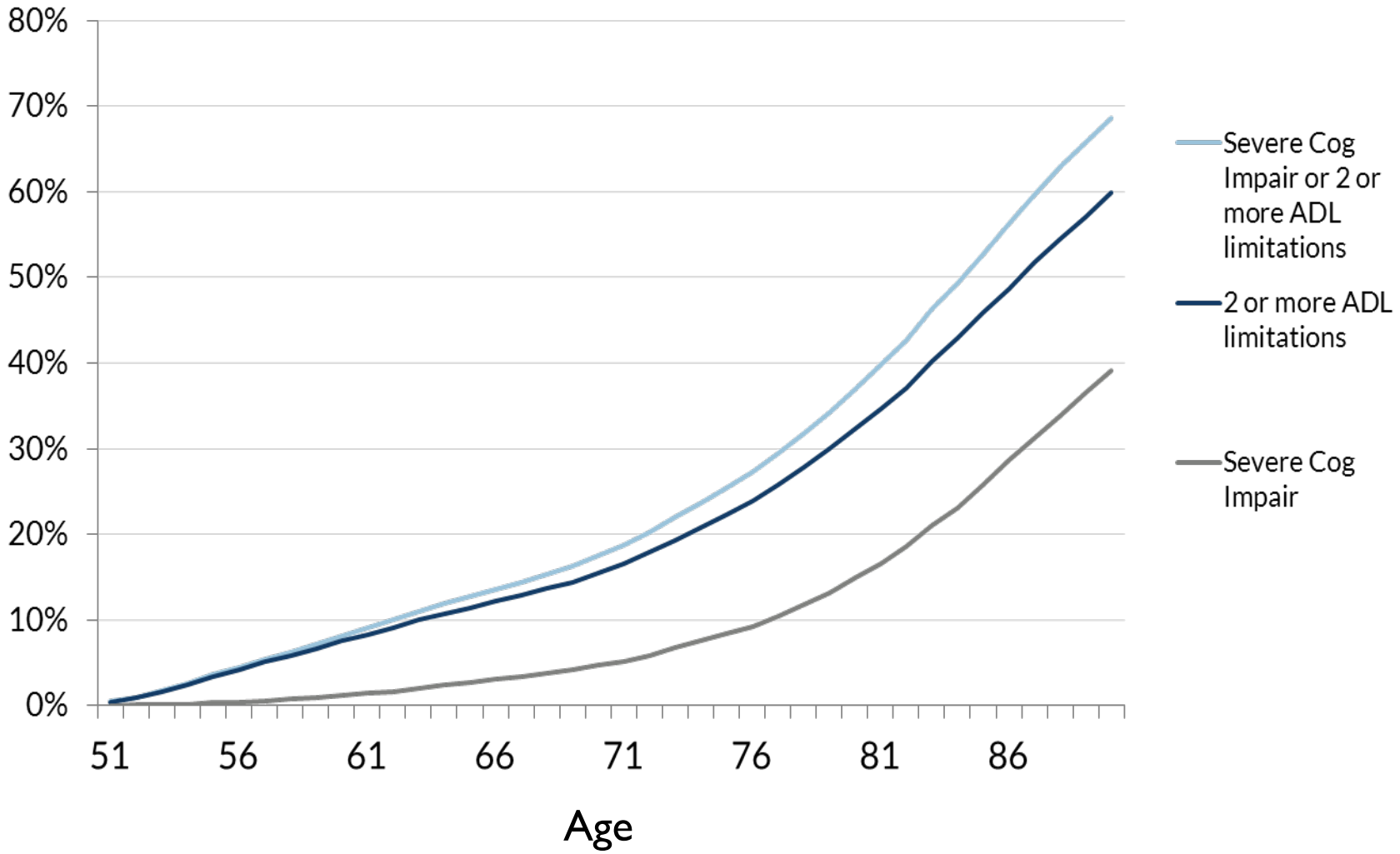
Baseline Risk and Spending Estimates

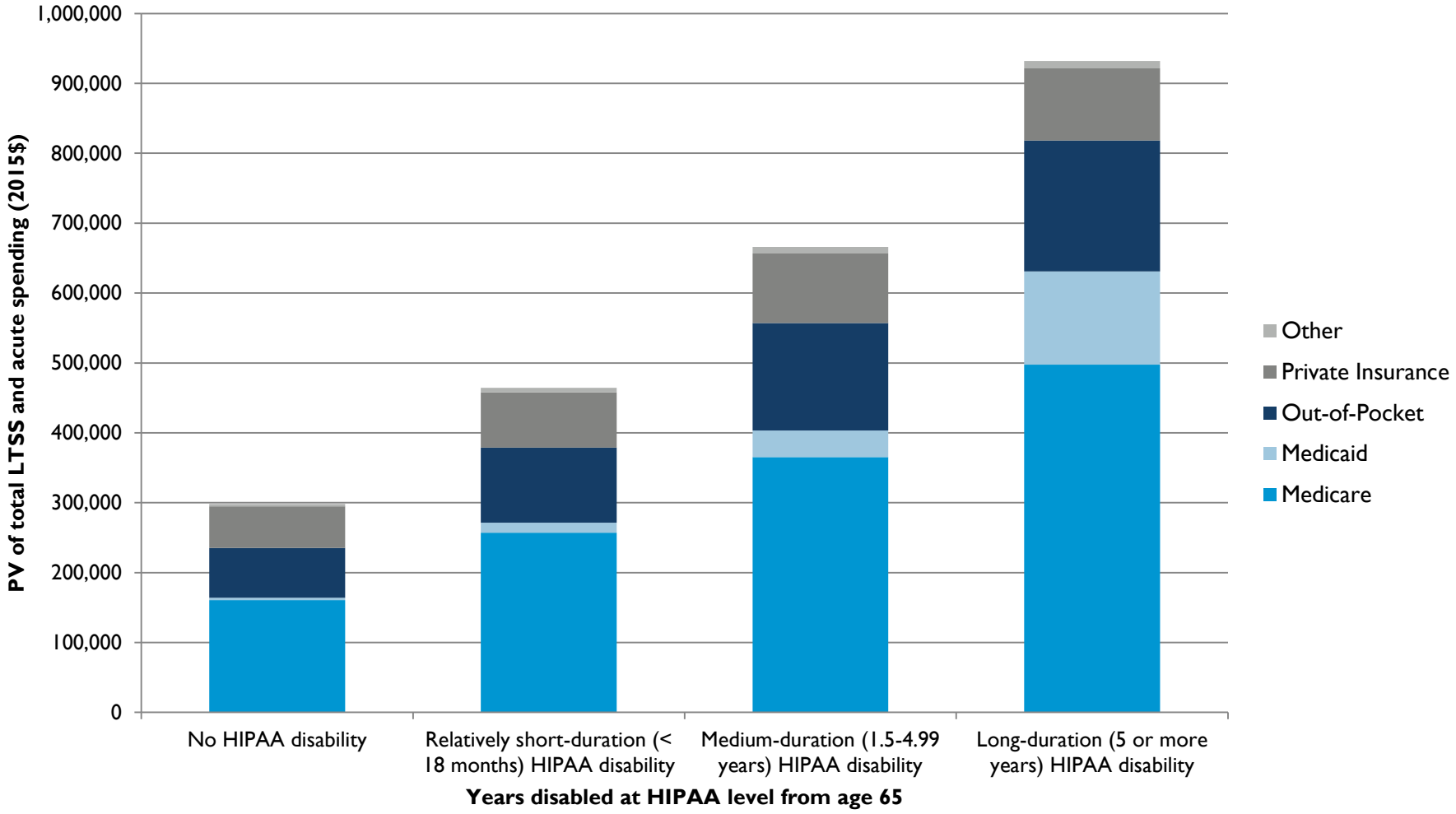
Our analytic focus

- Adults ages 65 and older
  - Focus on costs from age 65 through death
    - Paper also shows cross-section burdens
  - Present discounted values, real $2016, 2.7% discount rate
- Acute care costs, including premiums (Medicare, Medigap) and point-of-care cost shares
- Formal LTSS, which including nursing home care, paid home care, residential care
  - Informal care huge part of LTSS, but not in this draft
- Focus on severe disability
  - HIPAA definition for qualifying plans: 2 or more ADL limits or severe cognitive impairment

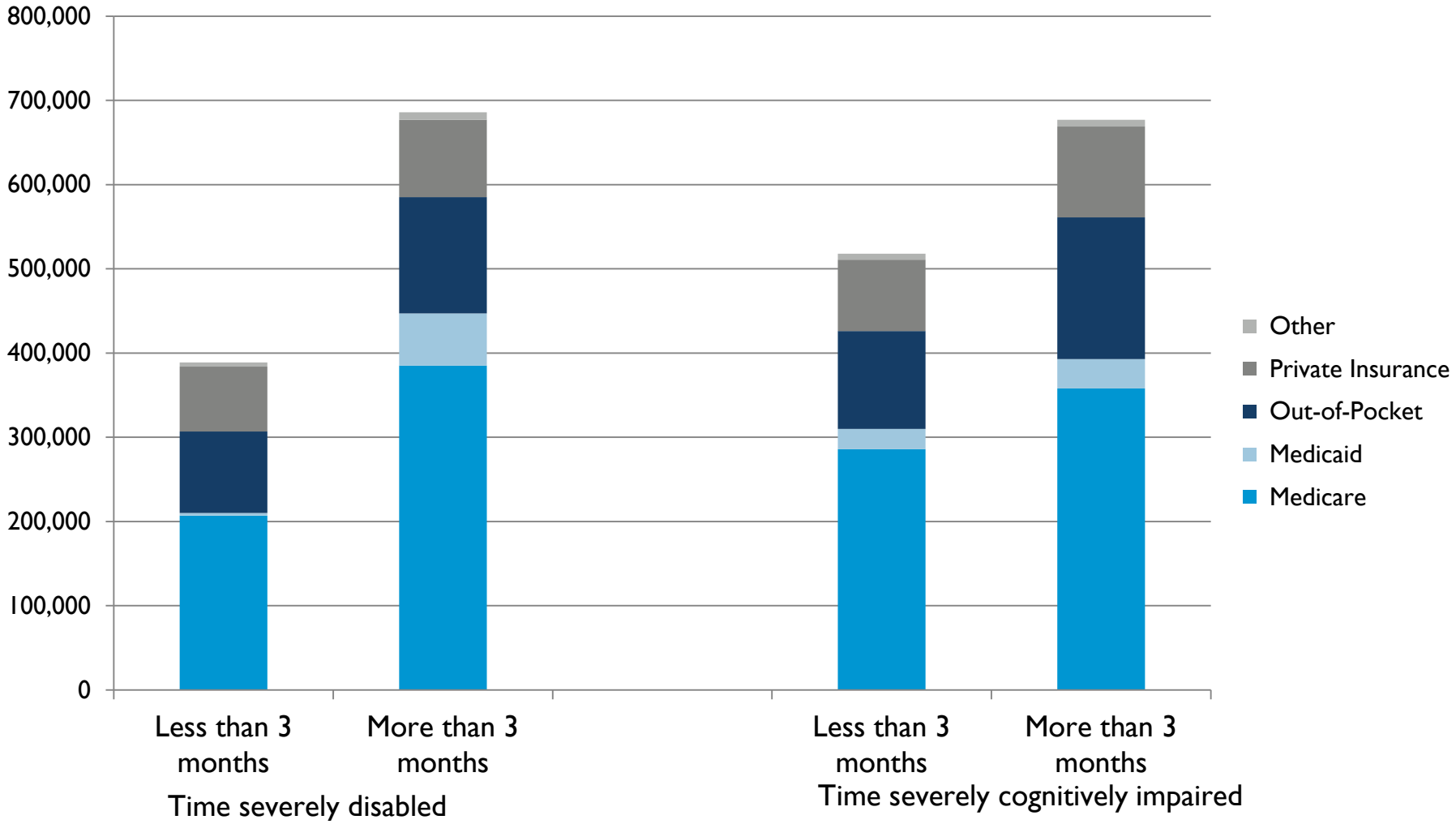
Chances of ever having severe disabilities increases with age



Authors' calculations from HRS

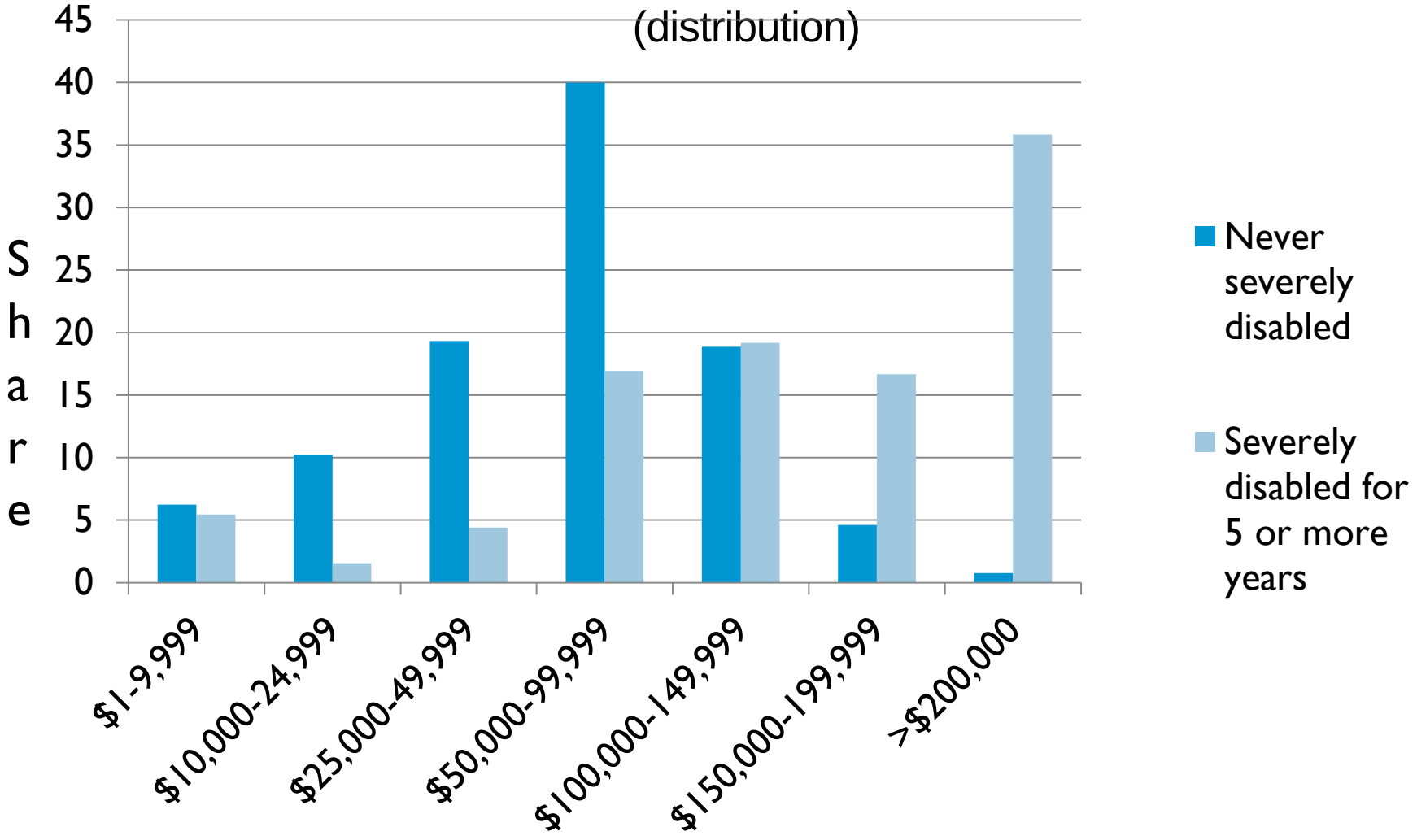


Source: Authors' tabulations from DYNASIM.



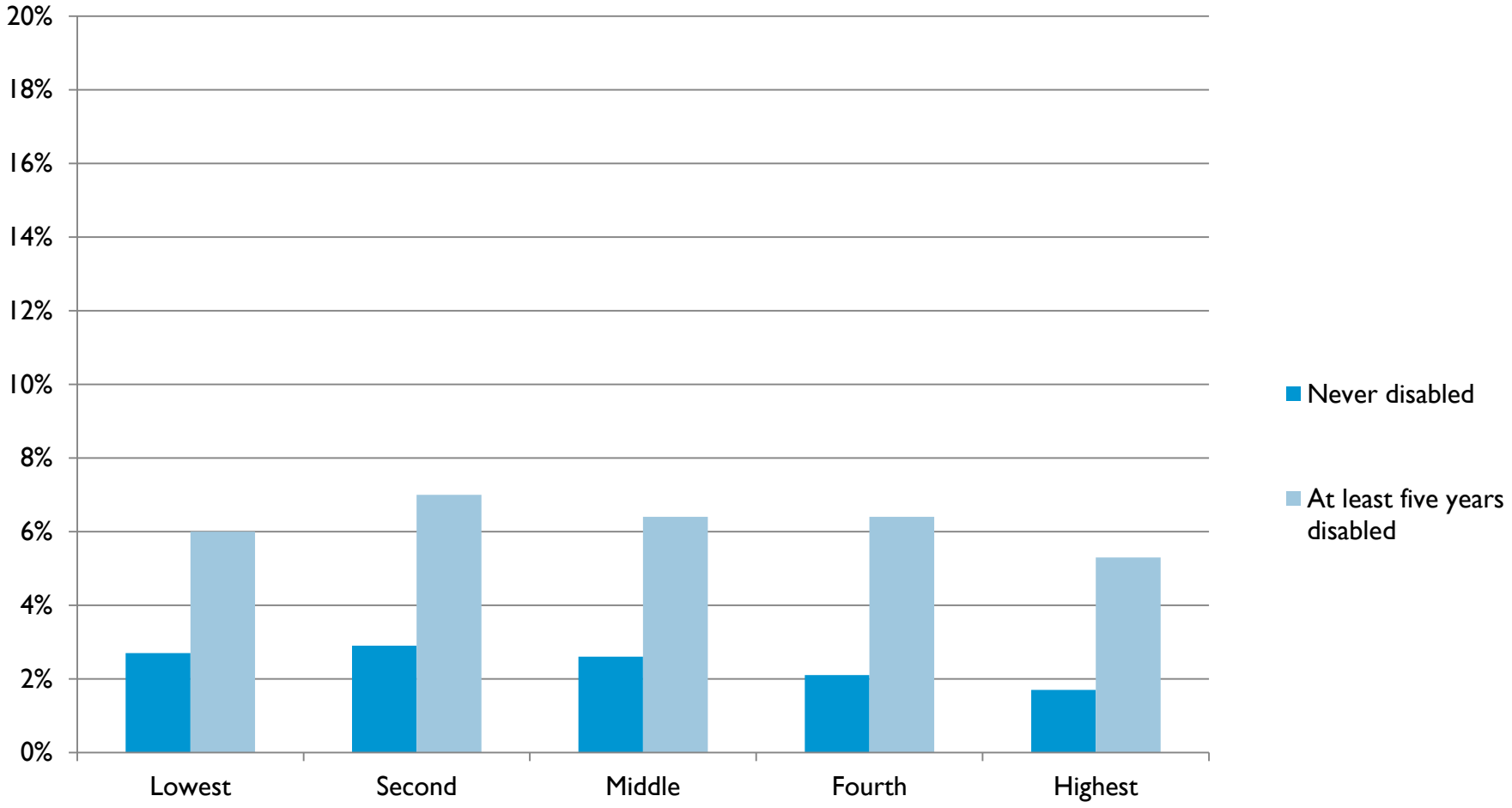
Source: Authors' tabulations from DYNASIM.

Mean spending masks important variation: Total acute-care and LTSS out-of-pocket costs



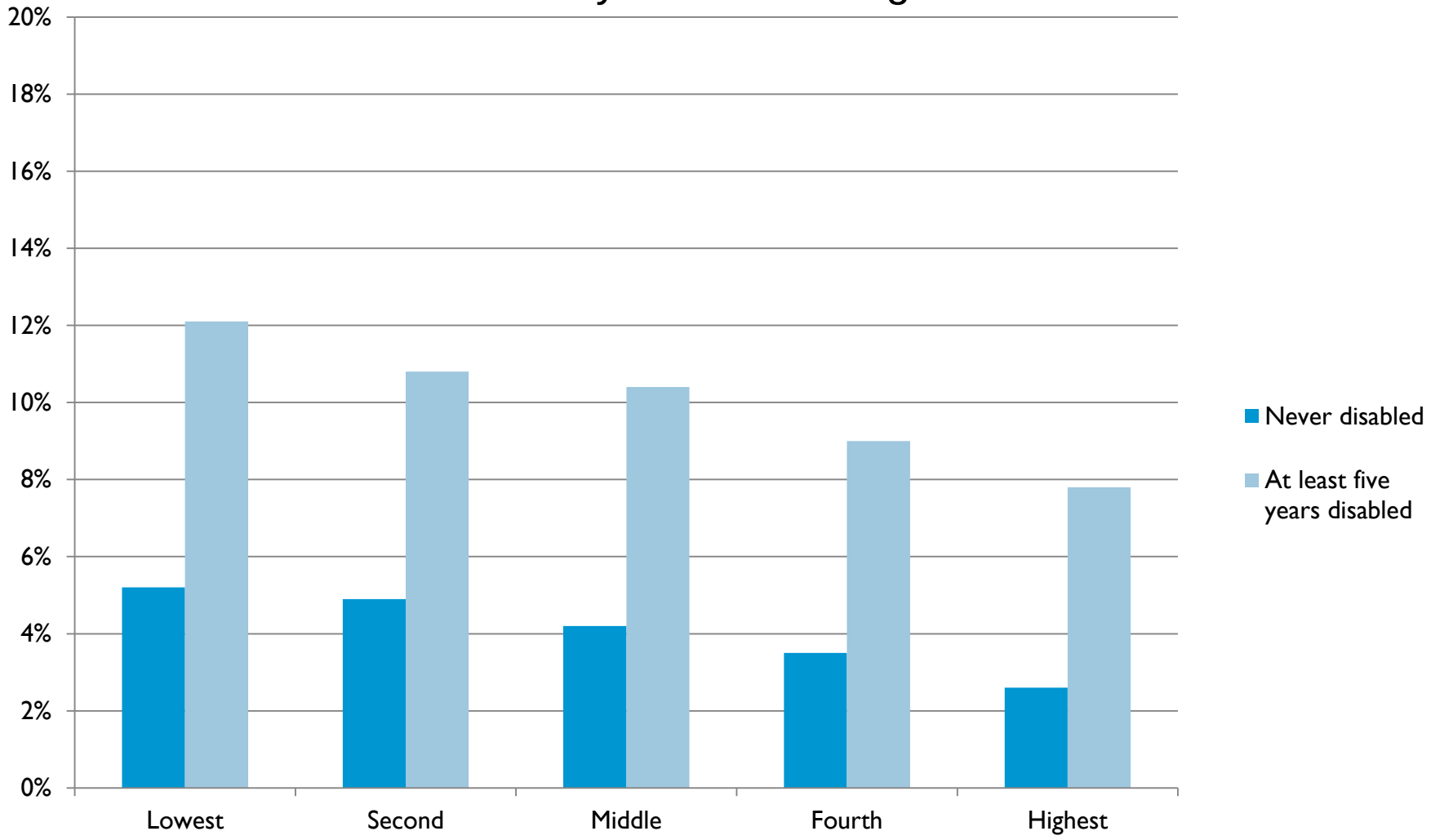
Spending burdens vary by lifetime income:

Median total acute-care and LTSS out-of-pocket costs as a percent of family lifetime earnings



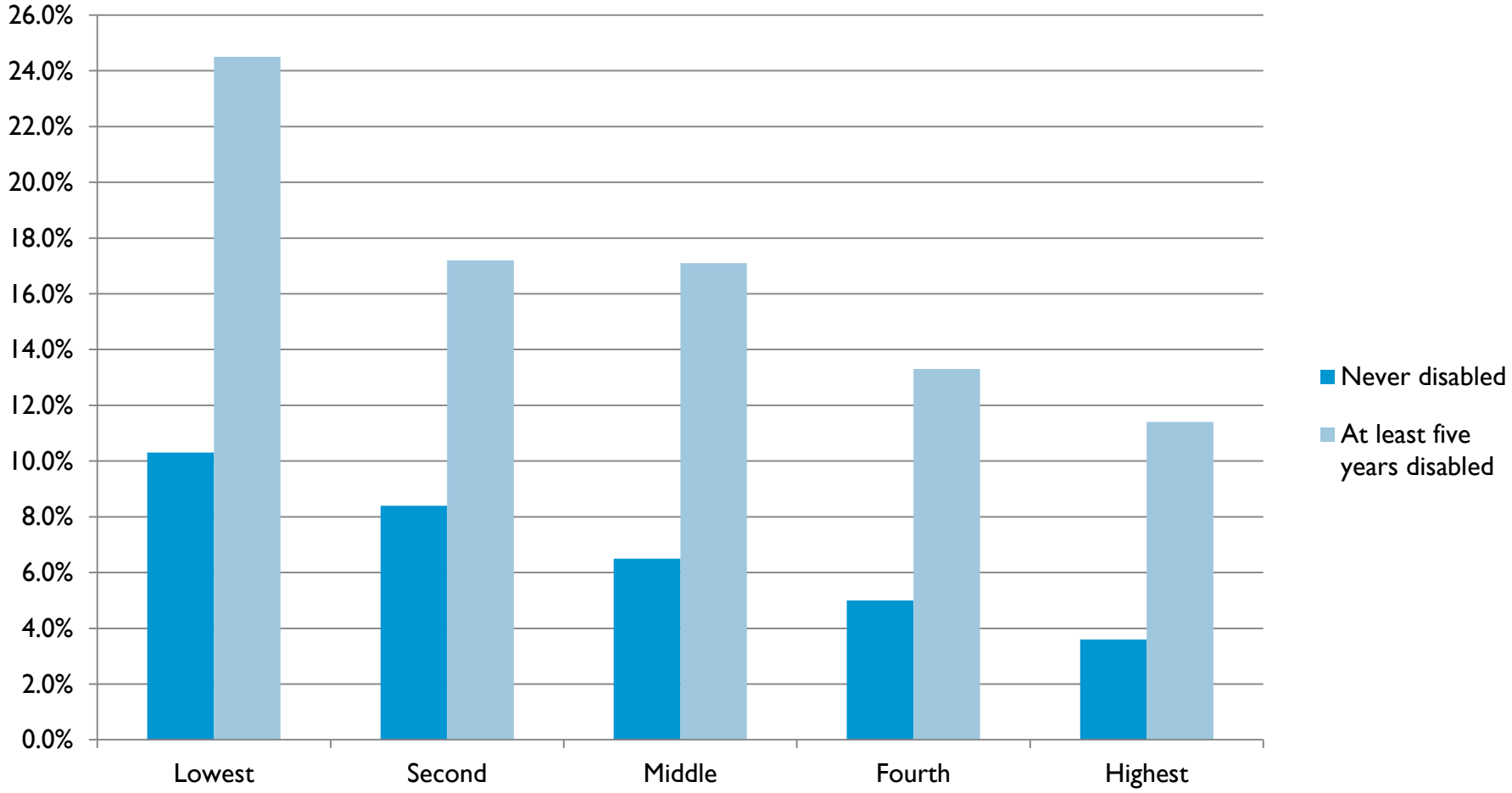
Spending burdens vary by lifetime income:

75th percentile of total acute-care and LTSS out-of-pocket costs as a percent of family lifetime earnings



Spending burdens vary by lifetime income:

90th percentile of total acute-care and LTSS out-of-pocket costs as a percent of family lifetime earnings



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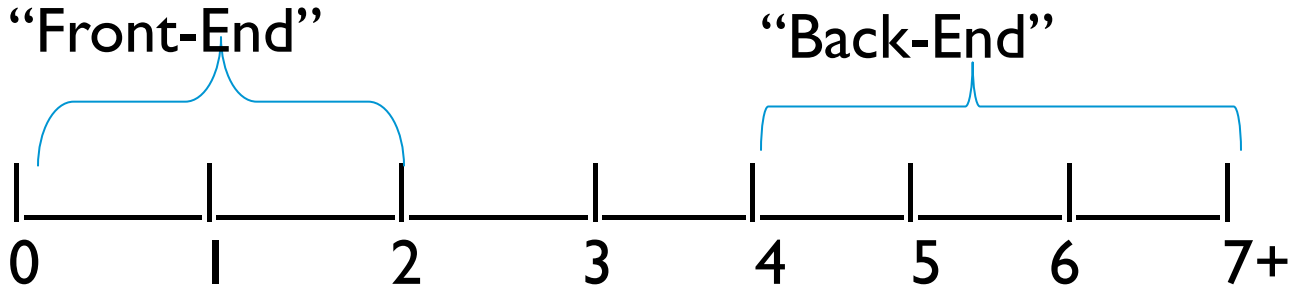
Federal Policy Options

Alternate policy options for addressing out-of-pocket risk from late-life disability

- Social Security
  - Benefit increases at ages 81-85 or 86-90
- Medicare point-of service cost sharing
  - Targeted to a.) **all** or b.) **high spenders**
- New LTSS insurance



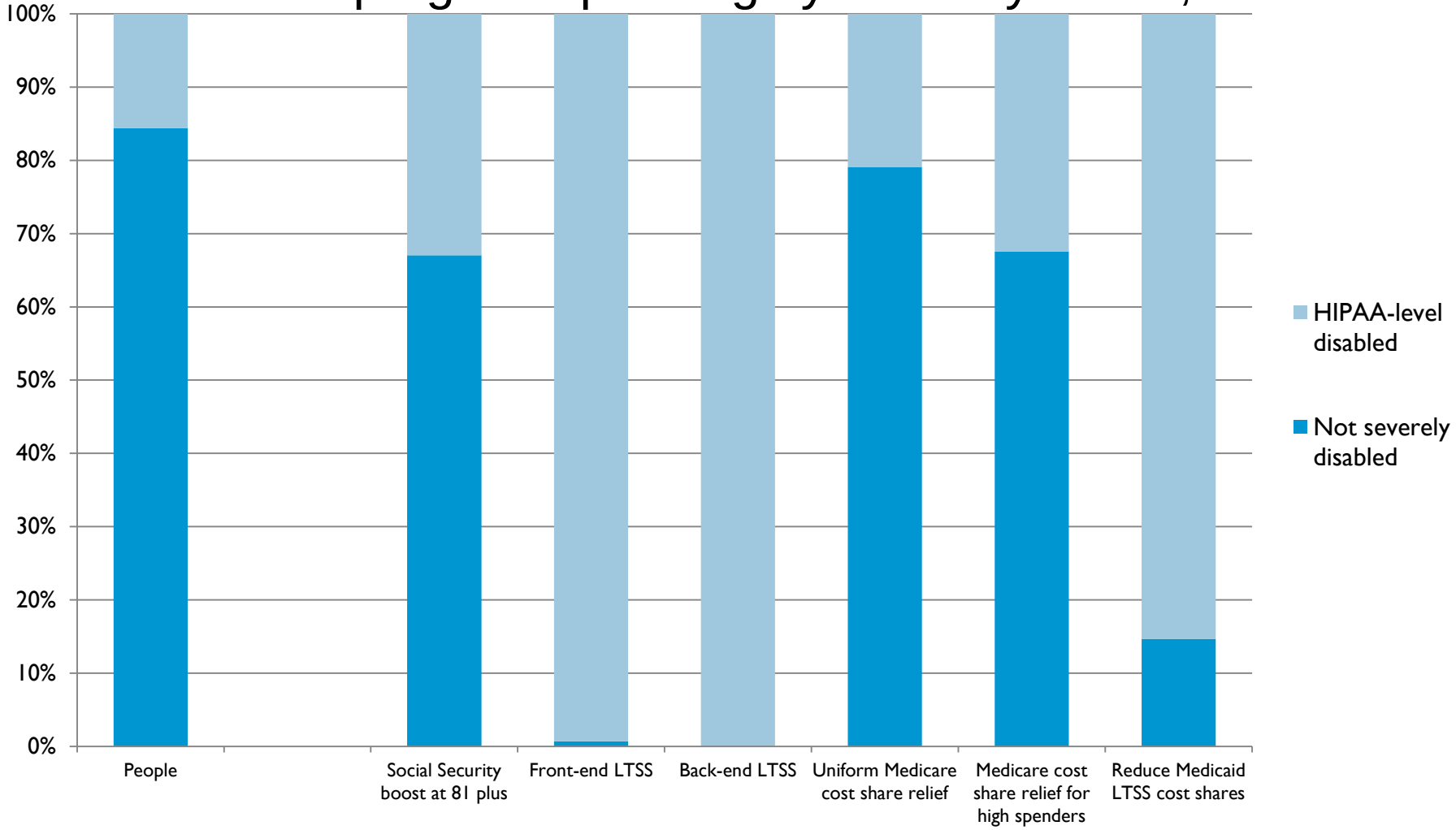
- Reduce Medicaid LTSS cost-sharing

Options modeled

- All cost about the same amount
  - Agnostic to financing the benefits
- Examine at a point when fully phased in
  - An issue for the LTSS insurance options if they were to be funded like OASDI with prefunding
- Consider effects per dollar spent for groups
- Vary generosity and eligibility

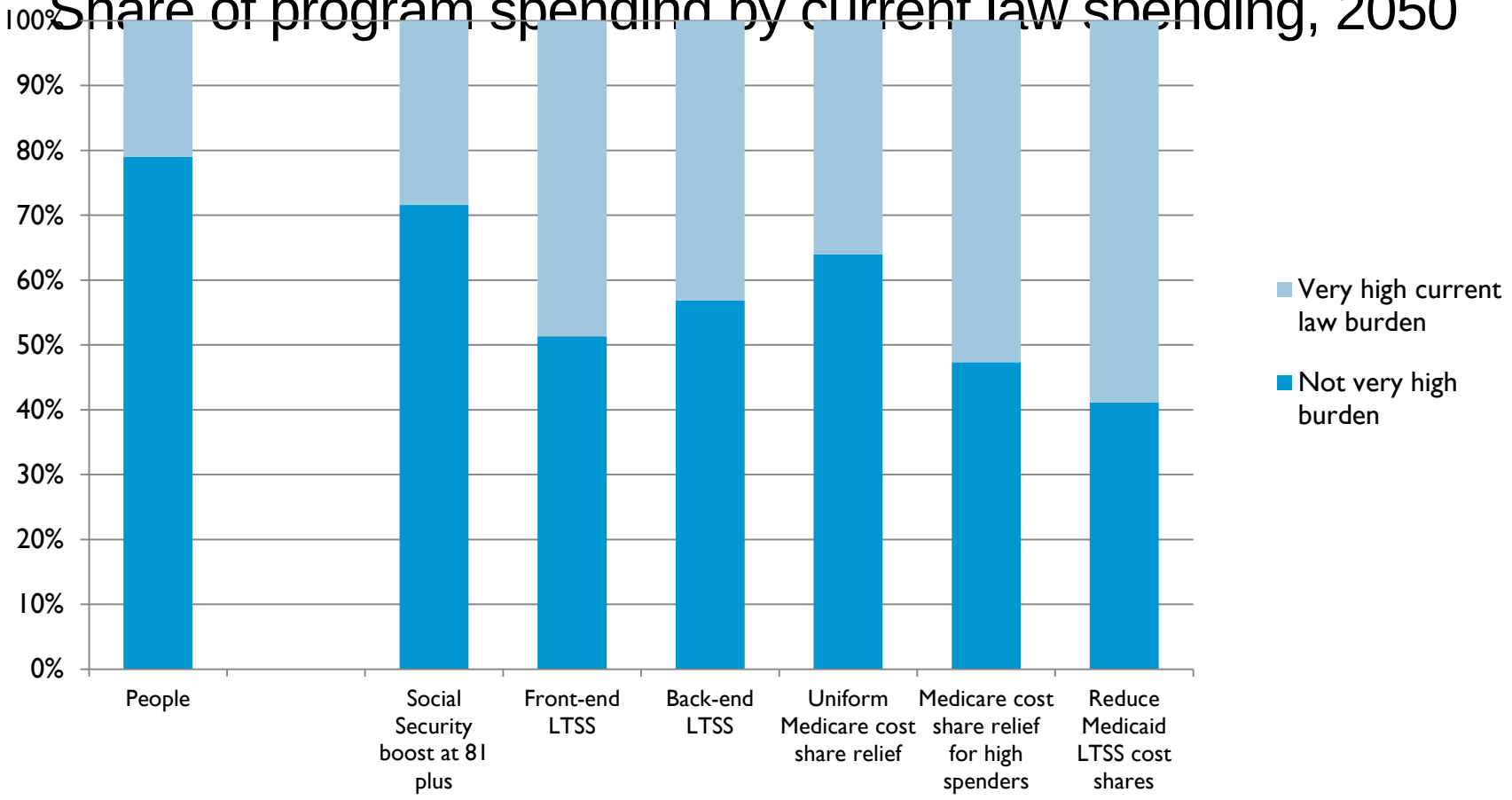
All Options Target Disabled Adults: LTSS and Medicaid Options More So

Share of program spending by disability status, 2050



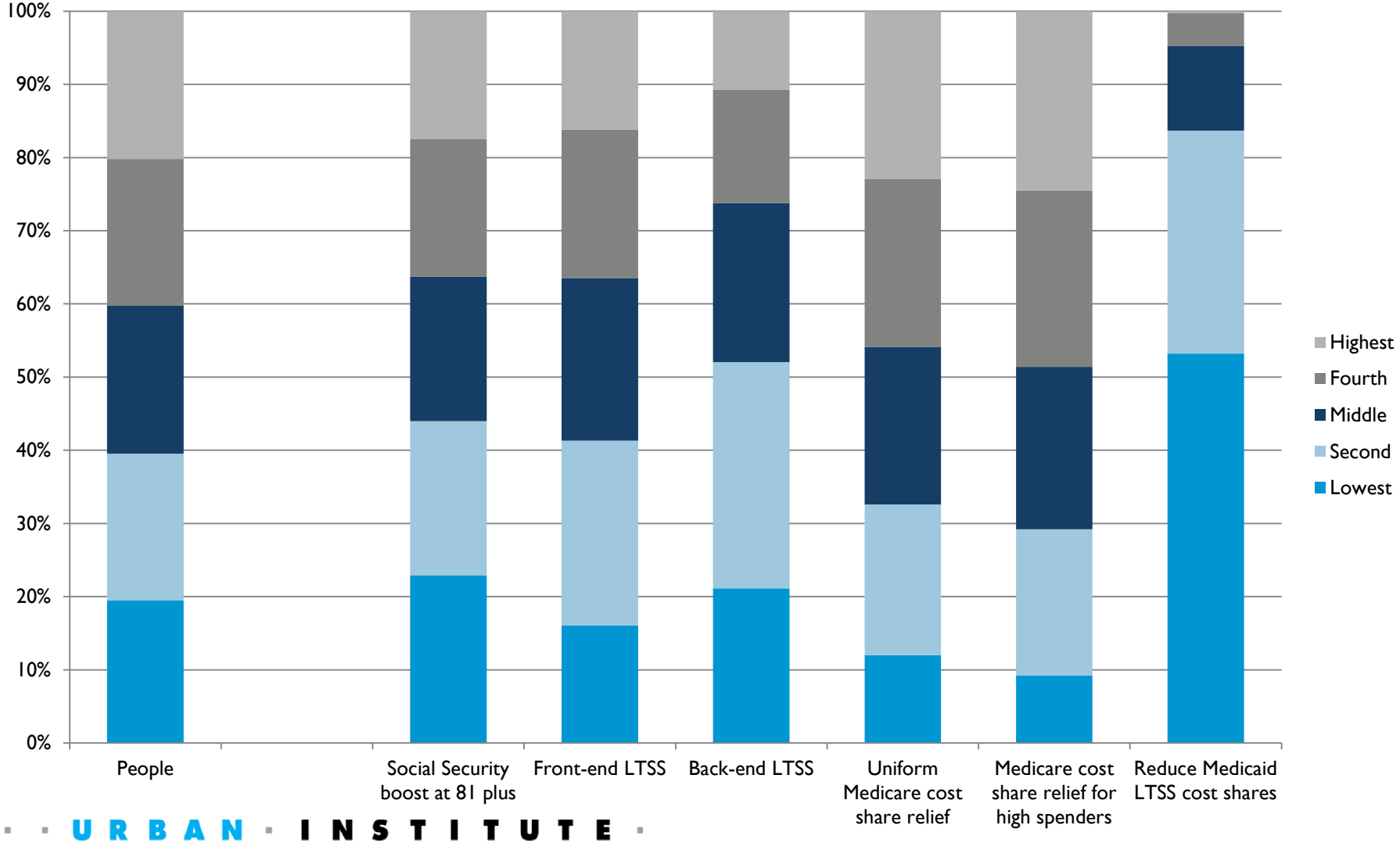
All Options Target High Spenders: LTSS, Targeted Medicare, and Medicaid Options

Share of program spending by current law spending, 2050



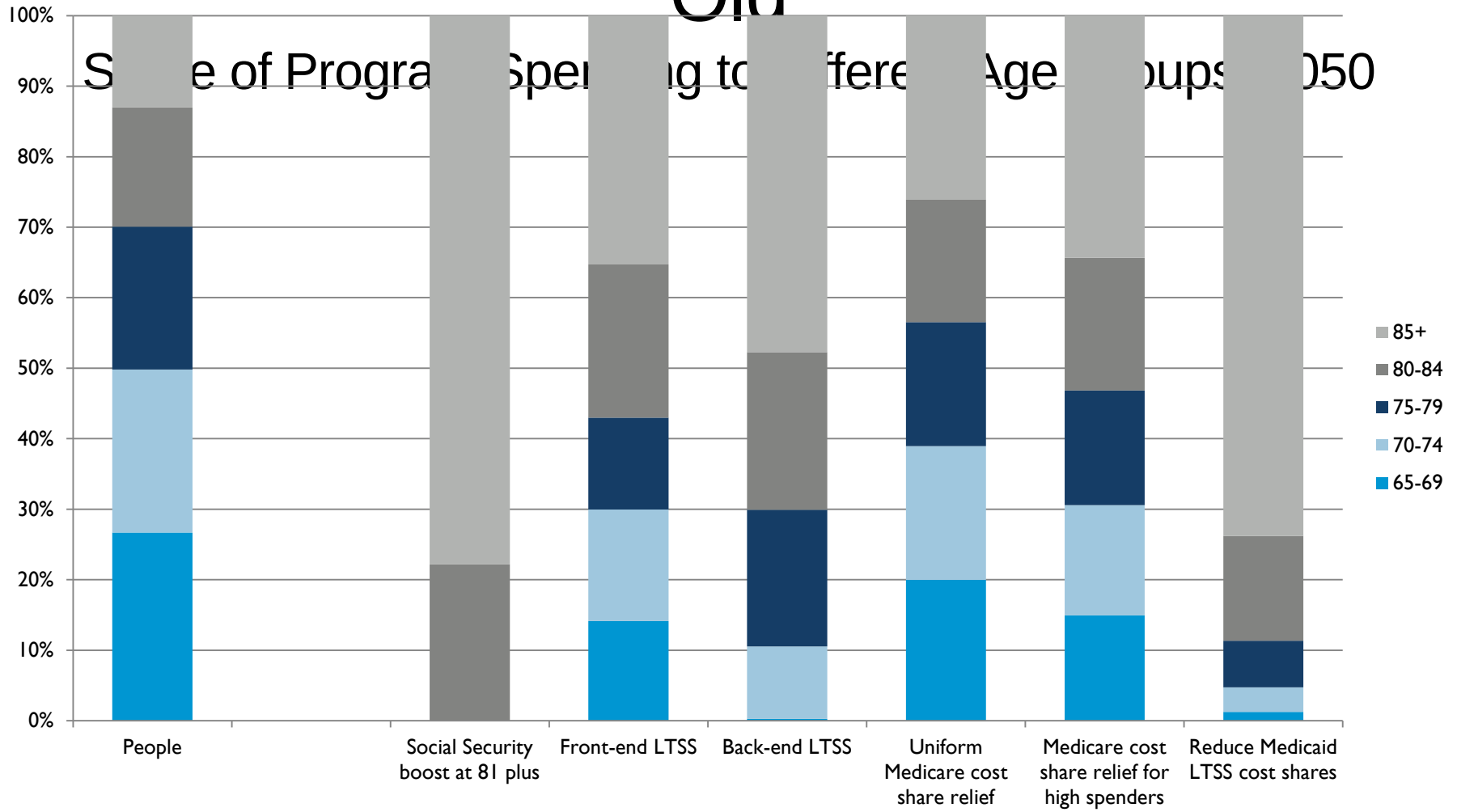
Options Vary in Income Targeting: Medicaid Options Most Progressive

Share of program spending by current law income, 2050



All Options Target Older Adults: OASDI, Back-end LTSS, and Medicaid Most to Old

S e of Progra Spe g to ffere Age oups 050



Caveats

- These projections depend on many assumptions, some controversial
  - Where to draw the line on disability?
  - What qualifies as LTSS (residential care)?
  - Spending growth for health care/LTSS
- Policies are highly stylized, illustrative
  - Each could be targeted better
    - Tradeoff: more people vs. high spenders
  - Important considerations besides targeting
    - Political viability / universality
    - Fairness
    - Cost of administration

Further policy ideas to compare

- SSI options
- Medicaid package of benefits
- Medicare package of benefits
- Asset tests
  - Medicaid and SSI
- Targeted relief based on health care and LTSS expenses as a share of income
  - Premiums and not just point-of-service cost shares
  - MSPs (QMB, SLMB, QI)
  - Income tested deductibles in LTSS

Thank you

All estimates in this paper are preliminary. Please consult the website of the Center for Retirement Research at Boston College in the fall for final results.

Views expressed are my own and not those of SSA, the Center for Retirement Research, or the Urban Institute.

No slides from discussant Paul Van de Water

How Does Cognitive Decline Affect Retirement Security?

Anek Belbase and Geoffrey Sanzenbacher
Center for Retirement Research at Boston College

18th Annual Meeting of the Retirement Research Consortium
Washington, DC
August 4, 2016

This project will review the literature on cognitive aging to produce three *briefs*

1) “Cognitive Change: The Lay of the Land”

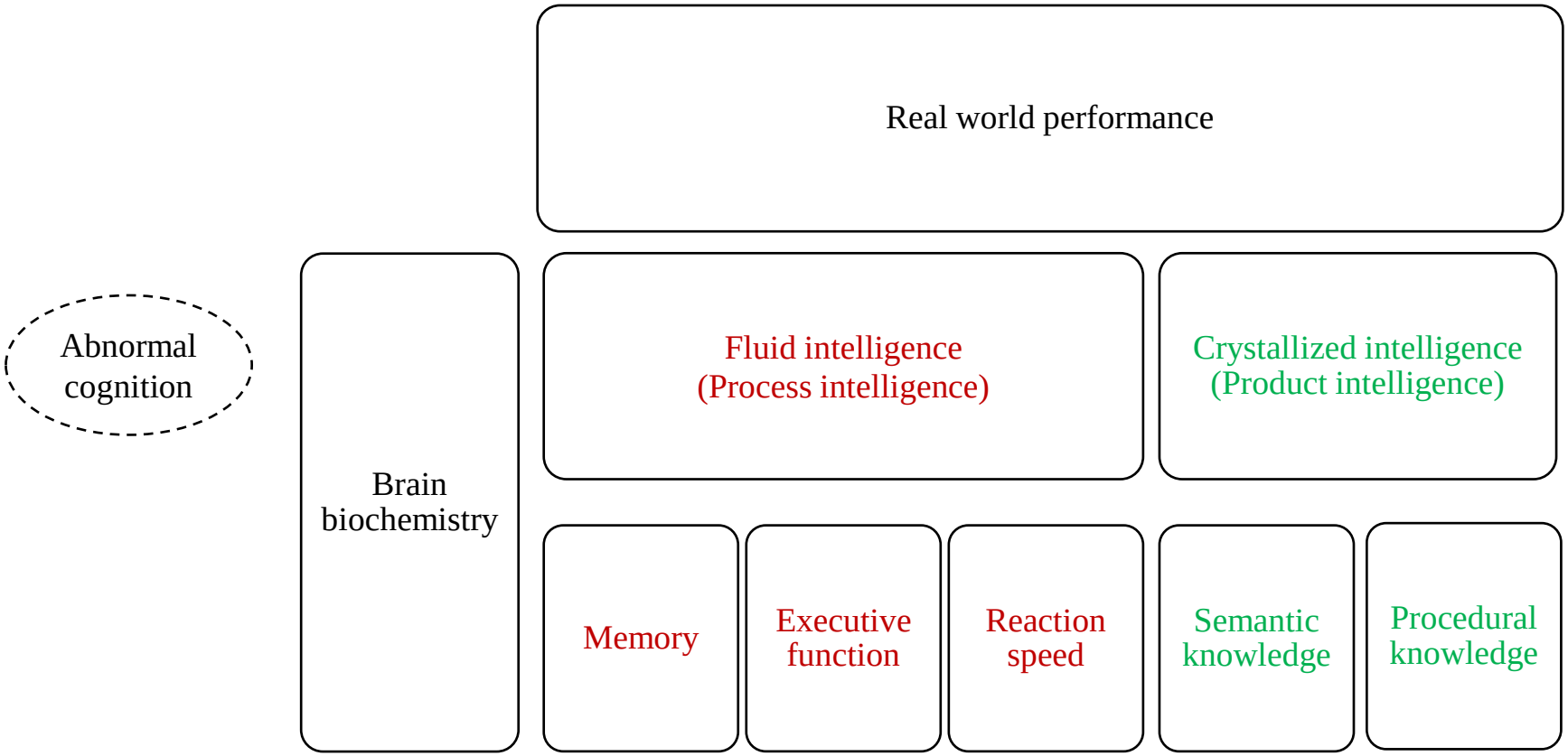
2) “Cognitive Change and the Ability to Work”

3) “Cognitive Change and Financial Decisions”

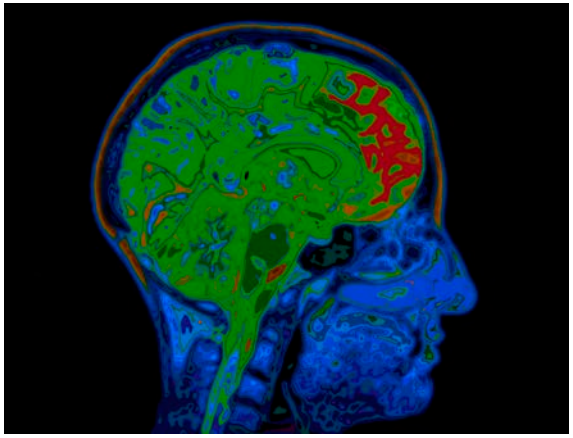
Key findings

- Numerous studies have documented biochemical, behavioral, and functional changes in cognition that are related to age.
- Most workers can remain productive despite changes in cognition, but lose capacity to respond to changes in health and employment with age.
- Financial ability also remains intact for most retirees unless they experience dementia – a condition that severely impairs financial ability and is increasingly likely to occur with age.

Many aspects of cognitive ability can be measured.

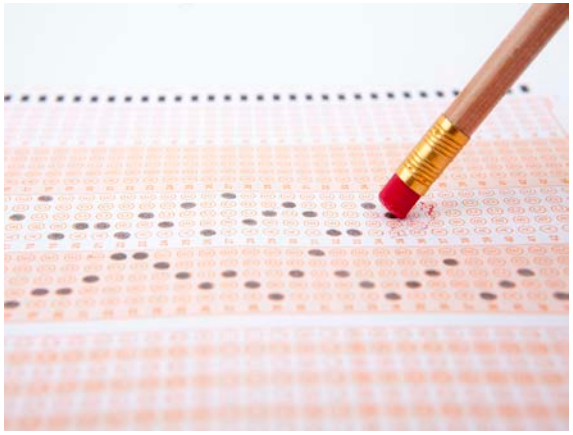


As a result, a variety of methods exist to measure cognitive ability.



Bio-chemical

Brain imaging can identify the bio-chemistry associated with cognitive processes.



Behavioral

Lab-based behavioral tests can isolate and measure a variety of cognitive processes and products.

Real-world

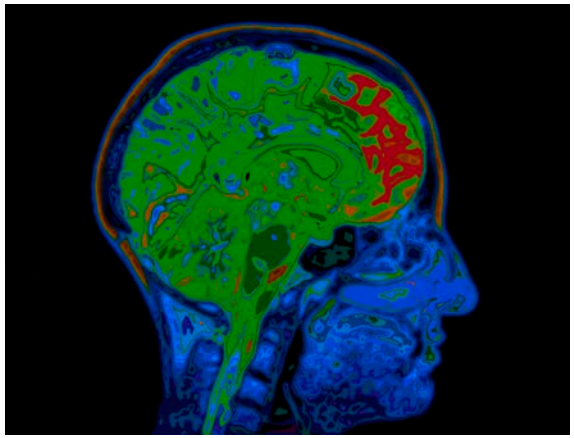
Tests of real-world performance are useful, but limited in number and application.

Source: Schaie, K. Warner and Sherry Willis. 2016. *Handbook of the Psychology of Aging: 8th Edition*. Boston, MA: Academic Press.

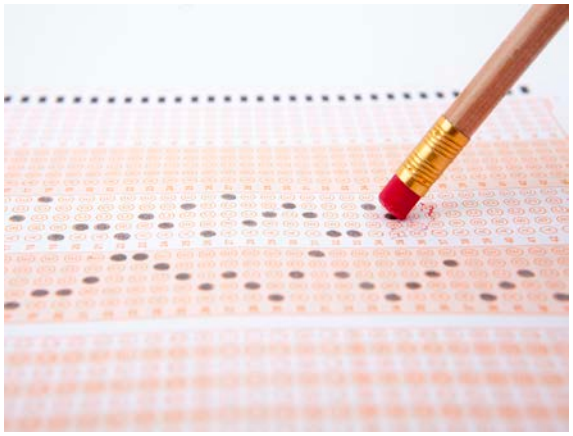
Measuring age-related change in cognitive ability poses methodological challenges.

- Short-term variability can obscure long-term changes in ability
- Cross-sectional and longitudinal approaches to measuring cognitive change yield varying results
- A number of age-related changes can confound attempts to measure change in cognitive ability

Despite challenges, several robust findings emerge regarding age-related change.



- The brain loses neurons
- Neurotransmitter sensitivity declines
- Brain activation is less specialized



- Reaction speed slows
- Working memory, attention, and reasoning ability declines
- Knowledge increases, then stabilizes.
- Risk of dementia increases exponentially

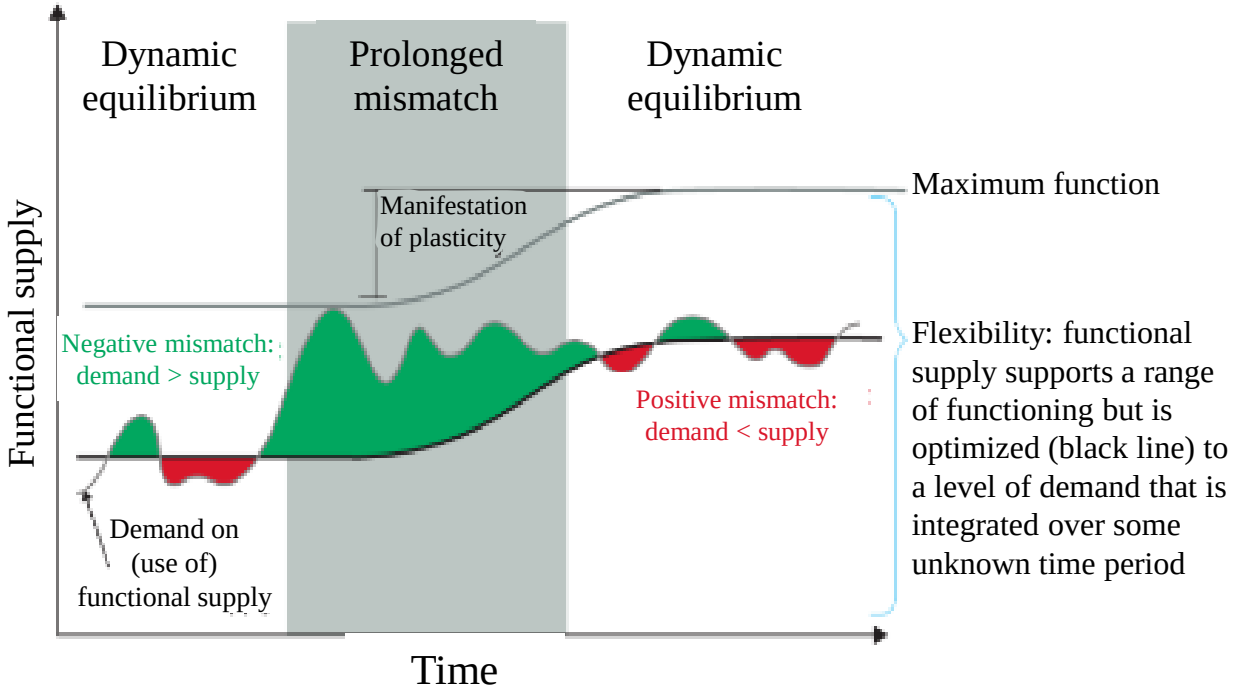
- Capacity to perform common daily activities is maintained
- Most workers can remain productive
- Dementia poses a threat to financial capacity

Source: Schaie, K. Warner and Sherry Willis. 2016. *Handbook of the Psychology of Aging: 8th Edition*. Boston, MA: Academic Press.

Plasticity and flexibility help explain the results of research on cognitive change.

Plasticity: *capacity to permanently increase flexibility, largely a function of "process" cognition.*

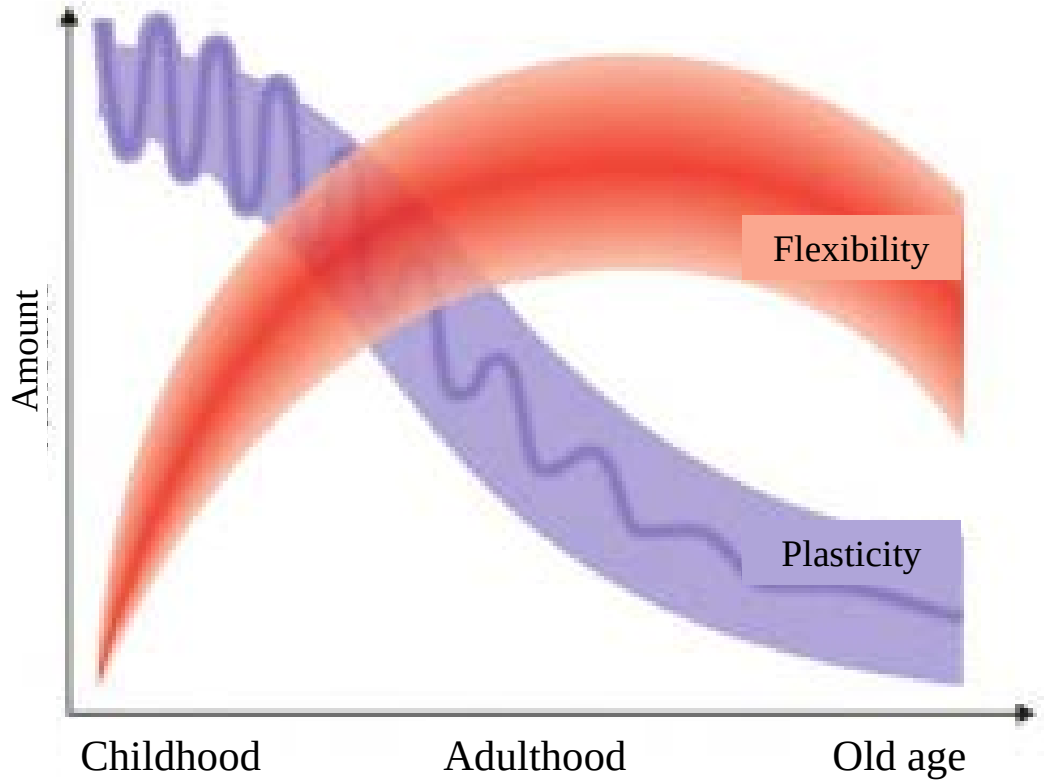
Flexibility: *range of cognitive functions supported by the brain, largely a function of "product" cognition.*



Source: Schaie, K. Warner and Sherry Willis. 2016. *Handbook of the Psychology of Aging: 8th Edition*. Boston, MA: Academic Press.

Plasticity peaks in childhood, while flexibility peaks in middle-age.

Plasticity and Flexibility over the Lifespan



Source: Schaie, K. Warner and Sherry Willis. 2016. *Handbook of the Psychology of Aging: 8th Edition*. Boston, MA: Academic Press.

Older workers generally remain productive due to accumulated cognitive flexibility.

- Studies report low to nonexistent age-related losses in productivity despite significant declines in behavioral test scores (Jeske and Rossnagel, 2015; Ng and Feldman, 2013).

- Older workers have significantly higher knowledge across a range of domains compared to younger workers (Craik and Salthouse, 2011).

- Studies of mandatory retirement ages have found age to be a very crude measure of ability (Salthouse, 2012).

But declines in plasticity and flexibility can affect specific types of workers.

- Lower plasticity reduces ability to respond to changes, such as changes in job requirements or changes in health.

- Lower flexibility can affect occupations where workers must regularly use all available cognitive ability.
  - Air traffic controllers must keep track of many flight paths and instructions under pressure.

- Increases in retirement age put all workers at higher risk of not being able to perform.

Financial ability also remains intact for most individuals unless they experience dementia.

- Retirees typically have cognitive capacity to carry out everyday financial tasks, like paying bills on time (Salthouse, 2012).
- But financial novices, particularly those with significant DC wealth, are at risk of making mistakes (Agarwal et al., 2009).
- Cognitive impairment affects financial ability years before diagnosis, and is associated with a higher risk of being financially abused (Riggs and Podrazik, 2014).

The risk of dementia grows exponentially with age, raising practical concerns.

- 32 percent of people over 85 experience dementia, and the number of people over 85 is increasing (Alzheimer's Association, 2015).

- But policy responses must navigate ethical, legal, and practical issues:
  - To what extent can financial capacity be evaluated, who should be evaluated, and who should administer tests?
  - When should "the keys be taken away?"
  - Who is responsible for the incapacitated?

Conclusion

- Cognitive plasticity peaks in childhood, while flexibility peaks in mid-life.
- Accumulated flexibility explains why most workers remain productive in old-age and most retirees have capacity to make financial decisions.
- Lower plasticity explains why older workers are less able to recover from health shocks or adapt to new job requirements.
- Dementia poses a serious threat to financial ability in old age.

Brief Commentary on Three Briefs

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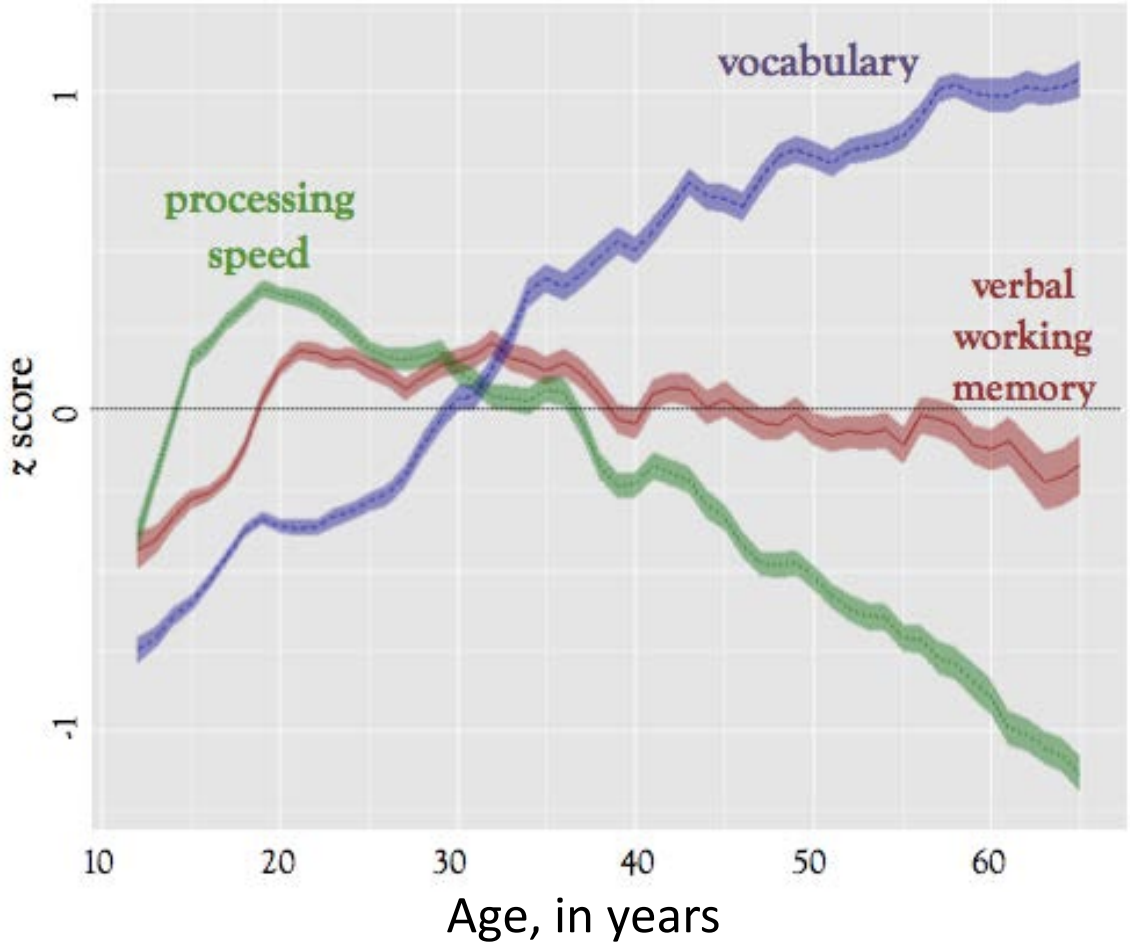
Division of Behavioral and Social Research
National Institute on Aging

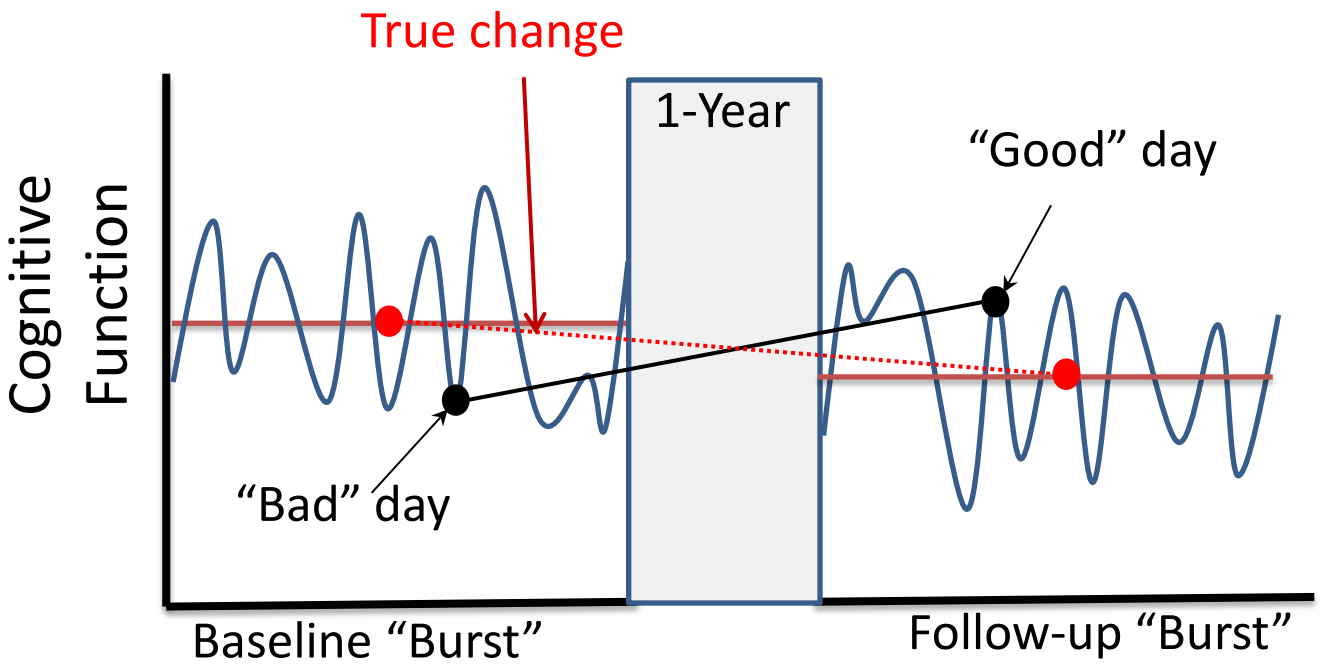
Cognitive Change and the Lay of the Land

Cross-sectional Measures of Cognition



Data from N=10,384 people visiting the **website** testmybrain.org over the course of one year. (Hartshorne & Germine, 2015)

Burst Measurement Design



Burst measurement designs give you estimates of mean level and variability as well as better measures of true change over time. (Sliwinski, 2015)

This is 2016; let's just phone it in

iPhone 6s

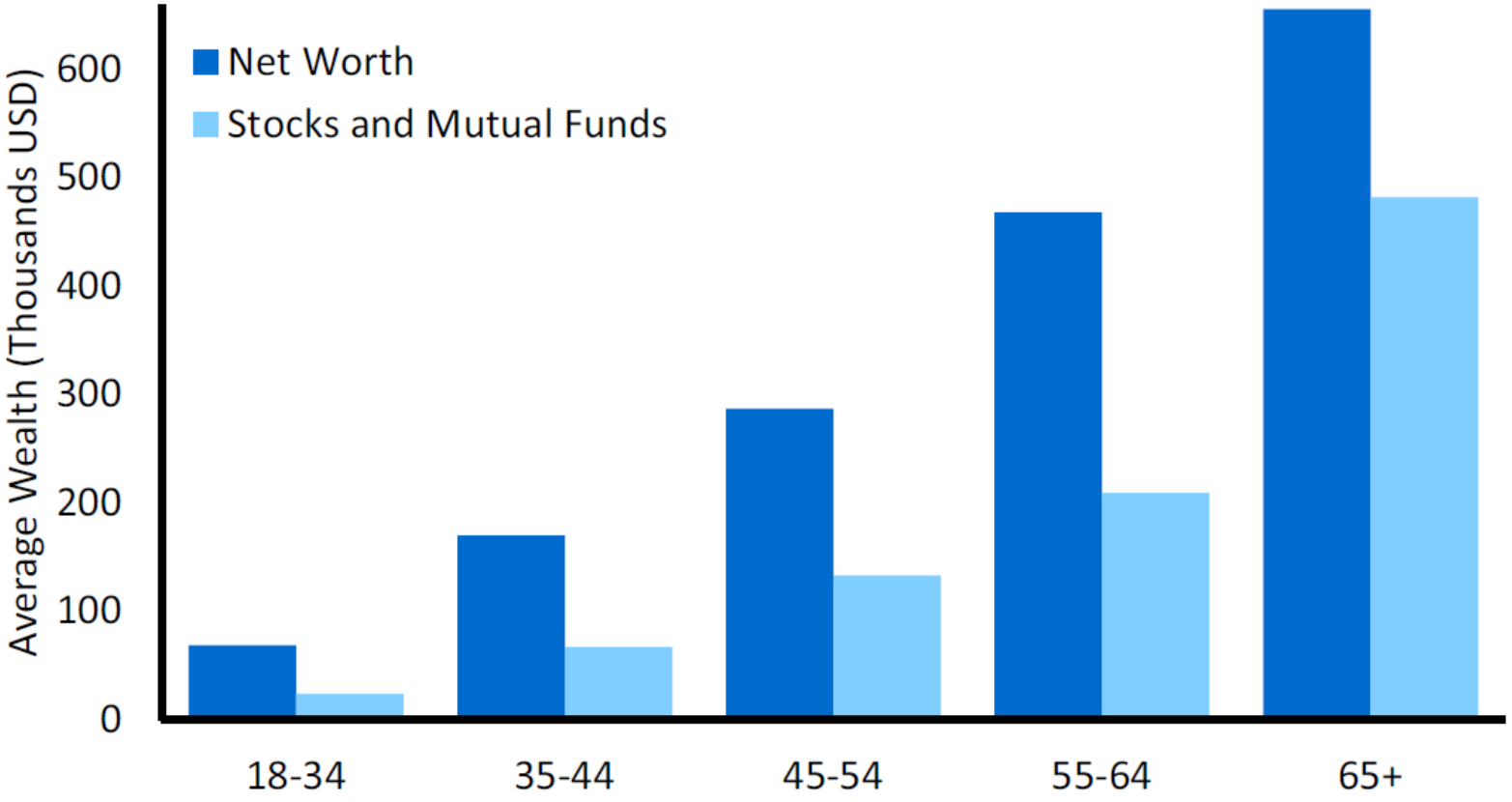
Galaxy S6

Make an App for that, in iOS and Android (market share: 95+%)

- Two smartphone platforms are stable and very popular.
- Distribution model (free online) likely will increase uptake.
- People are willing to spend a **lot** of time on their devices
- Programming and database issues well understood.
- Smartphones give access to many sensor types.
- This is now becoming the most prevalent computing platform.

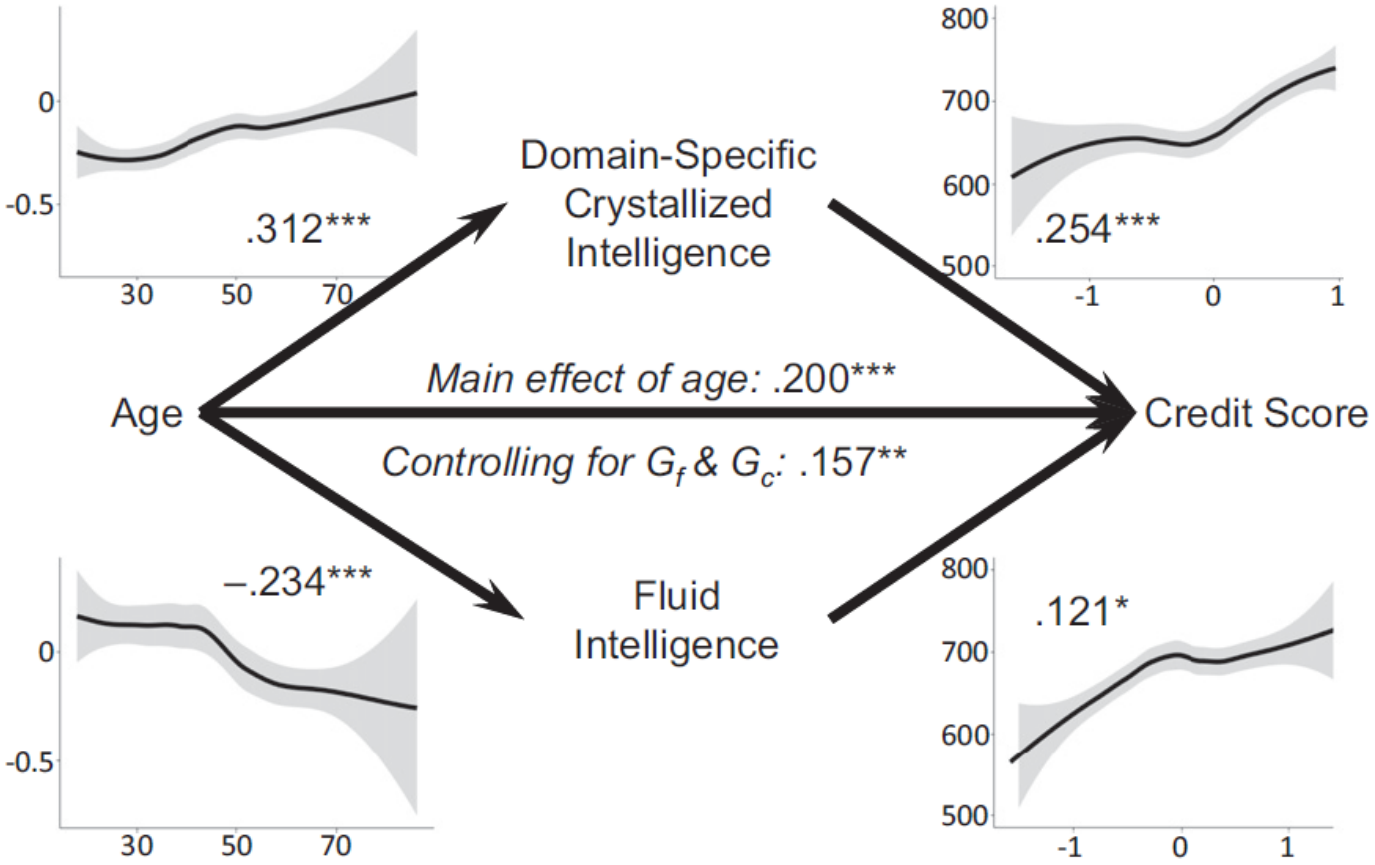
Cognitive Change and Financial Decisions

Age is Positively Associated with Many Measures of Wealth



2011 SIPP data replotted by Li et al. (2014; *PNAS*)

Credit Scores, Crystallized, and Fluid Intelligence



Li et al. (2014; *PNAS*)

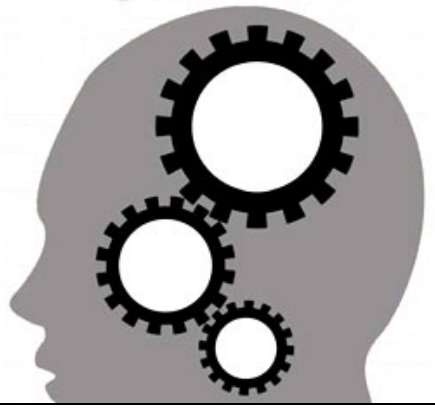
Cognitive Change and the Ability to Work

Capitalizing on Cognitive Training …

lumosity
reclaim your brain™

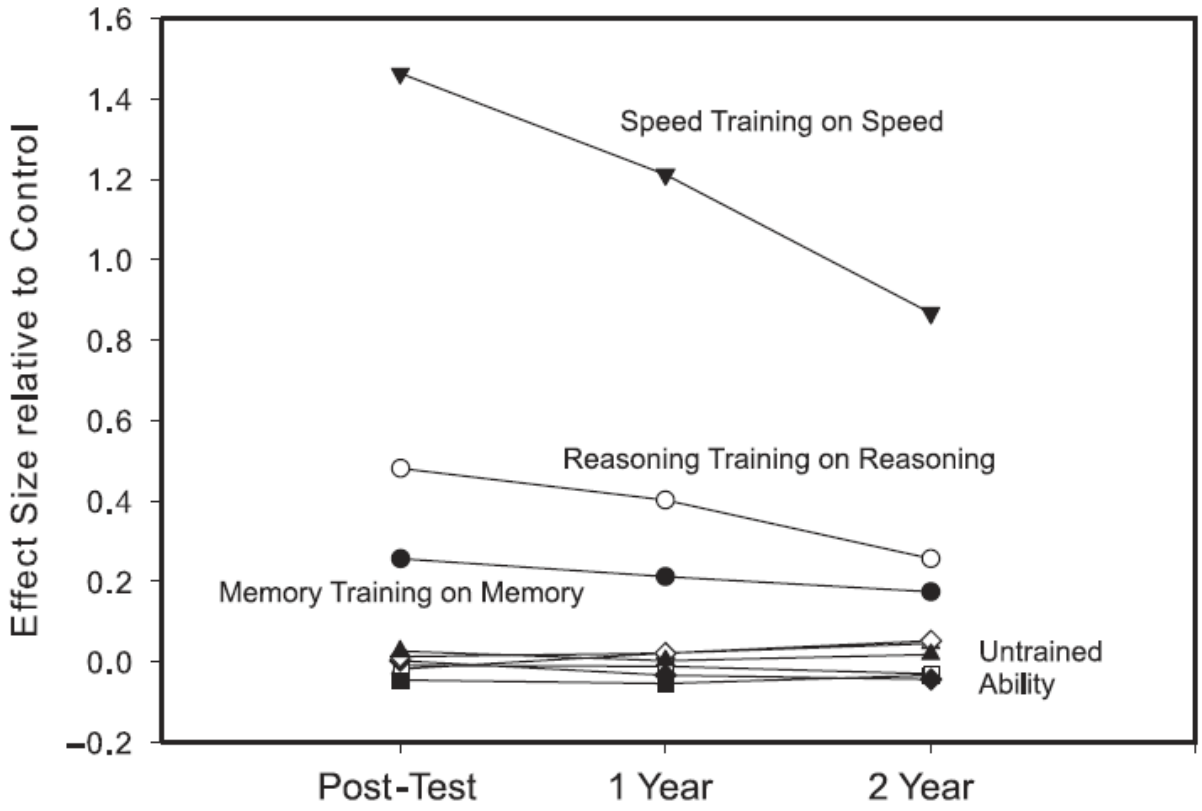
PositScience®
Train your brain.

MINDSTORM
TRAIN your BRAIN



CogniFit®

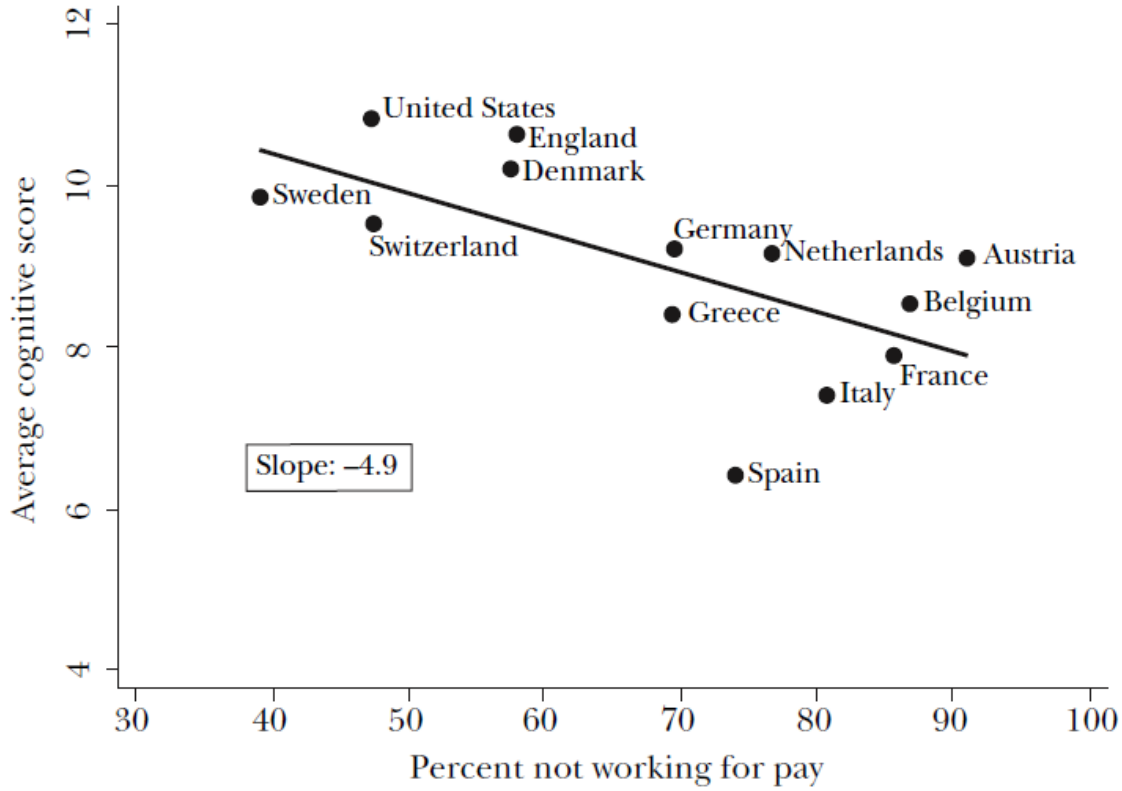
Near Transfer in ACTIVE



Effect sizes of three interventions used in ACTIVE (Ball et al., 2002) re-plotted by Salthouse (2006).

Could we Undo Mental Retirement?

Cognition by Percent Not Working for Pay, 60–64 Year-Old Men and Women, Weighted



Rohwedder and Willis (2010)