Cohort effects in the association between education and cognitive functioning at older ages. Evidence from Europe and Korea

Anja Leist, Jung Hyun Kim

11 September 2025

EAPS Health, Morbidity, and Mortality Working Group Meeting

Belval, Luxembourg

Motivation

- Education stimulates cognitive development and is associated with higher later-life cognitive functioning.
- Across birth cohorts, different secular changes in offering education (selectivity, quality…) may be associated with changes in the role of education for cognition
- U.S. data suggest a decreasing association between education and cognitive functioning across cohorts.
- We investigate to which extent birth cohorts may have been benefitting differently from education in Europe and Korea.

Key take-home messages

Cohort trends in education:

- Earlier-born cohorts had lower average educational attainment than later-born cohorts.
- Women had lower average educational attainment in earlier-born cohorts than men.
- Korean earlier-born cohorts had lower educational attainment than those in Europe, but both contexts experienced strong educational expansion across cohorts.

Key take-home messages

Cohort trends in the education-cognition relationship:

- Across observed cohorts born 1920-1965, earlier-born cohorts show stronger associations between education and cognition than later-born ones.
- These result patterns are to a large extent driven by the female subsample.
- Education-health relationships across cohorts follow different patterns.
- Results are robust to adjusting for assets and physical activity only in the European sample.

Education and cognitive functioning

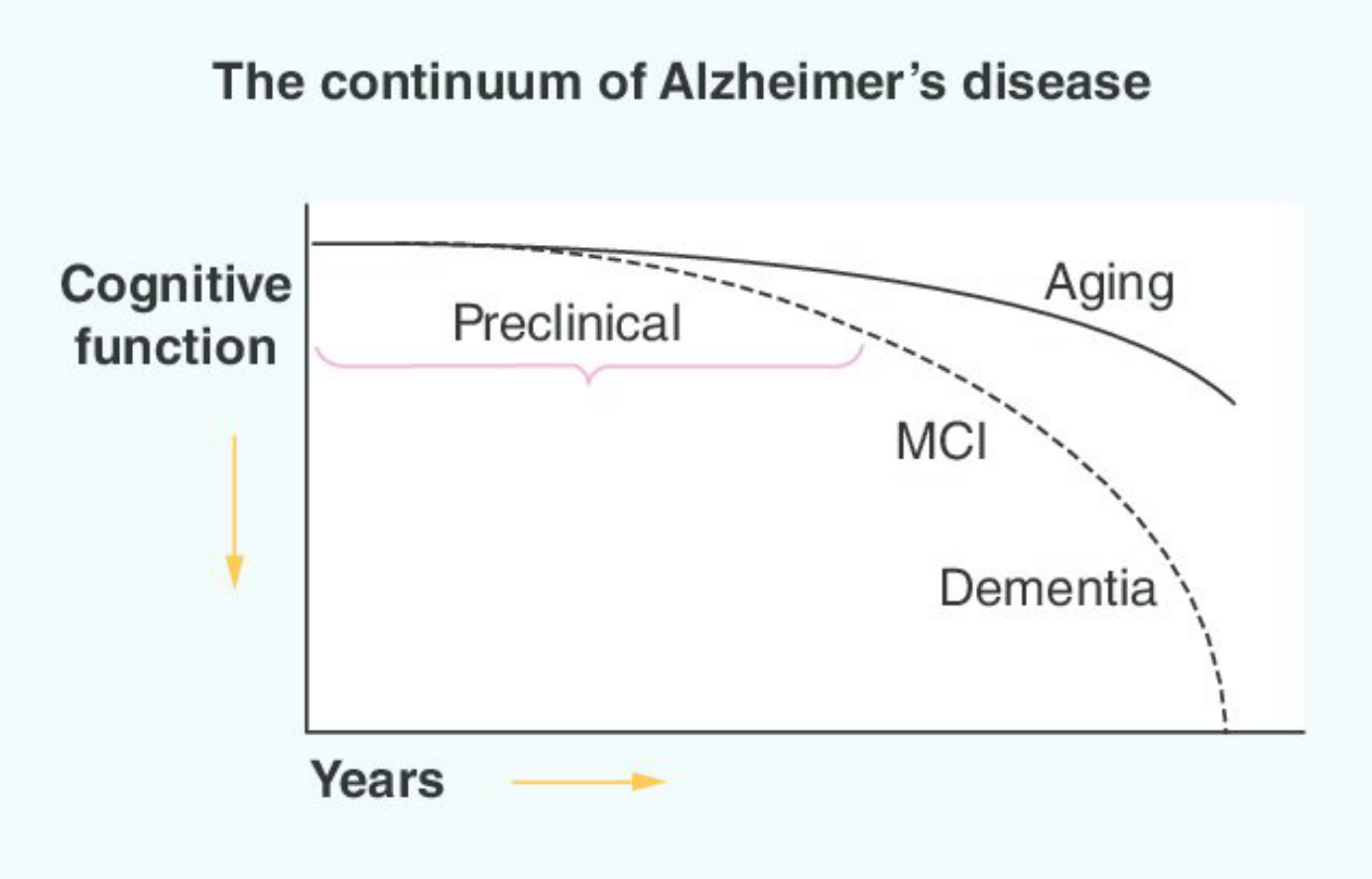


Figure credit: DOI: 10.2217/bmm.14.42

- Investigating cognitive functioning in later life, education is associated with higher initial level of cognition; however mixed findings on its role for cognitive trajectories
- Cognitive development in adulthood strongly determined by quality and intensity of education (Lövdén et al., 2020); cf. cognitive reserve (Stern, 2002)
- Changes in compulsory schooling beneficial for later-life cognition (Glymour et al., 2008; Schneeweis et al., 2014)

Background

- The Flynn effect describes the increases in average levels of cognition across cohorts and has been demonstrated in several contexts, e.g., United States (Gerstorf et al., 2011), Netherlands (Brailean et al., 2018), and Finland (Munukka et al., 2021).
- Secular changes being partly driven by more favorable health and education profiles of later-born cohorts (Hessel et al., 2018).
- Eng et al. (2023) found stronger associations between education and cognitive functioning among earlier-born birth cohorts in the United States

Brailean, A et al. (2018). doi: 10.1093/geronb/gbw129
Gerstorf, D et al. (2011). doi: 10.1037/a0023426
Munukka, M et al. (2021). doi: 10.1007/s40520-020-01702-0
Hessel, P et al. (2018). doi: 10.1136/jech-2017-209979
Eng, C et al. (2023). doi: 10.1002/alz.080328

Why should there be a cohort effect in the association between education and cognition?

Possible mechanisms

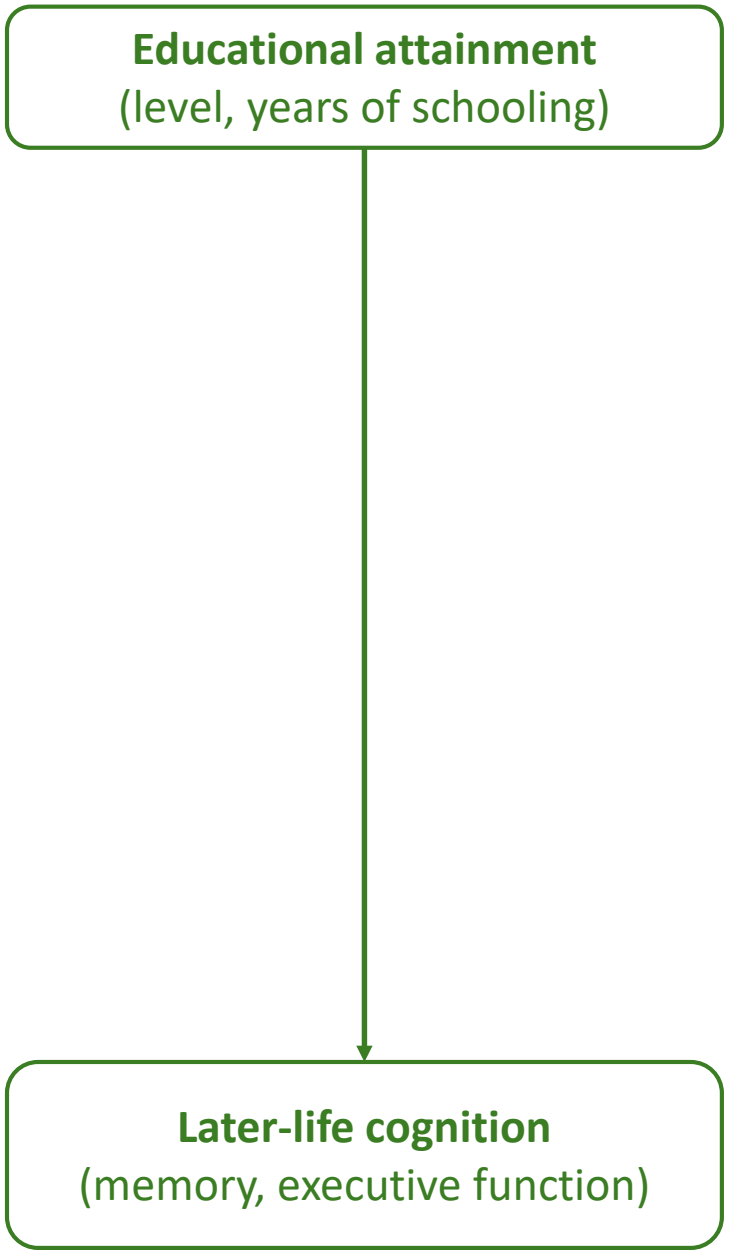
Related to the accessibility and function of **education**:

- Selectivity (who gets access) lower in later-born cohorts
- Policies on formal education (e.g. length of compulsory schooling) more favourable in later-born cohorts
- Quality and content of schooling more favourable in later-born cohorts

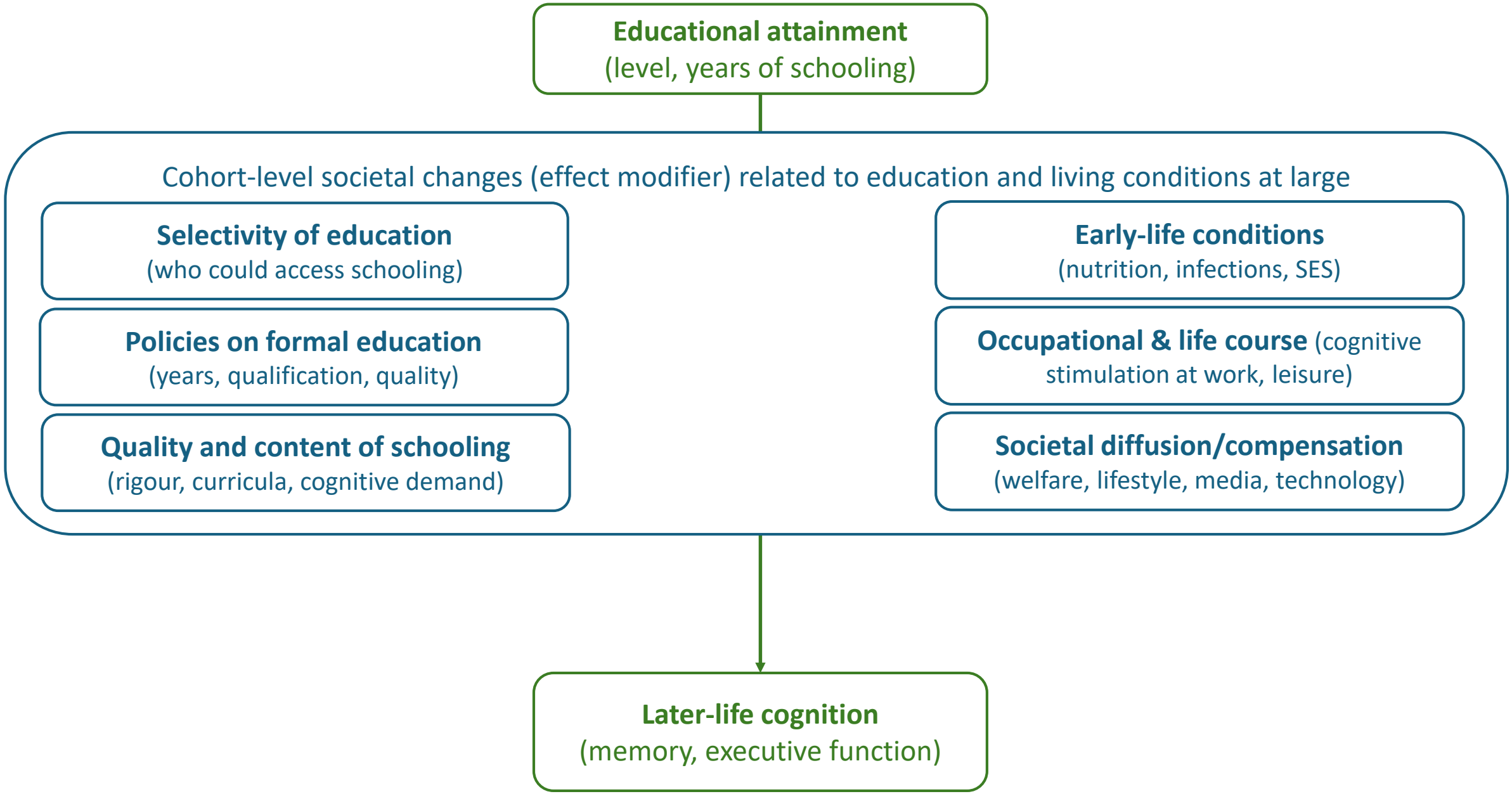
Related to **living conditions** at large:

- Early-life conditions (e.g. nutrition) more favourable in later-born cohorts
- Occupational and life-course cognitive stimulation more favourable in later-born cohorts
- Societal diffusion and compensation (e.g. healthcare, welfare, media, technology) more favourable in later-born cohorts

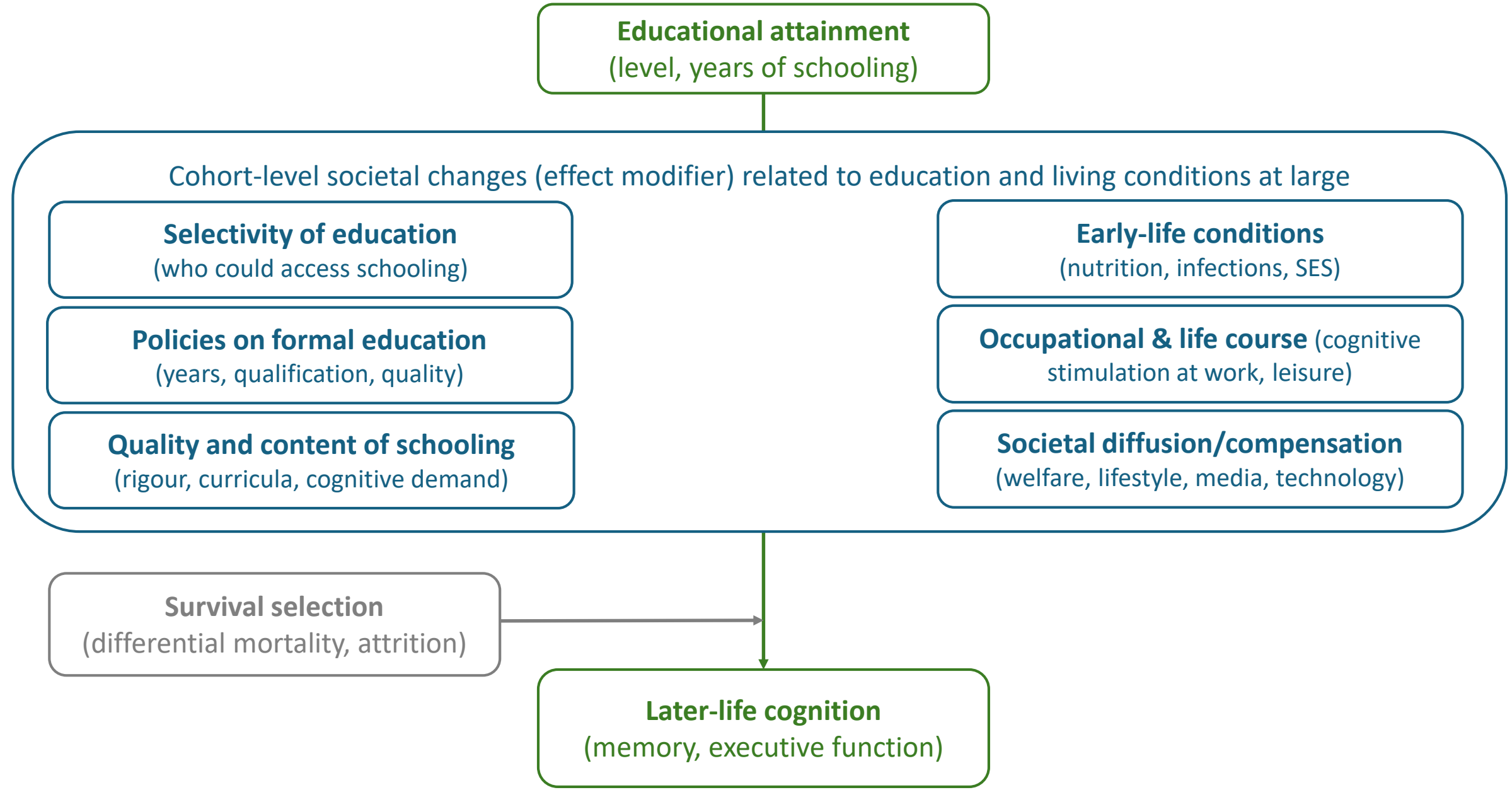
… all these factors may decrease the relative role of education for cognitive development.



Notes. Boxes in blue represent conceptual explanations; box in grey represents a methodological explanation. Arrows indicate plausible causal or mediating paths.



Notes. Boxes in blue represent conceptual explanations; box in grey represents a methodological explanation. Arrows indicate plausible causal or mediating paths.



Notes. Boxes in blue represent conceptual explanations; box in grey represents a methodological explanation. Arrows indicate plausible causal or mediating paths.

Method

- Two datasets:
  - Survey of Health, Ageing and Retirement in Europe (SHARE, version Wilkens et al., 2024) from 2004 to 2022, participants aged 50 and older; Cognition assessed through immediate recall (n=147,408 participants; k=430,959 observations)
  - Korean Longitudinal Study of Aging (KLoSA) from 2006 to 2020, participants aged 45 and older, Cognition assessed through K-MMSE (n=10,179; k=57,165)
- Birth cohorts in 5-year increments in line with earlier research
- Mixed-effects models with random intercepts, controlling for age, quadratic age, gender, and survey wave; additionally in SHARE: birthplace and country.

Table 1: Baseline characteristics of participants in SHARE and KLoSA

Variable	**SHARE**	**KLoSA**
Age, mean (SD)	67.4 (9.93)	64.9 (10.3)
Female, %	56.5%	57.9%
Education, %		
Elementary or below	17.4%	40.4%
Middle school	18.3%	17.0%
High school	31.5%	31.0%
College or more	32.9%	11.6%
Cognitive Score, mean (SD)		
Immediate word recall	5.15 (1.84)	-
MMSE	-	25.8(4.88)
Observations	433,011	50,320

Notes: SHARE: Survey of Health, Ageing and Retirement in Europe, KLoSA: Korean Longitudinal Study of Aging.

Cohort-age distributions

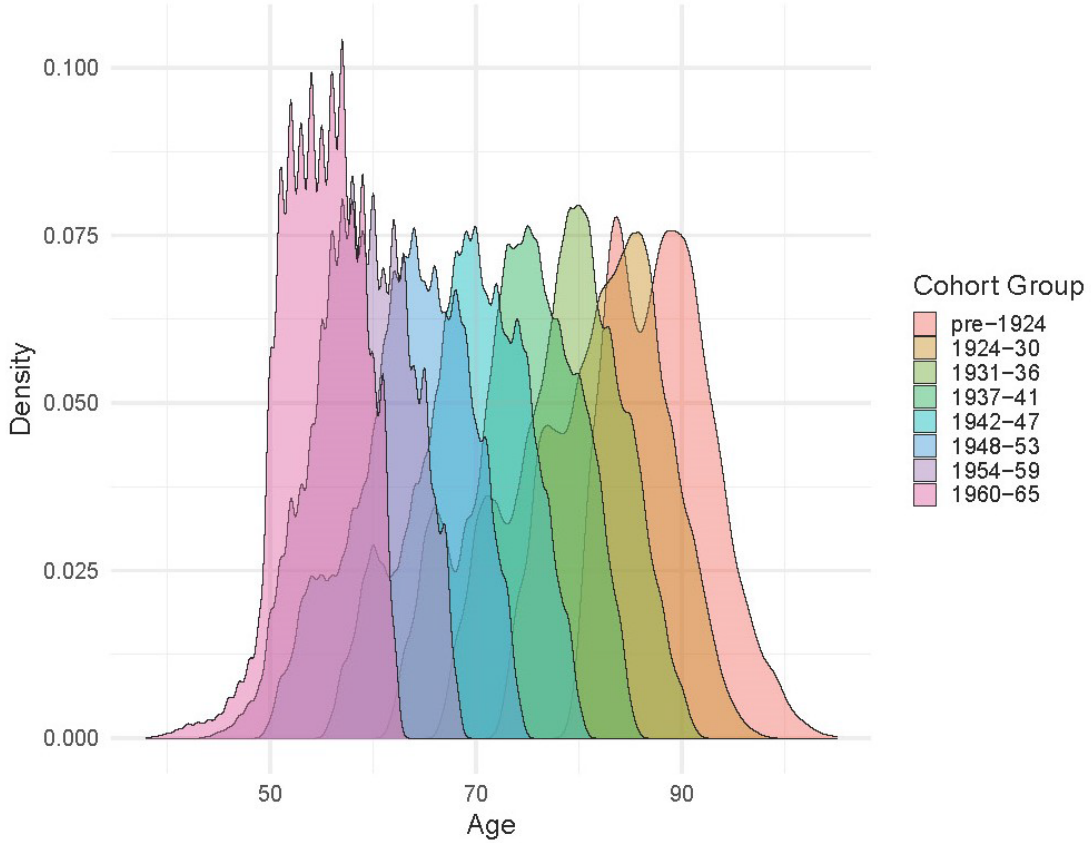


Figure 1: Age distribution across birth cohorts - SHARE

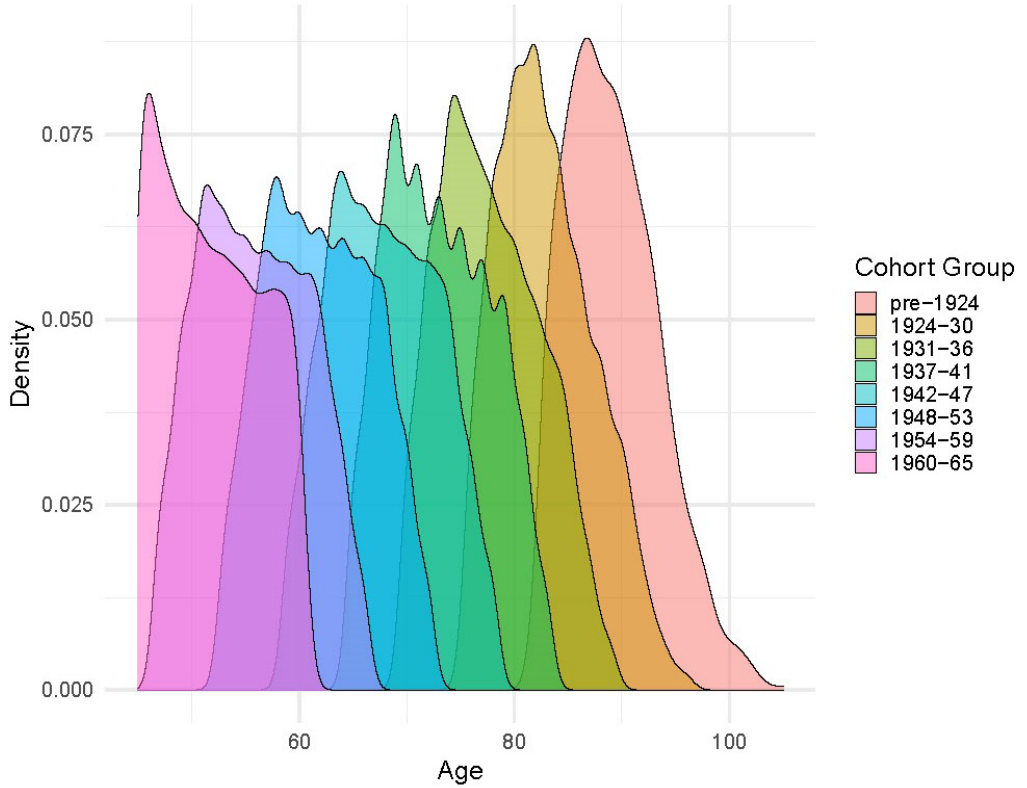


Figure 2: Age distribution across birth cohorts - KLoSA

Educational attainment across cohorts, SHARE and KLoSA

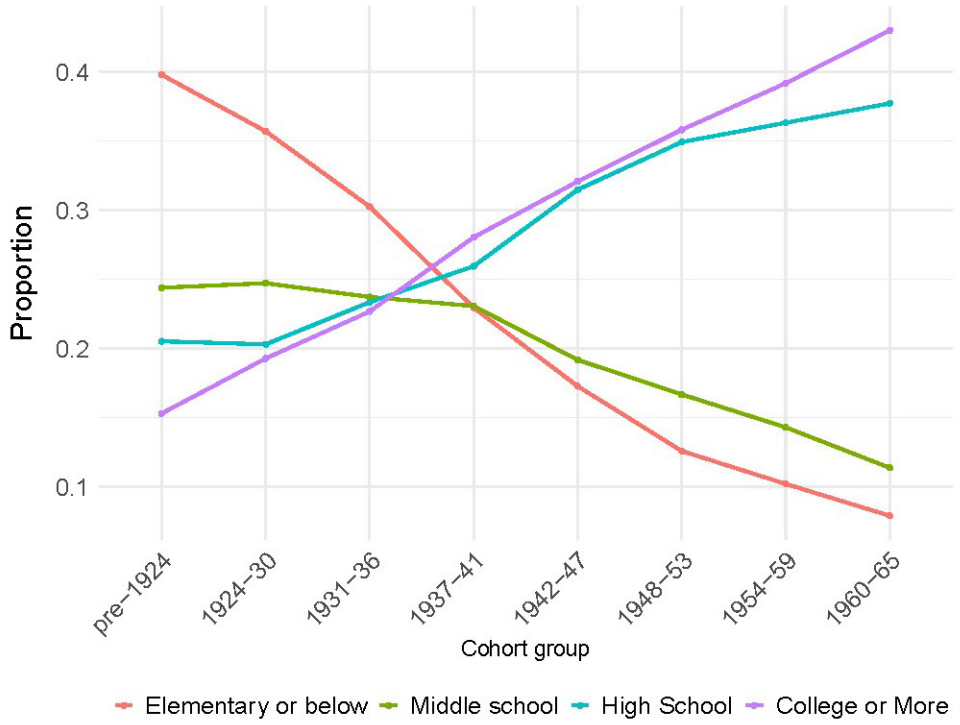


Figure 1: Trend in proportion of education attainment by birth cohort - SHARE

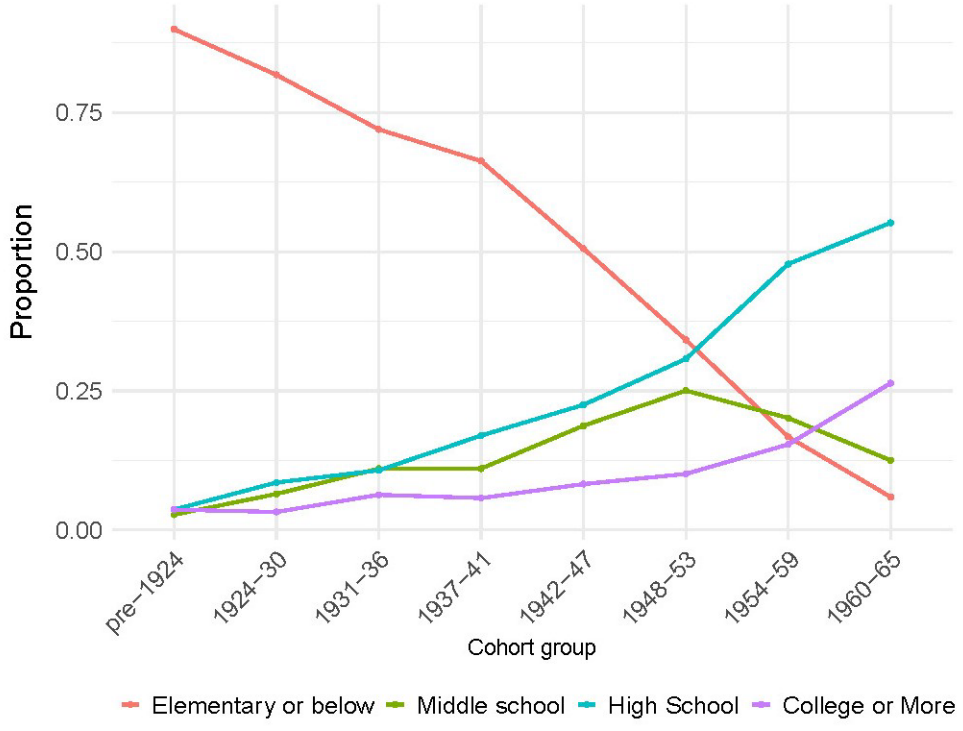


Figure 2: Trend in proportion of education attainment by birth cohort - KLoSA

Results

- SHARE: Individuals born before 1924 showed on average a 0.045 SD (95% CI: 0.034, 0.057) larger association between education and memory compared to those born between 1960 and 1965.
- KLoSA: The earliest-born birth cohorts had a 2.646 SD (95% CI: 1.963, 3.329) higher association between education and MMSE-assessed cognition compared to the youngest cohort.

Results

Table 2: Interaction effects between education and birth cohort on memory - SHARE

Birth Cohort	Estimate	Std. Error	95% CI Lower	95% CI Upper	P-value
pre-1924	0.045	0.006	0.034	0.057	<0.001
1924–30	0.037	0.004	0.029	0.045	<0.001
1931–36	0.031	0.004	0.025	0.038	<0.001
1937–41	0.023	0.003	0.017	0.03	<0.001
1942–47	0.019	0.003	0.013	0.026	<0.001
1948–53	0.011	0.003	0.005	0.018	<0.001
1954–59	0.005	0.003	-0.001	0.011	0.116

Note: SHARE: Survey of Health, Ageing and Retirement in Europe. The reference group is the 1960–65 birth cohort. Education refers to education years. Memory is the immediate word recall ranges from 0 to 10.

Results

Table 3: Interaction effects between education and birth cohort on MMSE - KLoSA

Birth Cohort	Estimate	Std. Error	95% CI Lower	95% CI Upper	P-value
pre-1924	2.646	0.348	1.963	3.329	<0.001
1924–30	1.546	0.216	1.121	1.970	<0.001
1931–36	1.111	0.185	0.749	1.474	<0.001
1937–41	0.711	0.178	0.361	1.060	<0.001
1942–47	0.449	0.173	0.109	0.788	0.010
1948–53	0.166	0.173	-0.173	0.505	0.336
1954–59	0.068	0.173	-0.270	0.407	0.692

Note: KLoSA: Korean Longitudinal Study of Aging, MMSE: Mini-Mental State Examination. The reference group is the 1960–65 birth cohort. Educational attainment is categorized into four groups: below elementary school, middle school, high school, and college or beyond. MMSE score ranges from 0 to 30.

Main results: Education-cognition relationships across cohorts, SHARE and KLoSA

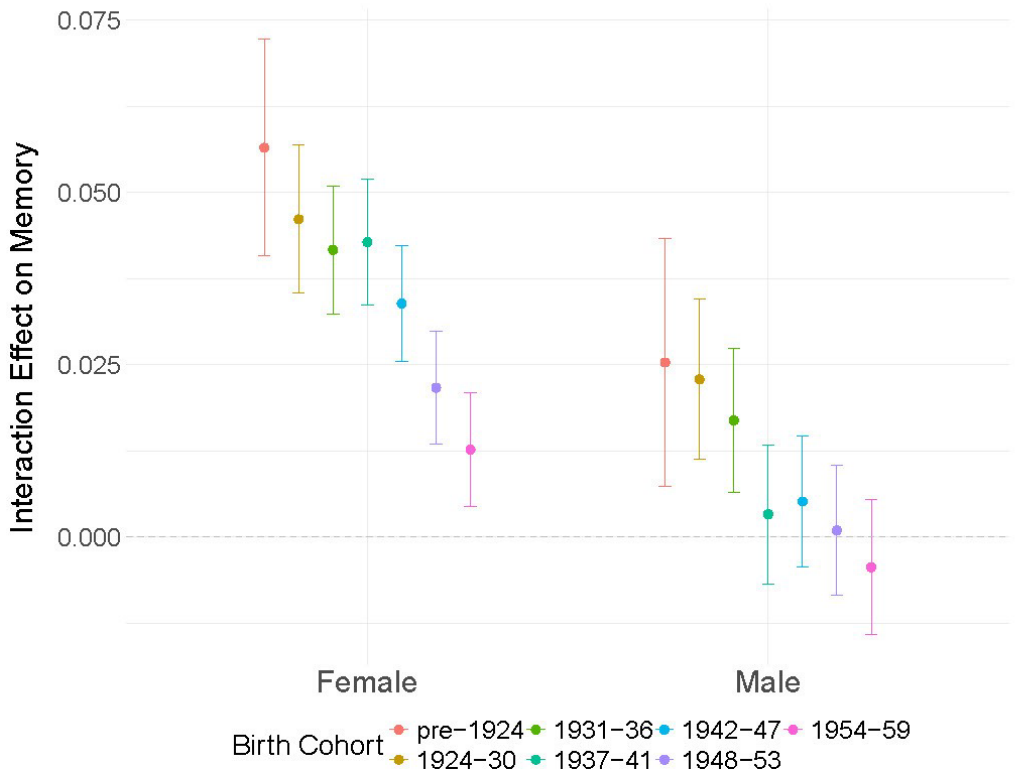


Figure 5: Interaction effect of education and birth cohort by gender - SHARE

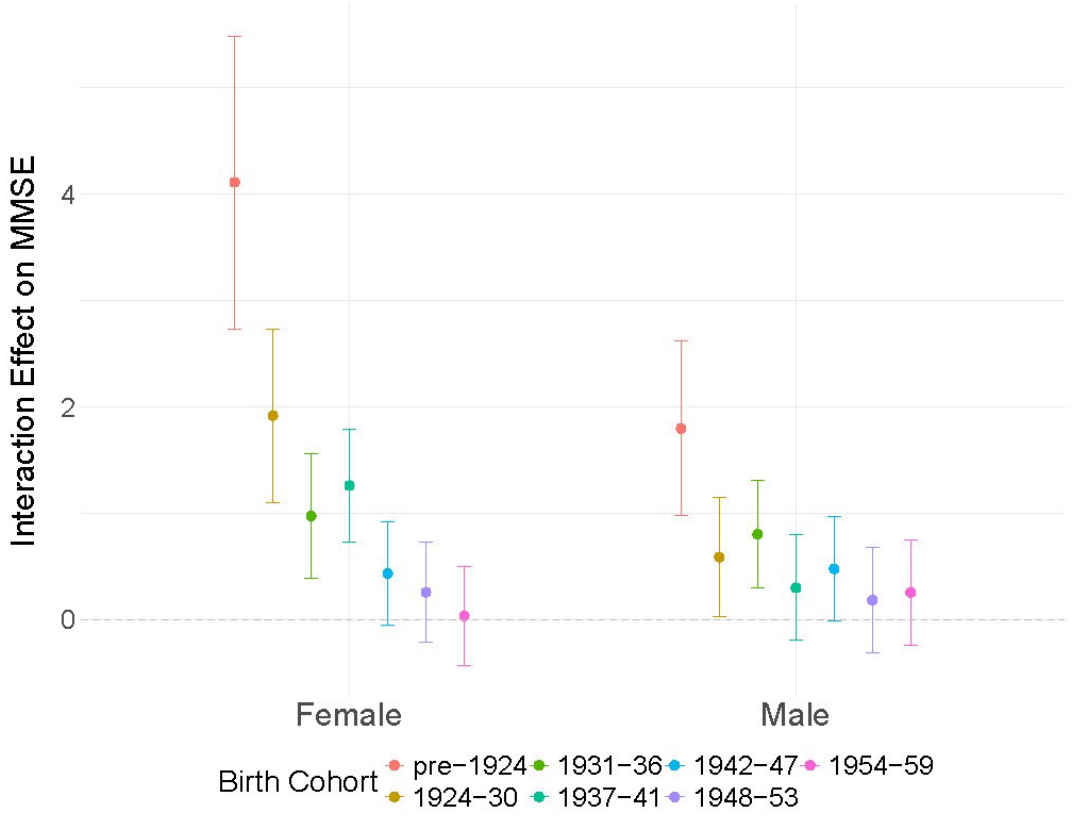


Figure 6: Interaction effect of education and birth cohort by gender - KLoSA

Sensitivity analyses to address selective mortality/attrition: Education-cognition within age brackets, SHARE

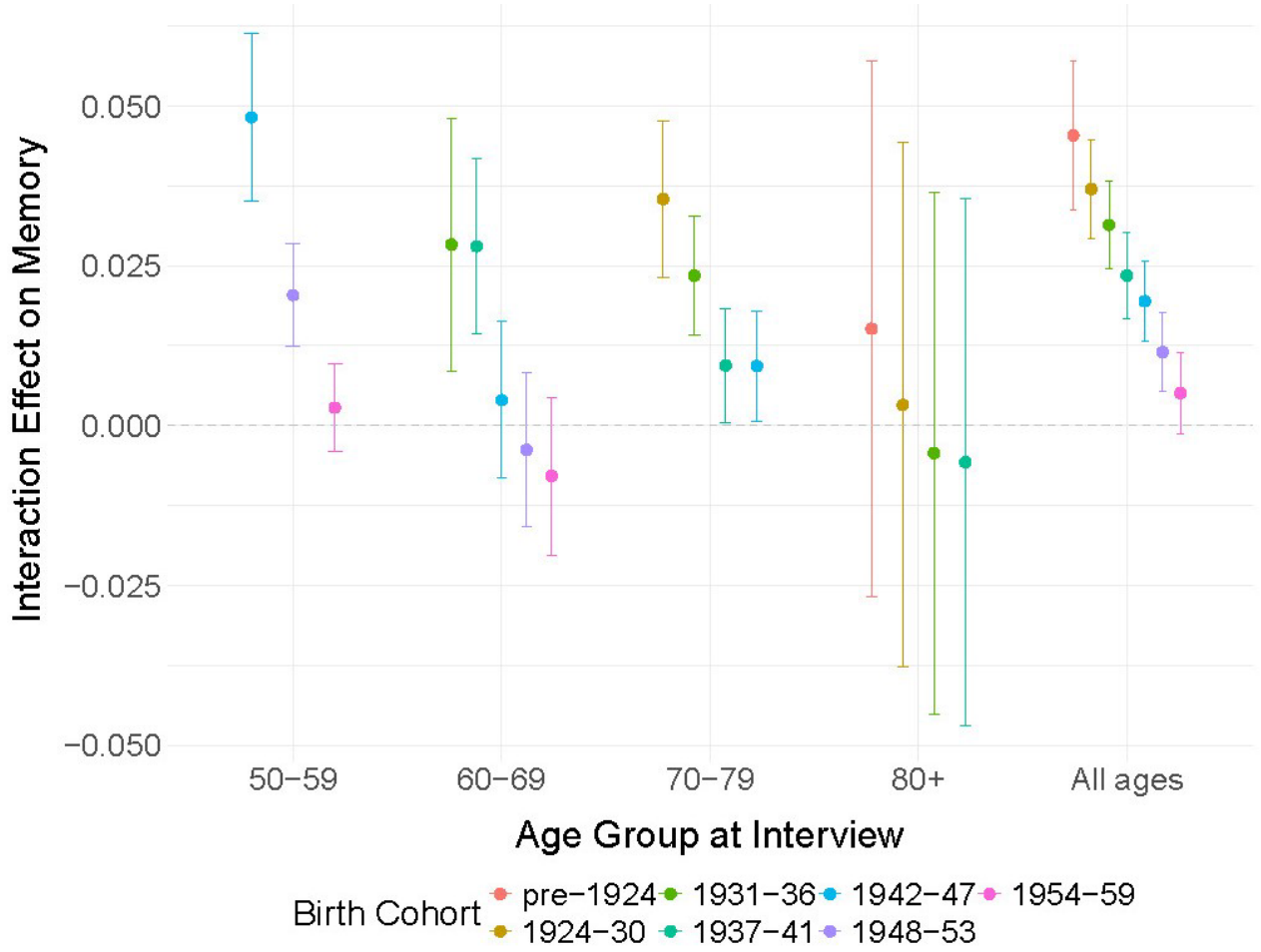


Figure A3: Interaction Effect of Education and Birth Cohort by Age Group - SHARE

Sensitivity analyses to address selective mortality/attrition: Education-cognition within age brackets, KLoSA

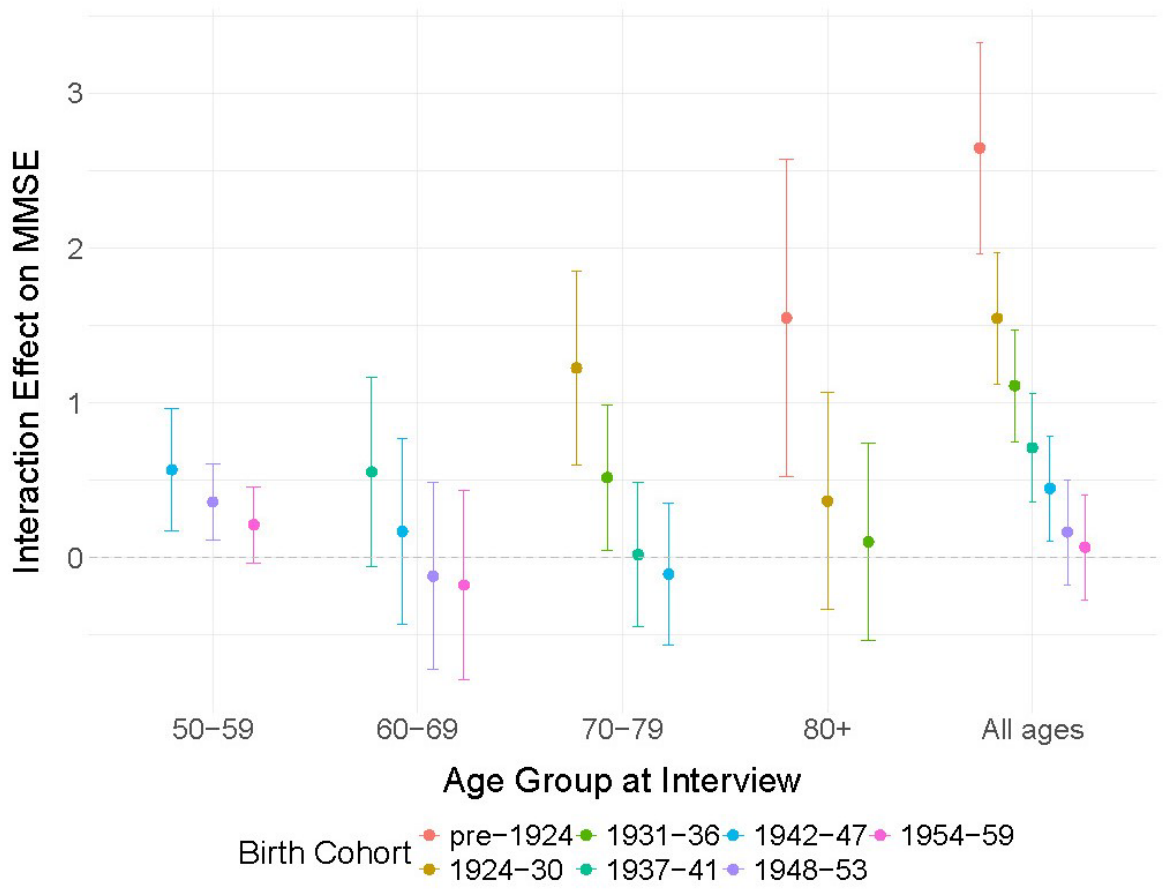


Figure A4: Interaction Effect of Education and Birth Cohort by Age Group - KLoSA

Sensitivity analyses: Controlling for asset levels and physical activity on memory, SHARE

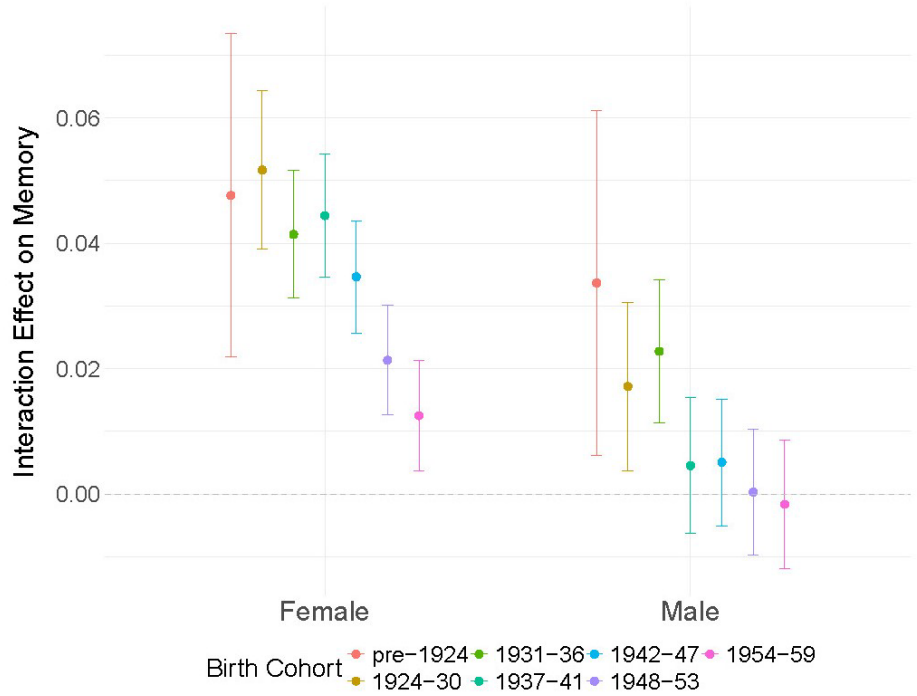


Figure A9: Interaction Effect of Education and Birth Cohort on Memory, controlling for asset level - SHARE

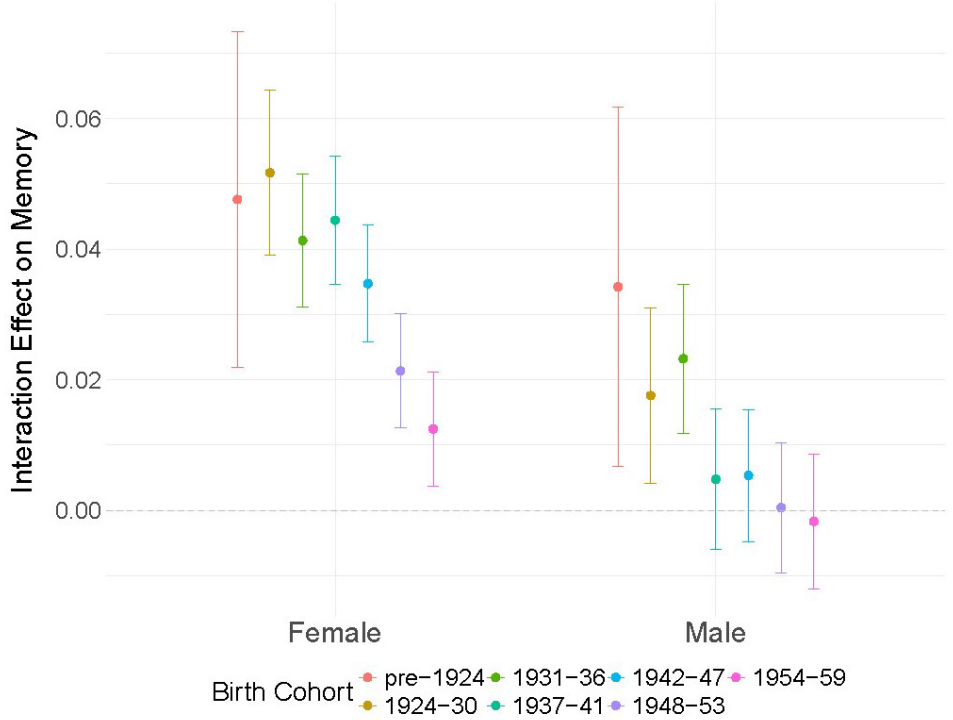


Figure A10: Interaction Effect of Education and Birth Cohort on Memory, controlling for asset level and physical activities - SHARE

Sensitivity analyses: Controlling for asset levels and physical activity on memory, KLoSA

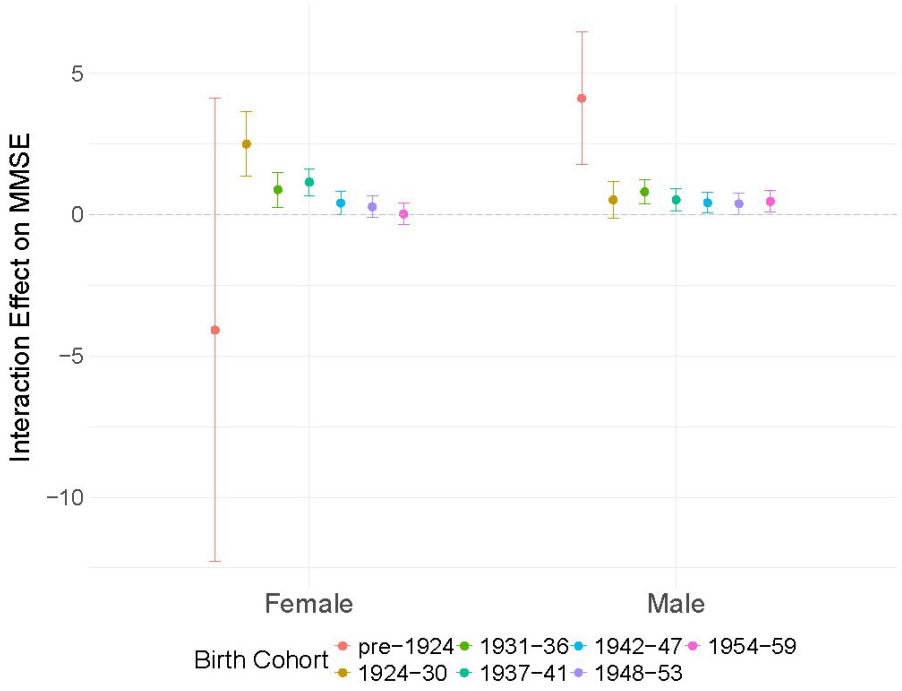


Figure A11: Interaction Effect of Education and Birth Cohort on Cognition, controlling for asset level - KLoSA

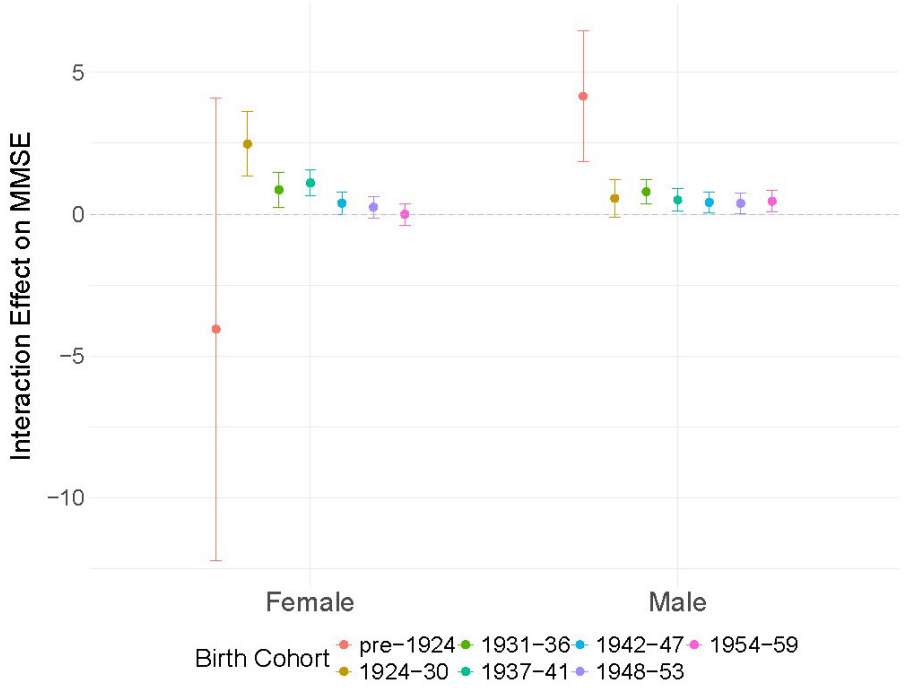


Figure A12: Interaction Effect of Education and Birth Cohort on Cognition, controlling for asset level and physical activities - KLoSA

Sensitivity analyses: Education-health relationships in SHARE and KLoSA

Figure A7: Interaction Effect of Education and Birth Cohort on Self-reported Health - SHARE

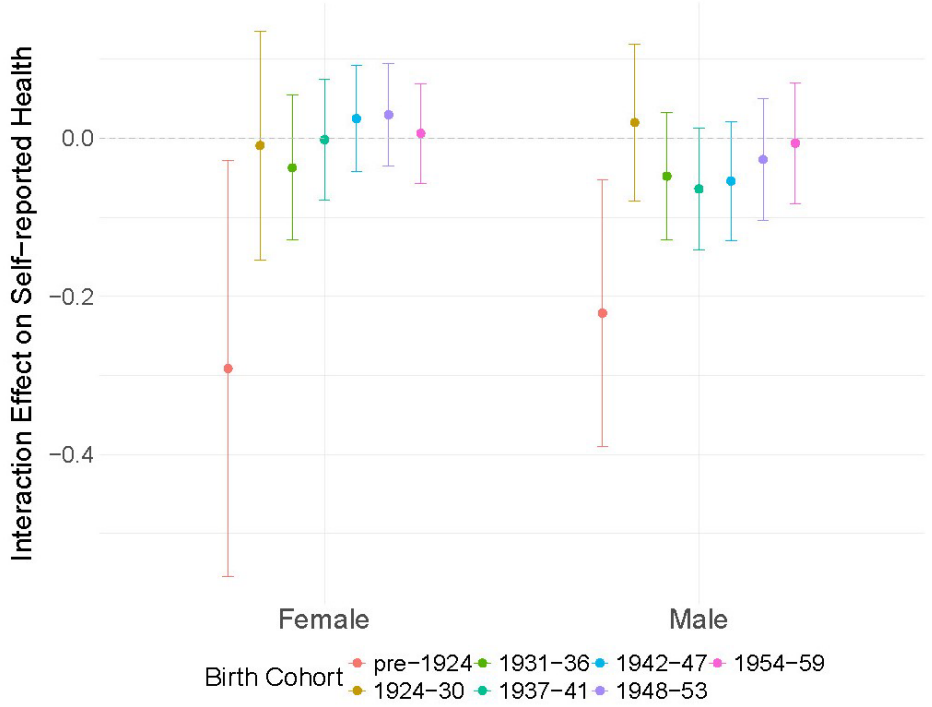


Figure A8: Interaction Effect of Education and Birth Cohort on Self-reported Health - KLoSA

Discussion

- We find a gradient in the education-cognition relationship across cohorts, with strongest associations between education and cognition of the earliest-born cohorts, in both Europe and Korea, confirming earlier findings from the U.S. (Eng et al., 2023).
- General potential of education to contribute to cognitive development (Lövdén et al., 2020), but education also entry for further life-course opportunities for cognitive stimulation, such as occupations with higher occupational complexity (Finkel et al., 2009).
- Women may have been benefitting more from education as their post-education opportunities were more limited than for men (Leist, Bar-Haim, Chauvel, 2021).
- Physical activity and assets were of differential importance in the two contexts.
- Other pathways, e.g., childhood SES (Ford et al., 2022) or life-course leisure activities (Iizuka et al., 2019) not considered here.

Eng C et al. (2023). doi: 10.1002/alz.080328; Leist A, Bar-Haim, Chauvel (2021). doi: 10.1016/j.ssmph.2021.100837. Lövdén M et al. (2020). doi: 10.1177/1529100620920576; Finkel D et al. (2009). doi: 10.1093/geronb/62.5.p286; Ford K, Kobayashi, Leist (2022). doi: 10.1093/geronb/gbac075; Iizuka A et al. (2019). doi: 10.1111/ggi.13671

Discussion

- Education as a positional good (Hirsch, 1976); but distinct relationships of education with later-life cognition as opposed to with later-life health.
- Any alternative explanation on secular changes in schooling, such as quality of education, unlikely to happen simultaneously in U.S., Korea, and Europe.

Limitations

- Observational research design; societal phenomena such as secular improvements in living conditions difficult to assess with exact causal (experimental) methodology.
- Datasets not fully harmonizable due to different assessments of cognition, but coordinated data analysis and interpretation within datasets.

Hirsch, F (1976). Social limits to growth. Harvard University Press.

UNIVERSITÉ DU LUXEMBOURG

Thanks!

anja.leist@uni.lu

junghyunkim@hsph.harvard.edu

Distribution of cognition scores

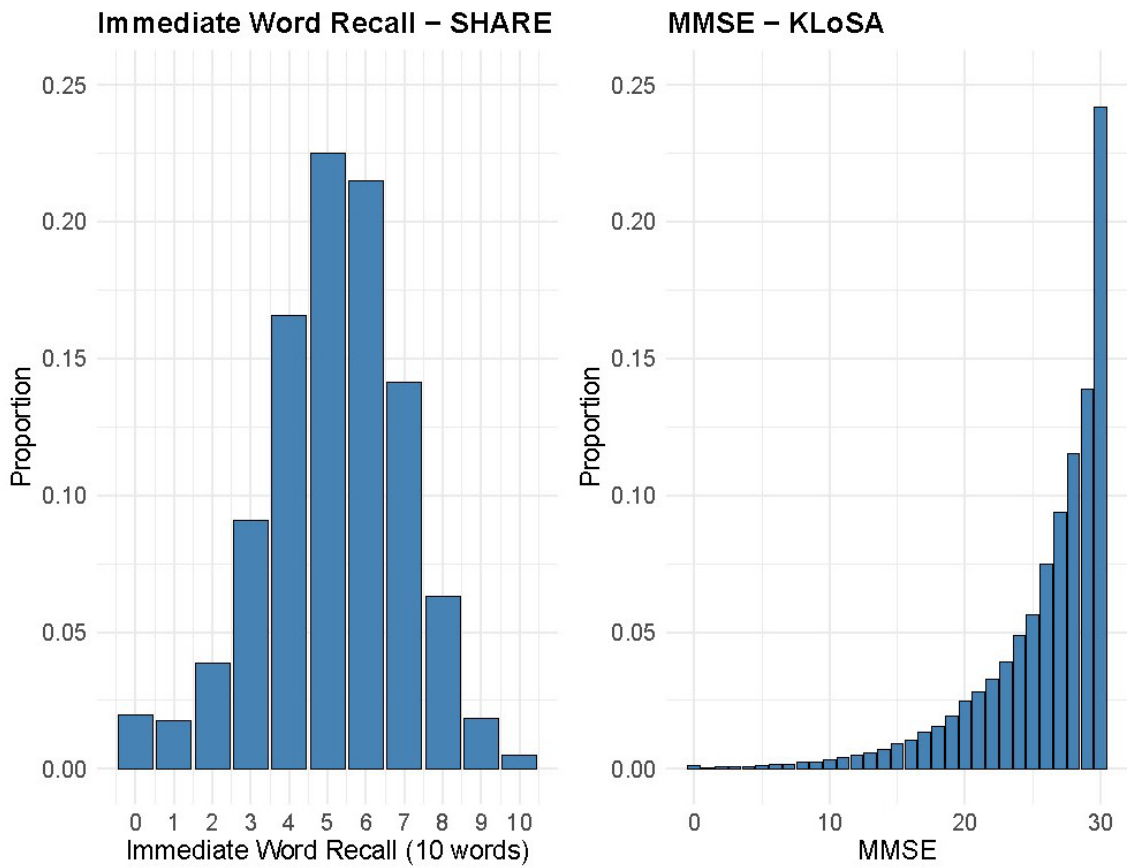


Figure A13: Distribution of Memory Score and MMSE

Education across cohorts separate by gender, SHARE

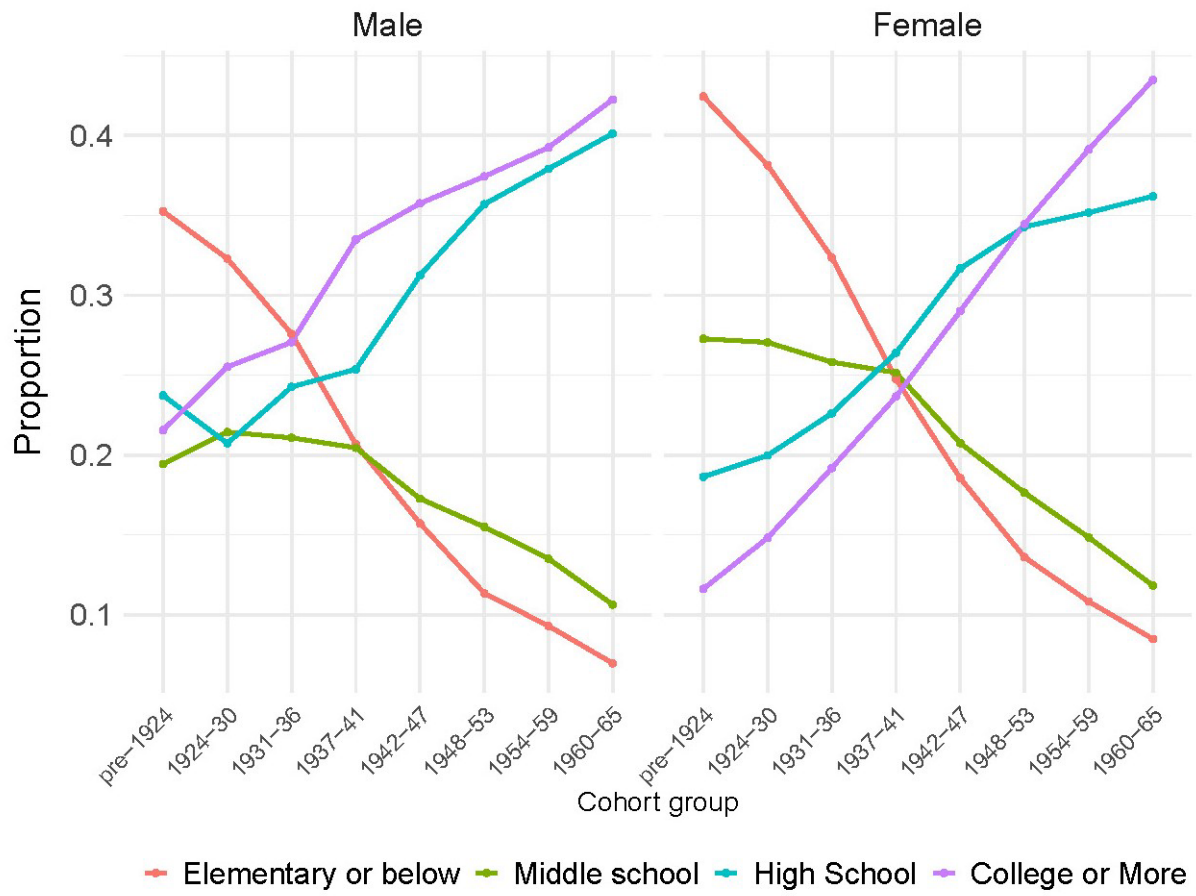


Figure A3: Trend in proportion of education attainment by birth cohort and gender - SHARE

Educational attainment across cohorts separate by gender, KLoSA

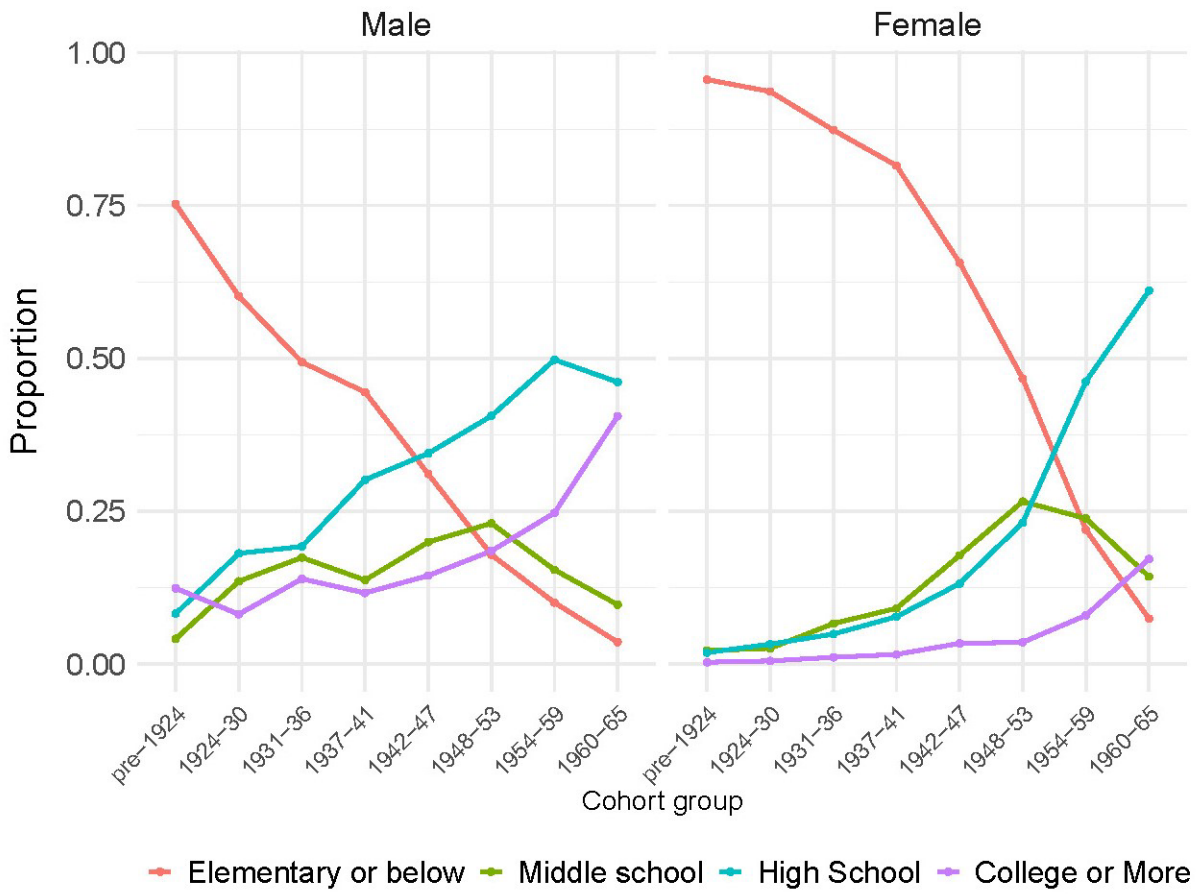


Figure A4: Trend in proportion of education attainment by birth cohort and gender - KLoSA