Fluid and Crystallized Abilities in the Seattle Longitudinal Study: Cohort Differences in Cognitive Aging and Dying

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Cohort Differences in Cognitive Aging?

Lifespan and life course theory

- **Historical processes and contextual factors shape individual development**
  (Baltes et al., 1979; Bronfenbrenner, 1986; Elder, 1974; Schaie, 1965)

- **Later-born cohorts outperform those born earlier in central life domains**
  - **functional health** (Crimmins et al., 1996; Manton et al., 2008)
  - **cognitive functioning** (Flynn, 1999; Schaie, 2005)

- **Do cohorts differ in rates of cognitive aging?**
  - **parallel age changes (62 to 78 years) for cohorts 1900–1925 vs. 1926–1948**
    (SATSA: Finkel et al., 2007; see also LBLS: Zelinski & Kennison, 2007)
  - **steeper 7-year age declines among earlier-born cohorts**
    (SLS: Schaie, 2008)

  --> What is the role of cohort differences in schooling and health?
  (HRS: Alwin, 2008; BETULA: Rönnlund et al., 2005)

Cohort Differences in Cognitive Dying?

Terminal decline at the end of life

- **Late-life cognitive functioning may relate to mortality rather than age**
  (Kleemaier, 1962; Riegel & Riegel, 1972; Siegler, 1975)

- **Precipitous decline in cognitive abilities with impending death**
  (Bäckman & MacDonald, 2006; Ghisletta et al., 2006; Sliwinski et al., 2003)

- **Do cohorts differ in rates of cognitive dying?**
  - **compression of morbidity** (Fries, 1980)
  - **pervasive nature of mortality may diminished previous cohort differences**

  --> Do positive secular trends generalize to mortality-related processes?

  --> What is the role of cohort differences in schooling and health?

Defining the Cohorts Broadly

	Age models			Mortality models	
	Earlier-born	Later-born		Earlier-born	Later-born
Year of birth	1883–1913	1914–1948		1883–1913	1914–1948
N	1,537	1,933		853	594

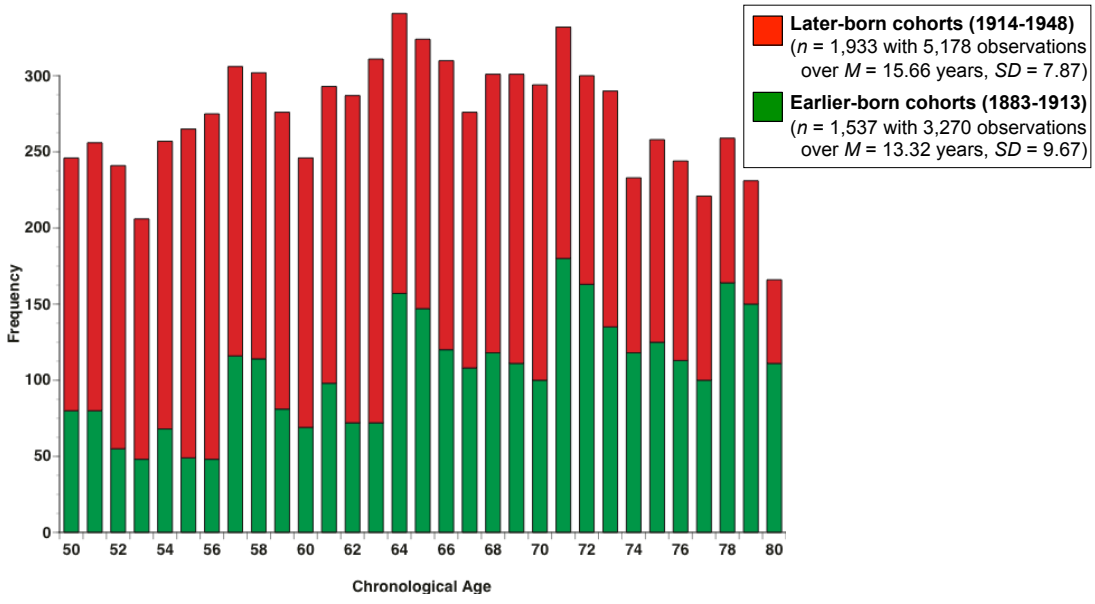
Criteria

- ❑ **Sample size (e.g., sufficient number of deceased participants)**
- ❑ **Overlapping ranges in chronological ages and times-to-death**
  (ages 50 to 80) (last 25 years of life)

Frequency of Observations by Cohort

Age-Related Analyses

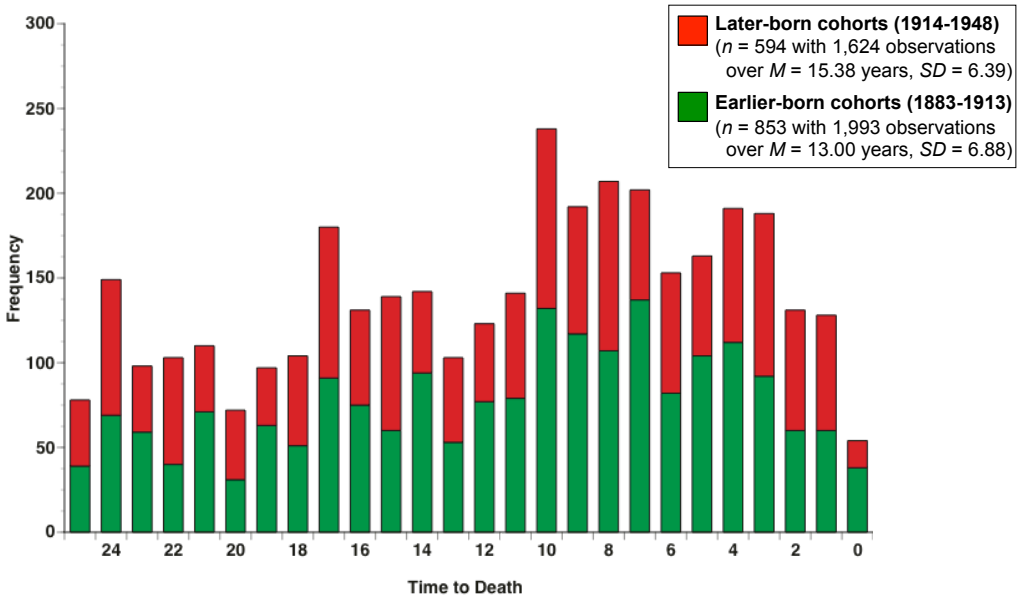
Each cohort encompassed 1,500+ participants contributing 3,000+ data points



Frequency of Observations by Cohort

Mortality-Related Analyses

Each cohort encompassed 550+ participants contributing 1,600+ data points



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Our cohort distinction overlaps with major differences in …

… early-life experiences

- **educational attainment** (e.g., compulsory schooling)
- **educational practices** (e.g., progressive curricula)
- **medical innovations** (e.g., antibiotics)

… late-life experiences

- **entering old age in 1960/70s vs. 1980/90s**

The Seattle Longitudinal Study: Sample and Measures

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Fluid	**Spatial Orientation** (visualize object rotation in two-dimensional space)				
	Inductive Reasoning (identify patterns in a letter series)				
	Word Fluency (list words beginning with letter S)				
Crystallized	**Number** (solve simple addition problems)				
	Verbal Meaning (recognize vocabulary)				

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	Verbal Meaning (recognize vocabulary)				
Covariates					
% women	53%	54%		48%	39%
M education	12.6	14.7		12.8	14.6
% circulatory diseases	61%	48%		58%	47%
M age T1				66.0	54.6
M age at death				84.5	76.8

Statistical Procedure: Growth Curve Models

Do earlier-born (1883–1913) **and later-born cohorts** (1914–1948) **differ in …**

… age-related cognitive change between ages 50 and 80?

Level 1: $\text{ability}_{ti} = \beta_{0i} + \beta_{1i}(\textbf{age}_{ti}) + \beta_{2i}(\textbf{age}^2_{ti}) + e_{ti}$

Level 2:

$\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{cohort}_i) + \gamma_{01}(\text{cov}_i) + \ldots + u_{0i}$

$\beta_{1i} = \gamma_{l0} + \gamma_{l1}(\text{cohort}_i) + \gamma_{l1}(\text{cov}_i) + \ldots + u_{1i}$

$\beta_{2i} = \gamma_{20}$

Cov = Gender, education, and circulatory diseases.

… mortality-related cognitive change in the last years of life?

Level 1: $\text{ability}_{ti} = \beta_{0i} + \beta_{1i}(\textbf{time-to-death}_{ti}) + \beta_{2i}(\textbf{time-to-death}^2_{ti}) + e_{ti}$

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Cov = Age at assessment, age at death, gender, education, and circulatory diseases.

Research Questions

Do earlier-born (1883–1913) **and later-born cohorts** (1914–1948) **differ in …**

… age-related cognitive change between ages 50 and 80?

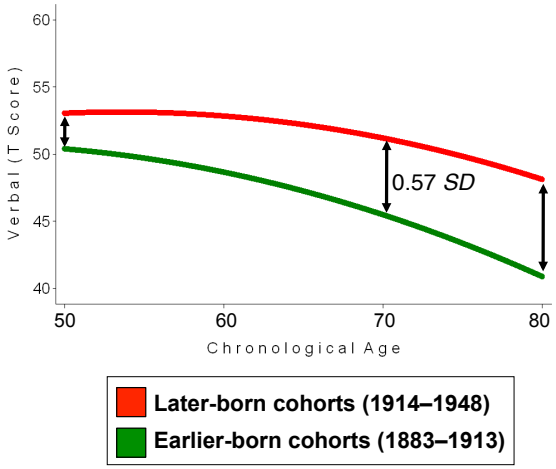
… mortality-related cognitive change in the last years of life?

Cohort Differences in Cognitive Aging: Higher Levels and Shallower Rates of Decline among Later-Born Cohorts

	Estimate	SE
Fixed effects		
Intercept	45.490*	0.367
Linear change	– 0.389*	0.021
Quadratic change	– 0.007*	0.001
Cohort	**5.713***	**0.366**
Cohort x linear change	**0.153***	**0.018**
Random effects		
Intercept	44.470*	1.864
Linear change	0.004*	0.001
Intercept, lin. change	0.285*	0.066
Residual	19.660*	0.575

Note. * $p < .01$

Crystallized Abilities:
Verbal Meaning



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Cohort Differences in Cognitive Aging:
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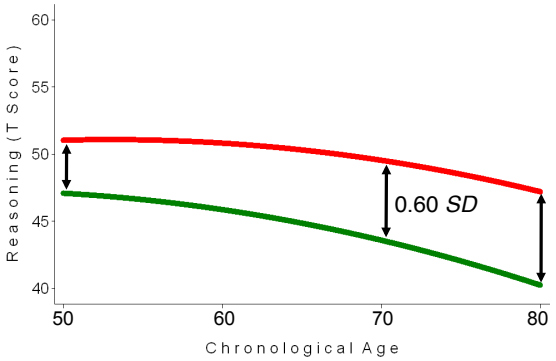
Fluid Abilities:
Inductive Reasoning



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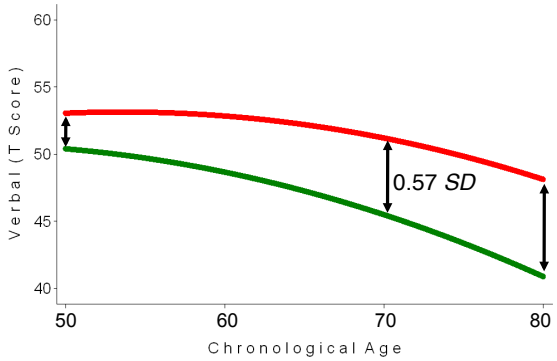

Later-born cohorts (1914–1948)
Earlier-born cohorts (1883–1913)

Note. Models include gender, education, and circulatory diseases.

Cohort Differences in Cognitive Aging:
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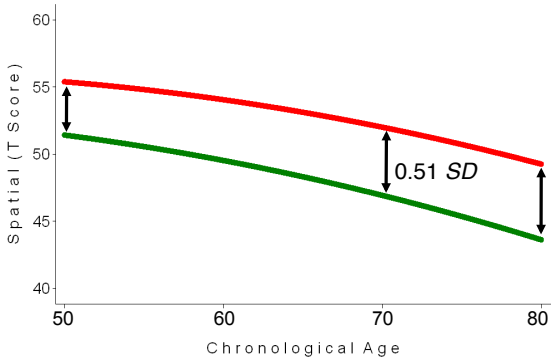
Fluid Abilities:
Spatial Orientation



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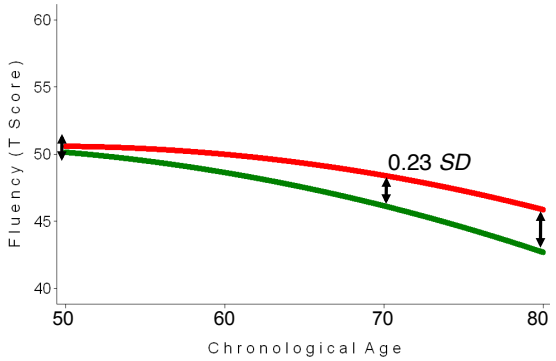
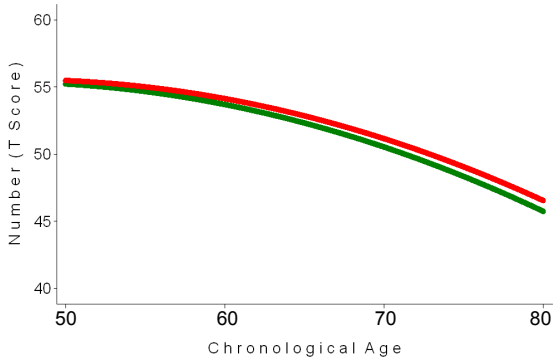
Fluid Abilities:
Word Fluency



Crystallized Abilities:
Number



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… age-related cognitive change between ages 50 and 80?

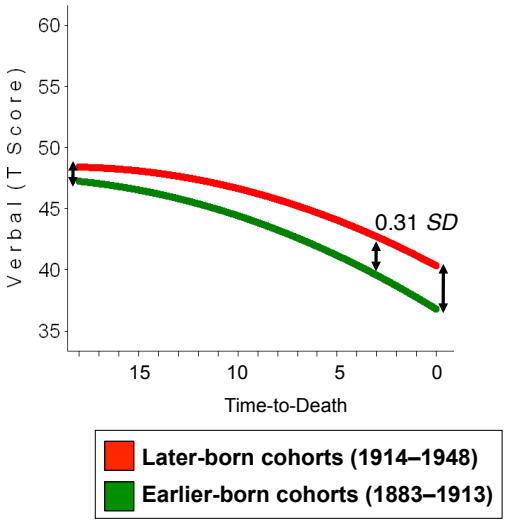
… mortality-related cognitive change in the last years of life?

Cohort Differences in Cognitive Dying:

	Estimate	SE
Fixed effects		
Intercept	39.579*	0.689
Linear change	– 0.856*	0.059
Quadratic change	– 0.023*	0.002
Cohort	**3.149***	**0.797**
Cohort x linear change	**0.133***	**0.044**
Random effects		
Intercept	55.787*	3.800
Linear change	0.081*	0.013
Intercept, lin. change	1.377*	0.191
Residual	18.001*	0.854

Note. * $p < .01$

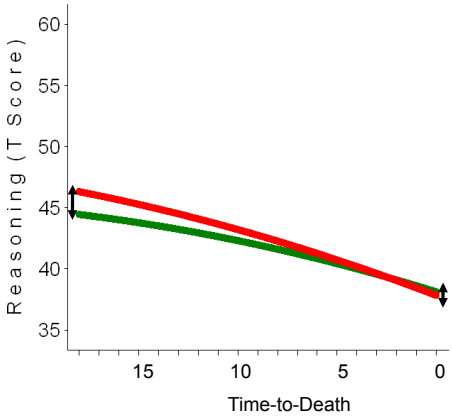
Crystallized Abilities:
Verbal Meaning



Note. Models include age at assessment, age at death, gender, education, and circulatory diseases.

Cohort Differences in Cognitive Dying:
Little evidence for positive cohort differences

Fluid Abilities:
Inductive Reasoning



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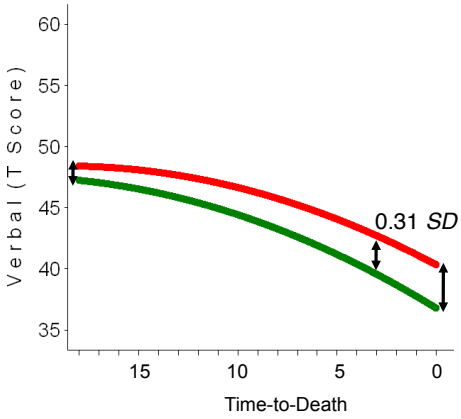

Later-born cohorts (1914–1948)
Earlier-born cohorts (1883–1913)

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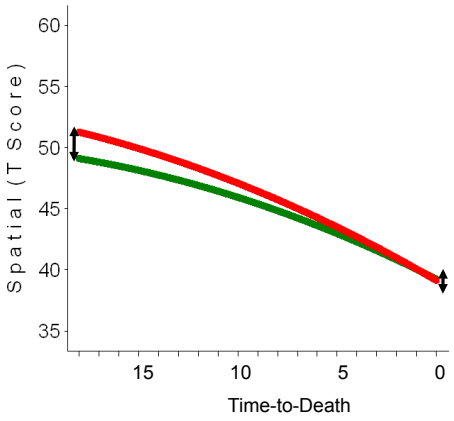
Cohort Differences in Cognitive Dying: Little evidence for positive cohort differences

Fluid Abilities:
Spatial Orientation



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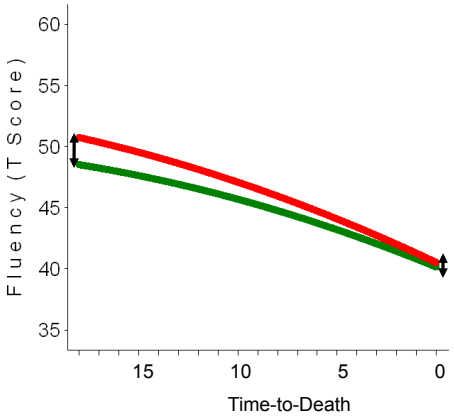

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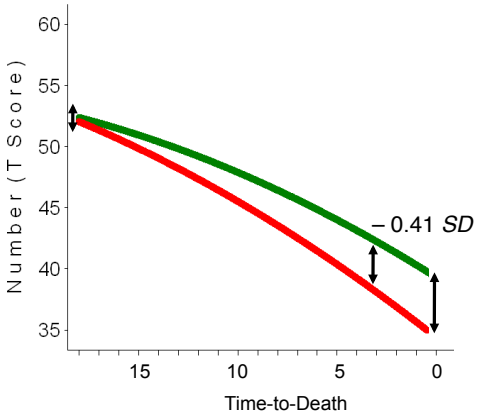

Later-born cohorts (1914–1948)
Earlier-born cohorts (1883–1913)

Note. Models include age at assessment, age at death, gender, education, and circulatory diseases.

Summary

Do earlier-born (1883–1913) **and later-born cohorts** (1914–1948) **differ in …**

… age-related cognitive change between ages 50 and 80?

– except for Number, results consistent across abilities

– at age 70, higher levels for later-born cohorts (0.5+ *SD*)

– shallower age declines for later-born cohorts **(--> differences get magnified)**

– net of education, circulatory diseases, and gender

… mortality-related cognitive change in the last years of life?

– except for Verbal, no evidence for positive cohort differences net of age, education, circulatory diseases, and gender

– steeper mortality declines for later-born cohorts **(--> differences get diminished)**

Cohort Differences in Cognitive Aging and Dying

Cognitive aging

❑ **Sizeable effects across 30 years of life during which age declines are expected; cohort may act as a proxy for moderators** (e.g., slows the rate of cognitive aging)

❑ **Discrepant pattern on Number** (Schaie, 1994)**: those born earlier trained arithmetic abilities more during (elementary) school**

Cognitive dying

❑ **Pervasive processes leading to death counteract previous cohort differences; verbal ability as the strongest positive secular effect not washed out**

❑ **Secular trends do NOT generalize to a vulnerable segment of society; compression vs. expansion of morbidity?**

❑ **Effects of mortality selection?**

Cohort Differences in Cognitive Aging and Dying

Some caveats

- **Sample drawn from an HMO may not be (equally) representative of the cohorts**
- **Statistical power differences between age and mortality models** (7-year intervals)
- **Defining cohort:** time-based (broad – specific) vs. event-based
- **Disregard within-cohort heterogeneity and changes therein**

Open Questions

- **Implications for processes of aging and dying among Baby Boomers?**
- **Other abilities** (e.g., memory) **or purer fluid measures** (e.g., brain efficiency)**?**
- **Do findings generalize to advanced ages** (age 80+)**?**
- **Covariates:** Quantifying effects? Further factors (e.g., technology, occupation)?
- **Cohort differences in multivariate profiles of functioning and change?**