Higher-Order Cognitive Functioning and Intelligence

Outline

- Intelligence
- Does Intelligence Decline with Age?
- Factors Related to Intelligence Decline

Intelligence

Intelligence definition

- No single agreed-upon definition
- Cognitive ability with interindividual differences (Oxford: “ability to aquire and apply knowledge”)
- Multifaceted

Intelligence

- Spearman (1904) original idea of general intelligence or *g factor*
- Fluid-Crystalized Theory
  - Fluid (Gf) vs. crystalized (Gc)(Cattell 1963; Horn & Cattell 1966)
  - Visual (Gv) auditory (Ga) processing speed (Gs) reaction and decision (Gt) reading and writing (Grw) (Horn 1991; Woodcock 1994)
- Gardner's theory of multiple intelligences – broadens definition further

Intelligence

Early versions of intelligence tests such as the Stanford-Binet focused primarily on verbal skills and later added non-verbal such as quantitative reasoning

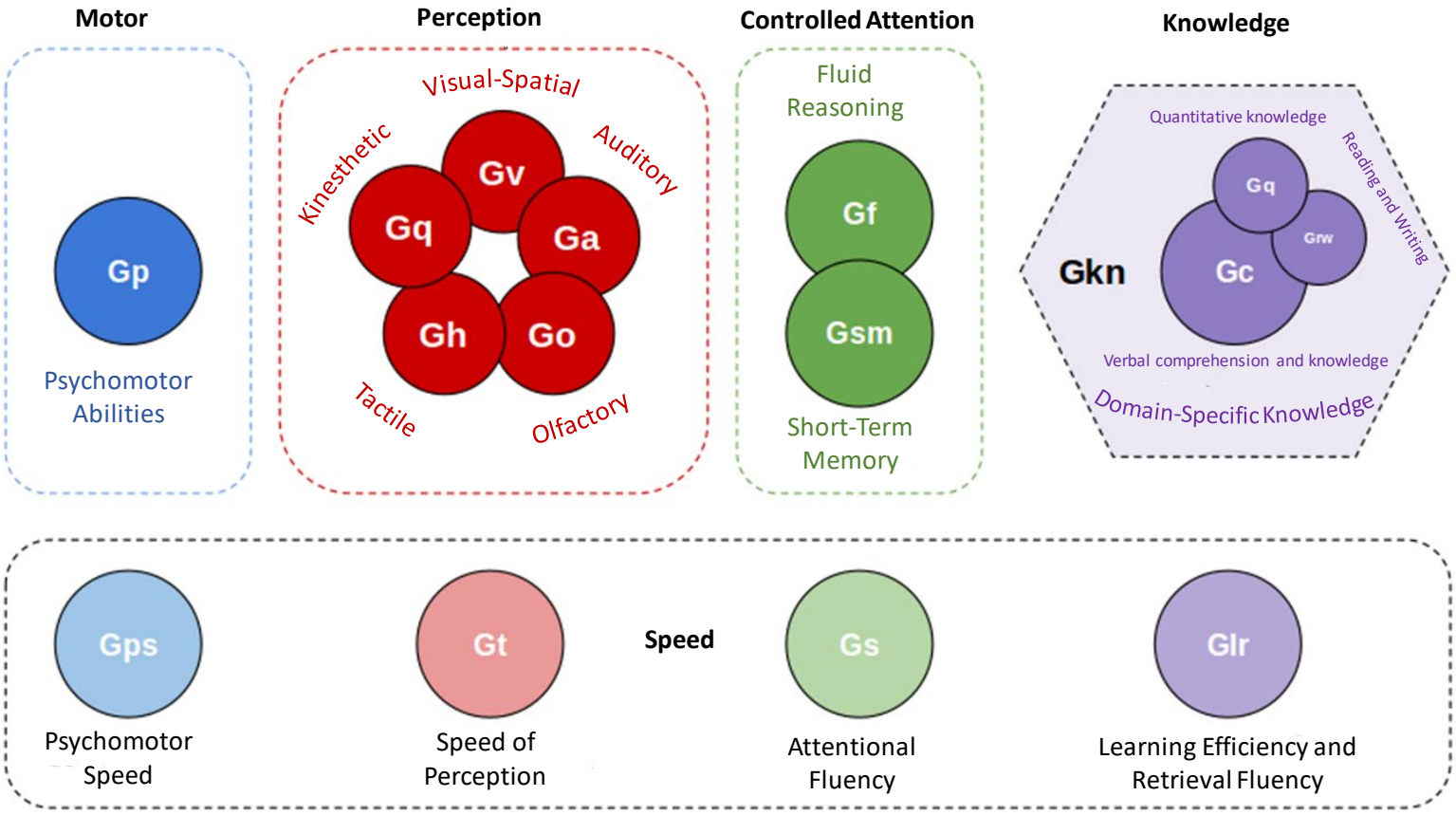
Intelligence

Fluid intelligence – ability to learn and incorporate new information problem solving abilities

Crystalized intelligence – already acquired knowledge or ability such as factual information

Intelligence

Cattell–Horn–Carroll (CHC) Model of Intelligence

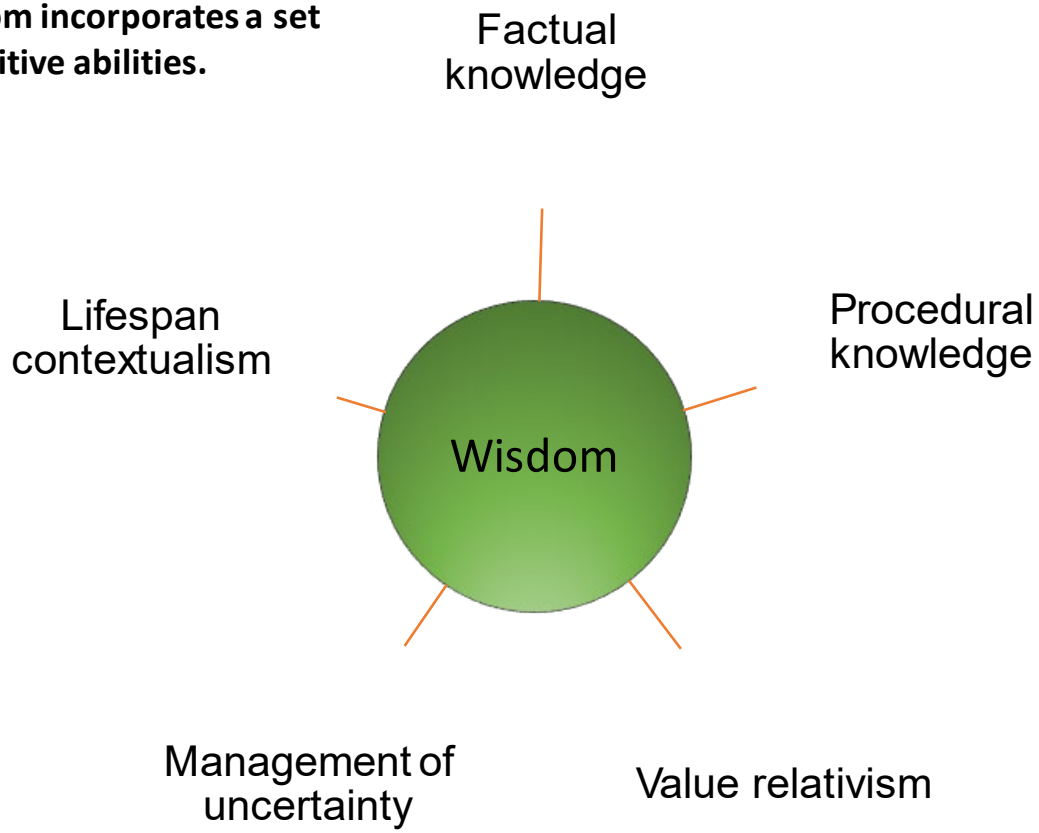


Intelligence

Gardner's theory of multiple intelligences

Beyond Intelligence

According to the Berlin Wisdom Paradigm, wisdom incorporates a set of complex cognitive abilities.



Intelligence

Current tests of intelligence such as the Weschler Intelligence Scale for Children (WISC) The Wechsler Adult Intelligence Scale (WAIS) and the current Stanford-Binet now have multiple subscales

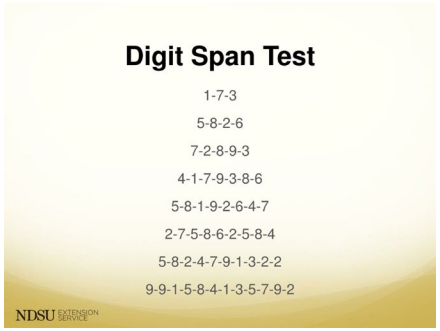
e.g. WAIS subscales:

- Similarities
- Vocabulary
- Block Design
- Matrix Reasoning
- Figure Weights
- Digit Span
- Sequencing
- Coding

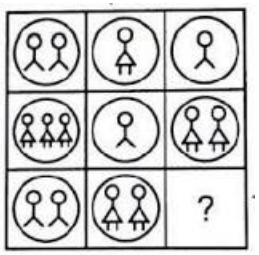
Intelligence

Block Design

Digit Span



Matrix Reasoning



Sequencing

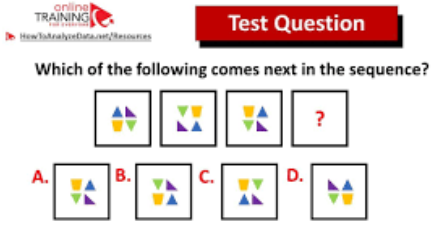
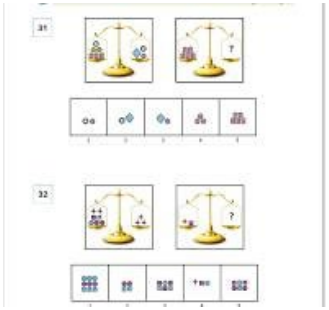
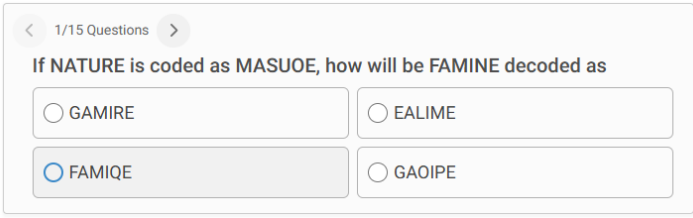


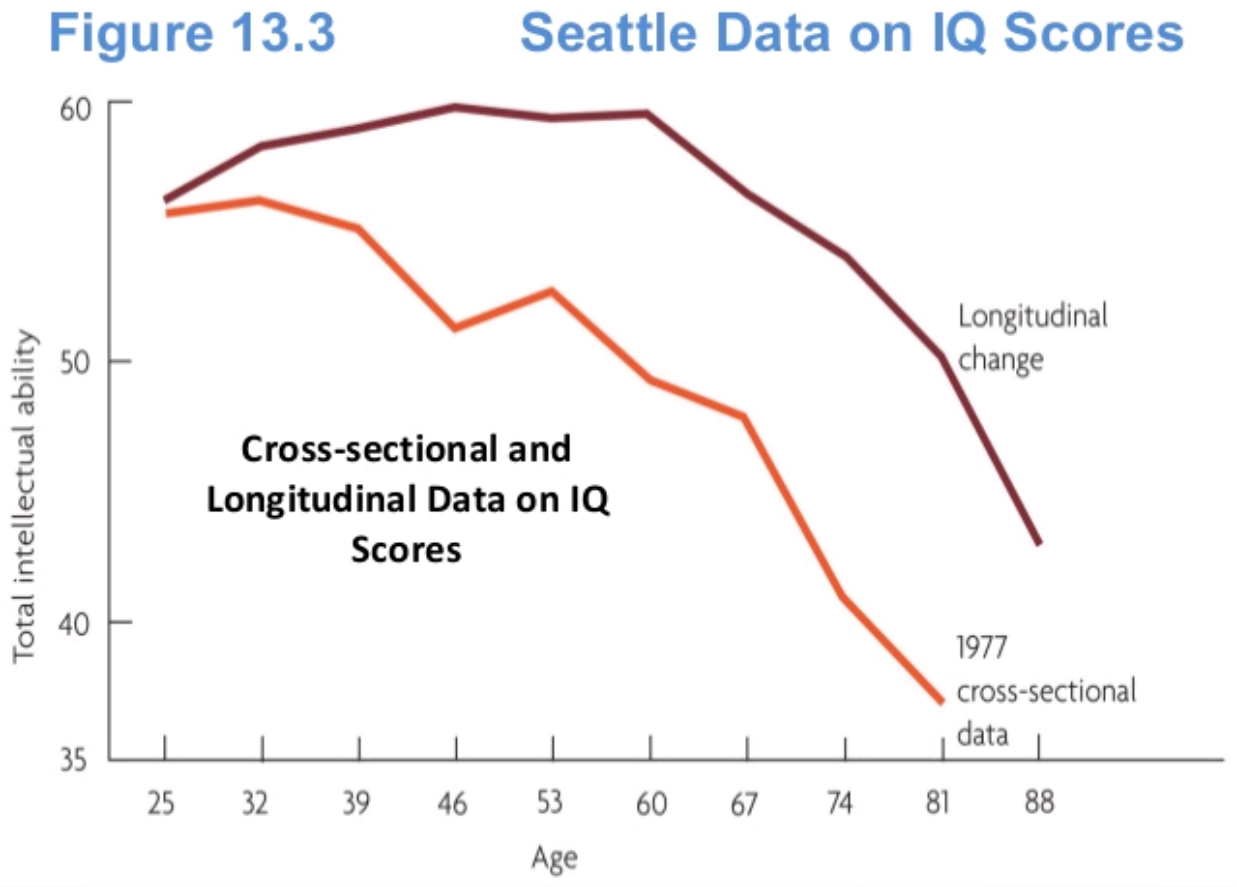
Figure Weights



Coding



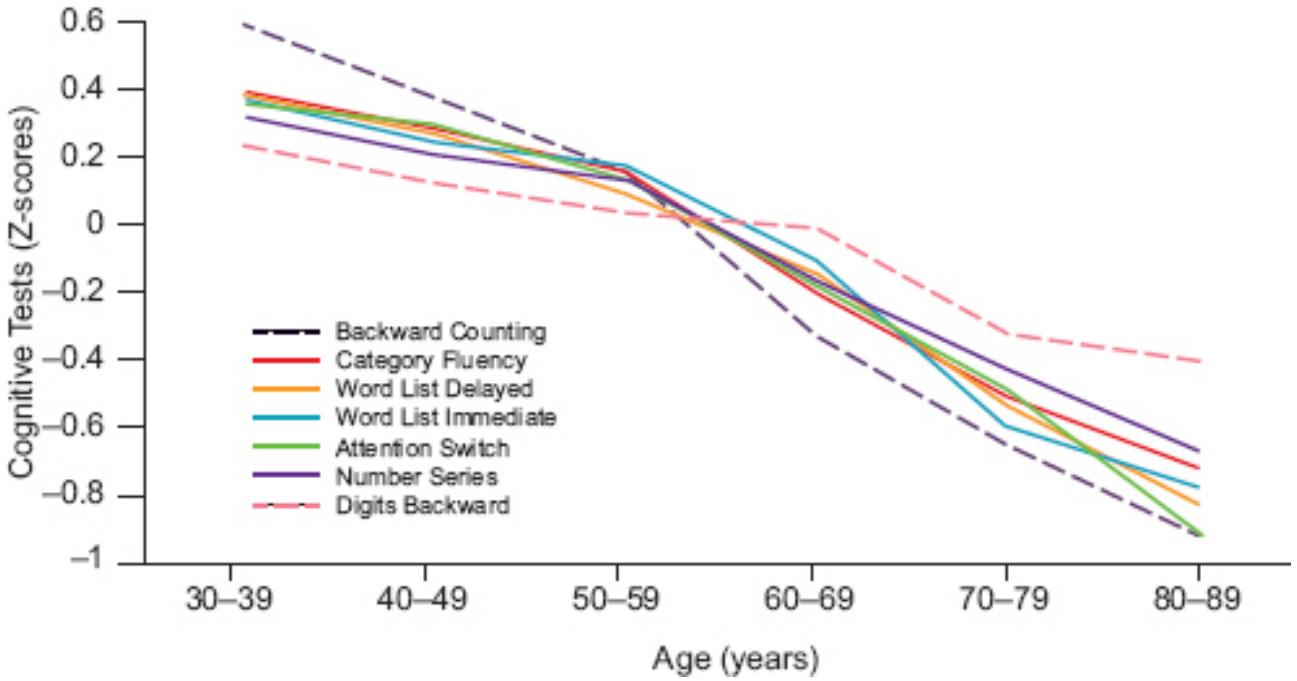
Does Intelligence Decline with Age?



Source: Boyd D. R. Bee H. L. & Johnson P. A. (2006). Lifespan development. Pearson/A and B.

Does Intelligence Decline with Age?

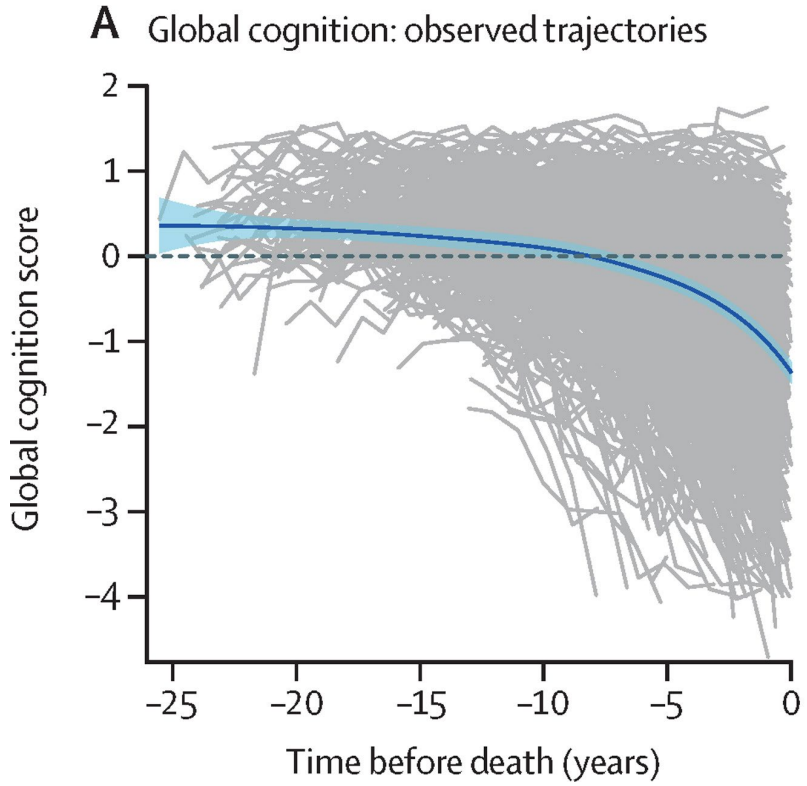
*Intra*individual variation



Liverman, C. T., Yaffe, K., & Blazer, D. G. (Eds.). (2015). *Cognitive aging: Progress in understanding and opportunities for action.* National Academies Press.

Does Intelligence Decline with Age?

*Inter*individual variation



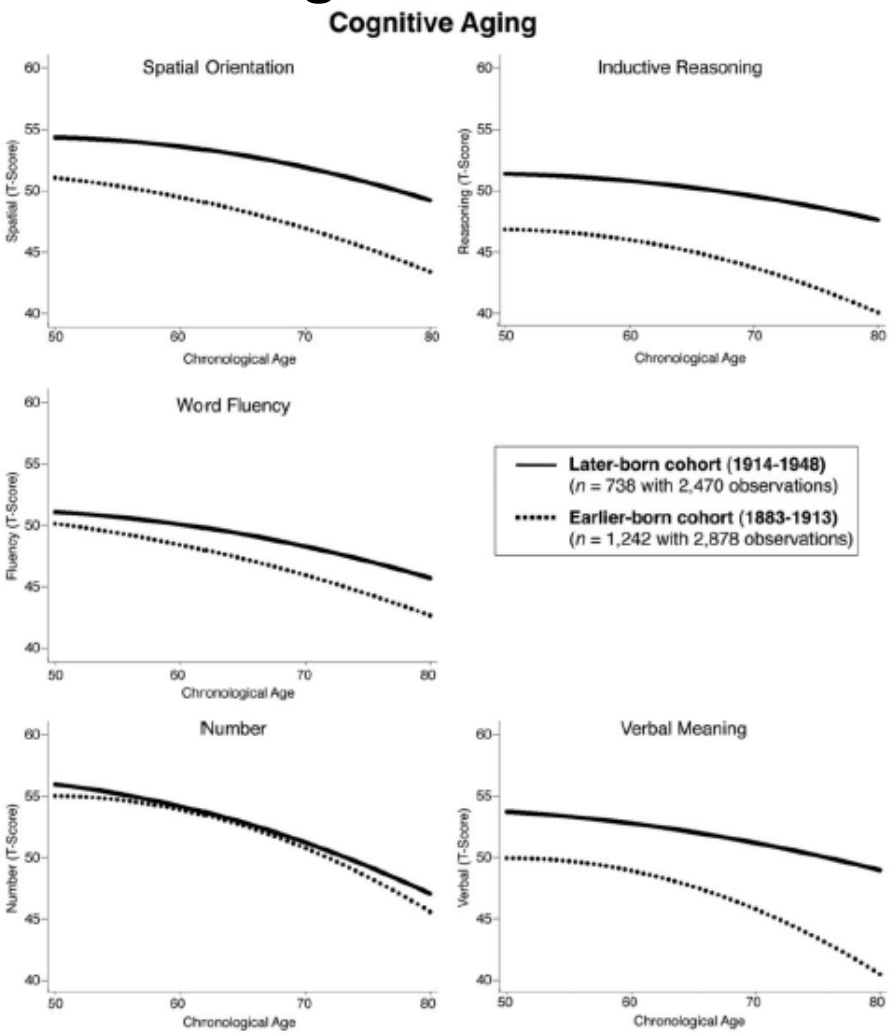
Oveisgharan, S., Wang, T., Barnes, L. L., Schneider, J. A., Bennett, D. A., & Buchman, A. S. (2024). The time course of motor and cognitive decline in older adults and their associations with brain pathologies: a multicohort study. The Lancet Healthy Longevity, 5(5), e336-e345.

Does Intelligence Decline with Age?

- Cross-sectional and Cohort Differences vs. Longitudinal Differences
  - Gertof and colleagues (2011) argue that research showing cohort improvements over time in cognitive functioning is based on cross-sectional data
  - Once longitudinal data is used (time until death) there is a clearer decline

Does Intelligence Decline with Age?

Cross-sectional and cohort differences



Gerstorf D. Ram N. Hoppmann C. Willis S. L. & Schaie K. W. (2011). Cohort differences in cognitive aging and terminal decline in the Seattle Longitudinal Study. Developmental psychology 47(4) 1026.

Does Intelligence Decline with Age?

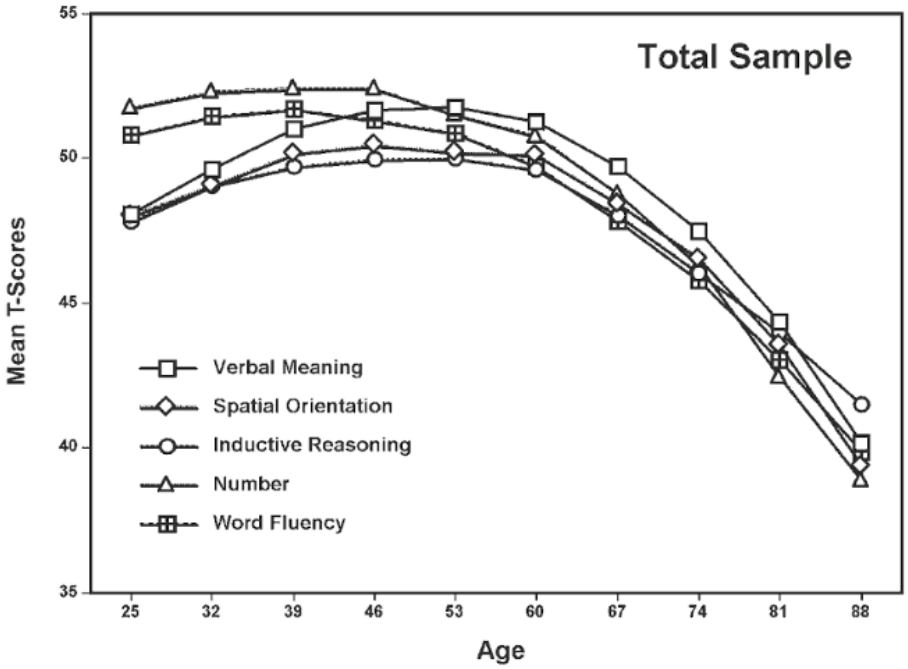


FIGURE 5.1 Longitudinal estimates of age changes on observed measures of five primary mental abilities.

Schaie K. W. & Zanjani F. A. (2006). Intellectual development across adulthood. Handbook of adult development and learning 99-122.

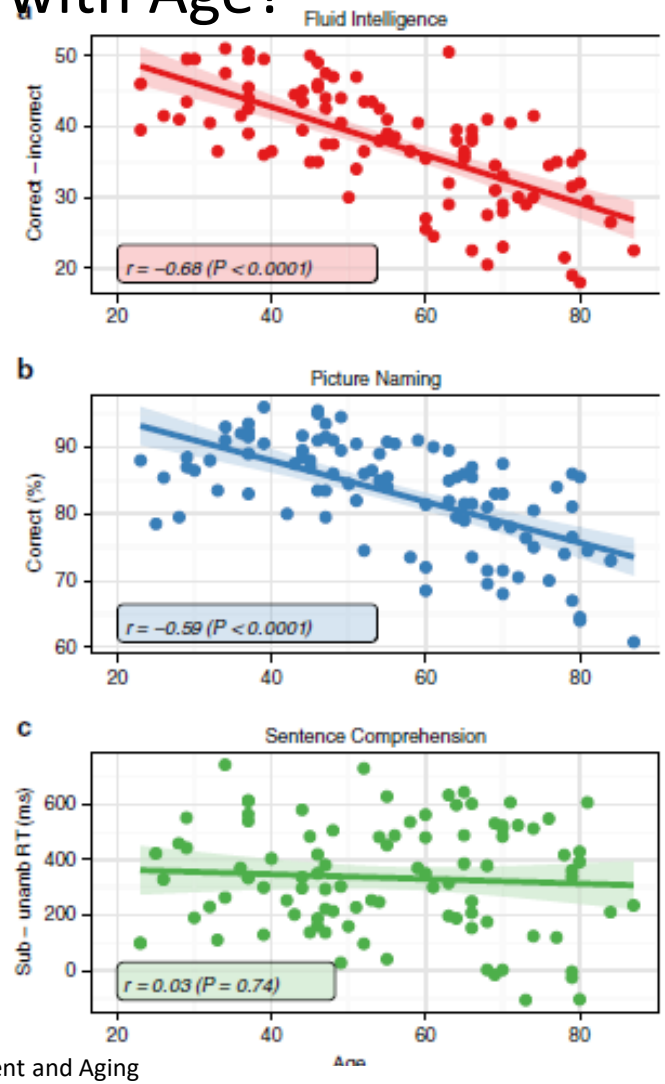
Does Intelligence Decline with Age?

Ages: 20-90 years

Fluid intelligence

Picture Naming

Sentence Comprehension



Samu, D., Campbell, K. L., Tsvetanov, K. A., Shafto, M. A., & Tyler, L. K. (2017). Preserved cognitive functions with age are determined by domain-dependent shifts in network responsivity. *Nature communications*, *8*(1), 14743.

Factors Related to Intelligence Decline

Factors associated with intelligence scores (and cross-sectional age differences)

- Age cohort (Gerstorf Ram Hoppmann & Willis & Schaie 2011)
- Less education (Akbaraly et al. 2009)
- Disease (Gerstorf et al. 2001; Schaie 1996)
- BMI (Elovainio et al 2009)
- Smoking poor diet alcohol abstention sedentary lifestyle (Sabia et al. 2009)
- Mental activities/training (Willis et al. 2009)

Factors Related to Intelligence Decline

Review of Education and Age-Related Decline (Seblova et al. 2019)

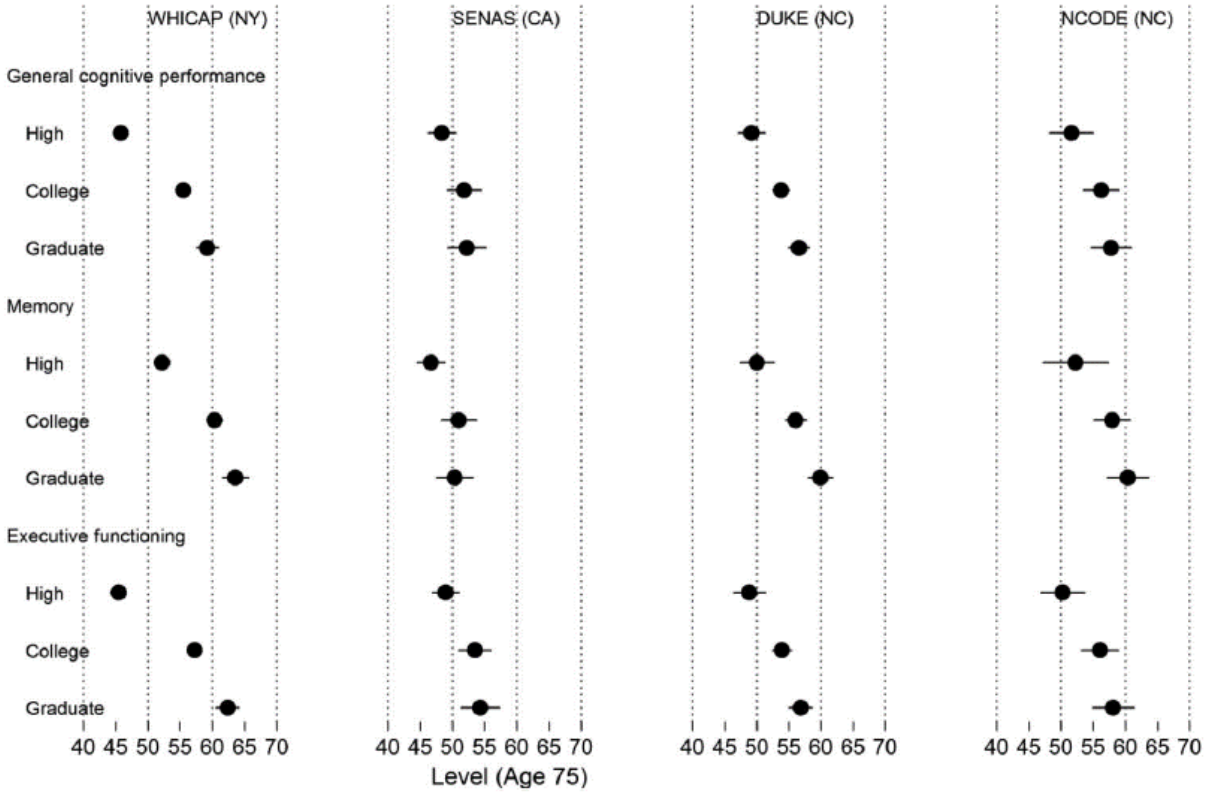
Reviewed studies on risk for lower education:

Episodic memory (evidence mixed)
Processing speed (evidence mixed)
Global cognition (evidence leans toward relation to greater decline)
Verbal fluency (little evidence of relation to decline)
Crystalized intelligence (evidence mixed leans toward no relation to decline)
Fluid intelligence (mixed leans toward relation to greater decline)

Review does not support "*the hypothesis that educational attainment is consistently and positively associated with inter-individual differences in rate of cognitive change in any cognitive domain.*"

Factors Related to Intelligence Decline

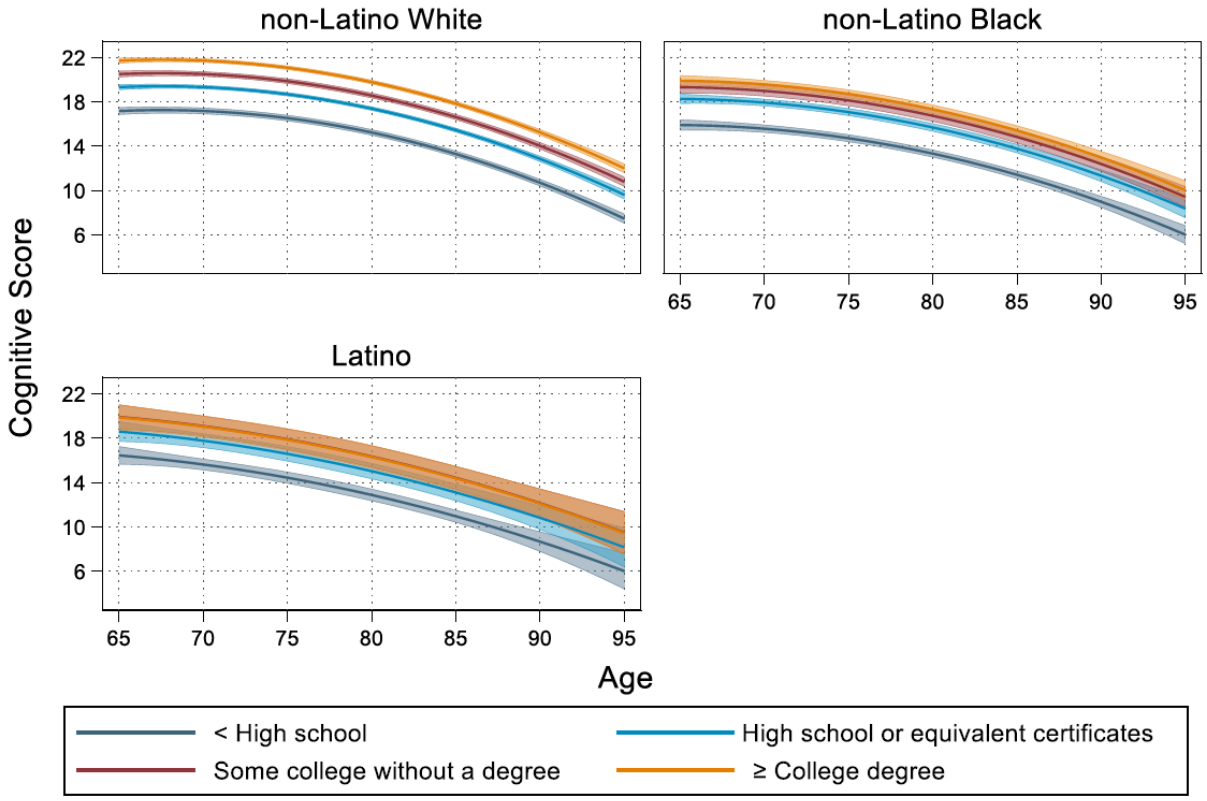
Education differences in cognitive decline in older ages (*Gross et al. 2015)*



Gross, A. L., Mungas, D. M., Crane, P. K., Gibbons, L. E., MacKay-Brandt, A., Manly, J. J., ... & Jones, R. N. (2015). Effects of education and race on cognitive decline: An integrative study of generalizability versus study-specific results. Psychology and aging, 30(4), 863.

Factors Related to Intelligence Decline

Education: Quiñones and colleagues (2022)



Quiñones, A. R., Chen, S., Nagel, C. L., Botoseneanu, A., Allore, H. G., Newsom, J. T., ... & Kaye, J. (2022). Trajectories of cognitive functioning in later life: Disparities by race/ethnicity, educational attainment, sex, and multimorbidity combinations. SSM-population health, 18, 101084.

Factors Related to Intelligence Decline

Race/Ethnicity: Quiñones and colleagues (2022)

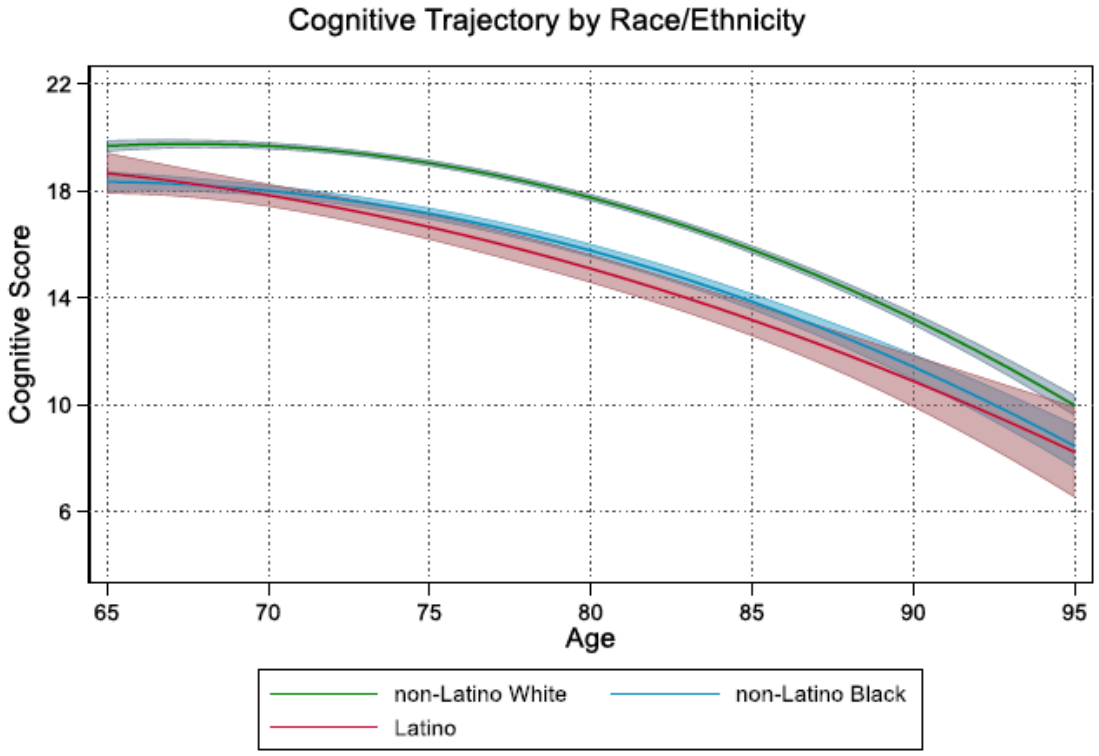


Fig. 1. Note: Bands around each trajectory represent 95% CI.

Quiñones, A. R., Chen, S., Nagel, C. L., Botoseneanu, A., Allore, H. G., Newsom, J. T., ... & Kaye, J. (2022). Trajectories of cognitive functioning in later life: Disparities by race/ethnicity, educational attainment, sex, and multimorbidity combinations. SSM-population health, 18, 101084.

Factors Related to Intelligence Decline

Longitudinal study of race and education differences in cognitive decline in older ages (Gross et al. 2015)

"Non-Hispanic Whites consistently had higher baseline scores than Blacks in all four studies and even larger differences were observed in comparison with Hispanics in the two studies that included Hispanics."

"In contrast racial/ethnic differences in rate of change in cognition were small and when present favored Blacks and Hispanics. That is these minority groups declined less on average than non-Hispanic Whites."

Gross, A. L., Mungas, D. M., Crane, P. K., Gibbons, L. E., MacKay-Brandt, A., Manly, J. J., ... & Jones, R. N. (2015). Effects of education and race on cognitive decline: An integrative study of generalizability versus study-specific results. Psychology and aging, 30(4), 863.

Factors Related to Intelligence Decline

Race differences in cognitive decline in older ages (Gross et al. 2015)