Reliability of measures in normal cognitive ageing

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ELSA English Longitudinal Study of Ageing

Immediate and delayed word recall

I will now read a set of 10 words. I would like you to recall as many as you can. We have purposely made the list long so it will be difficult for anyone to recall all the words. Most people recall just a few. Please listen carefully to the set of words as they cannot be repeated. When I have finished, I will ask you to recall aloud as many of the words as you can, in any order. Is this clear?

A little while ago, you were read a list of words and you repeated the ones you could remember. Please tell me any of the words that you can remember now.

Research Questions

- It’s a cliché to say that memory declines with age, but what does that mean?

- To what extent does word recall performance vary:
  1. Between persons of different birth date (cohort differences)?
  2. Within-persons over time (ageing)?

- To what extent does the reliability of word recall vary over 1. and 2.?
- What are the influences of practice on 2.?

Cohort /		Waves in which data collected for ages 80-85						
DoB	**(younger)**	**80**	**81**	**82**	**83**	**84**	**85**	**(older)**
1920				2002		2004		**…**
1921			2002		2004		2006	
1922		2002		2004		2006		**…**
1923	**…**		2004		2006		2008	
1924		2004		2006		2008		**…**
1925	**…**		2006		2008		2010	
1926		2006		2008		2010		
1927	**…**		2008		2010			
1928		2008		2010				
1929	**…**		2010					
1930		2010						
1931	**…**							
…								

Structural Equation Latent Growth Model

Classical "True Score" Model: $Y_i(t) = \Theta_i(t) + \epsilon_i(t)$

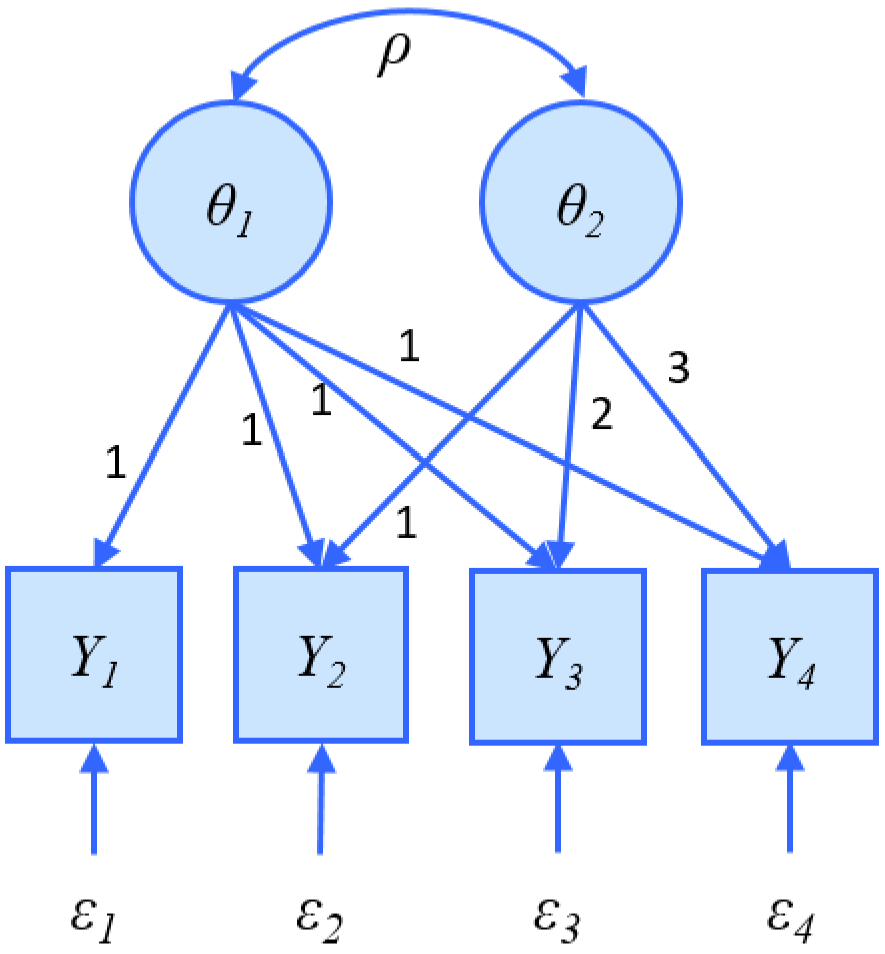
Latent Growth, Structural Model: $\Theta_i(t) = \theta_{1i}(t^*) + \theta_{2i}(t - t^*) + \theta_{3i}(t - t^*)^2$

Where:

$Y_i(t)$ = observed score Y from person i at age t
$\Theta_i(t)$= latent 'true" score for person i at age t
$\epsilon_i(t)$ = error of measurement for person i at age t

$\theta_{1i}(t^*)$ = common origin to which age is scaled, i.e. growth **Intercept**
$\theta_{2i}(t - t^*)$ = Linear change in true score from the origin to age t, i.e. linear **Slope**
$\theta_{3i}(t - t^*)^2$ = change squared, i.e. **quadratic** component of the slope

Measurement model



Item intercepts set to zero (for identification)

Factor loadings for growth intercept set to 1

Factor loadings for linear slope shown here reflect linear change by wave, but this is wrong – we need to set them to age (centred on 60 years) (Mehta & West, 2000).

"Accelerated" cohorts

Age/wave is different for each cohort

So 32 separate measurement models needed

Cohort / Date of Birth	**Age in each wave**				
	Wave 1 2002	**Wave 2 2004**	**Wave 3 2006**	**Wave 4 2008**	**Wave 5 2010**
1920	82	84	86	88	90
1921	81	83	85	87	89
1922	80	82	84	86	88
1923	79	81	83	85	87
1924	78	80	82	84	86
…	…	…	…	…	…
1947	55	57	59	61	63
1948	54	56	58	60	62
1949	53	55	57	59	61
1950	52	54	56	58	60
1951	51	53	55	57	59
1952	50	52	54	56	58

Model Estimation

- Each birth cohort treated as a separate group, with its own set of linear and quadratic slopes, appropriate for its cohort/wave
- Quadratic slope variances set to zero
- Intercept and slope variances, and their covariance, fixed equal across cohorts
- Parameter restrictions applied across groups to evaluate the ‘best’ model for the growth factors and the residual variances
- Models estimated in Mplus by Maximum Likelihood
- Separate models for females and males (McCarry et al. 2016)

Model Selection

Latent growth factors

IS = (latent) **I**ntercept, linear **S**lope

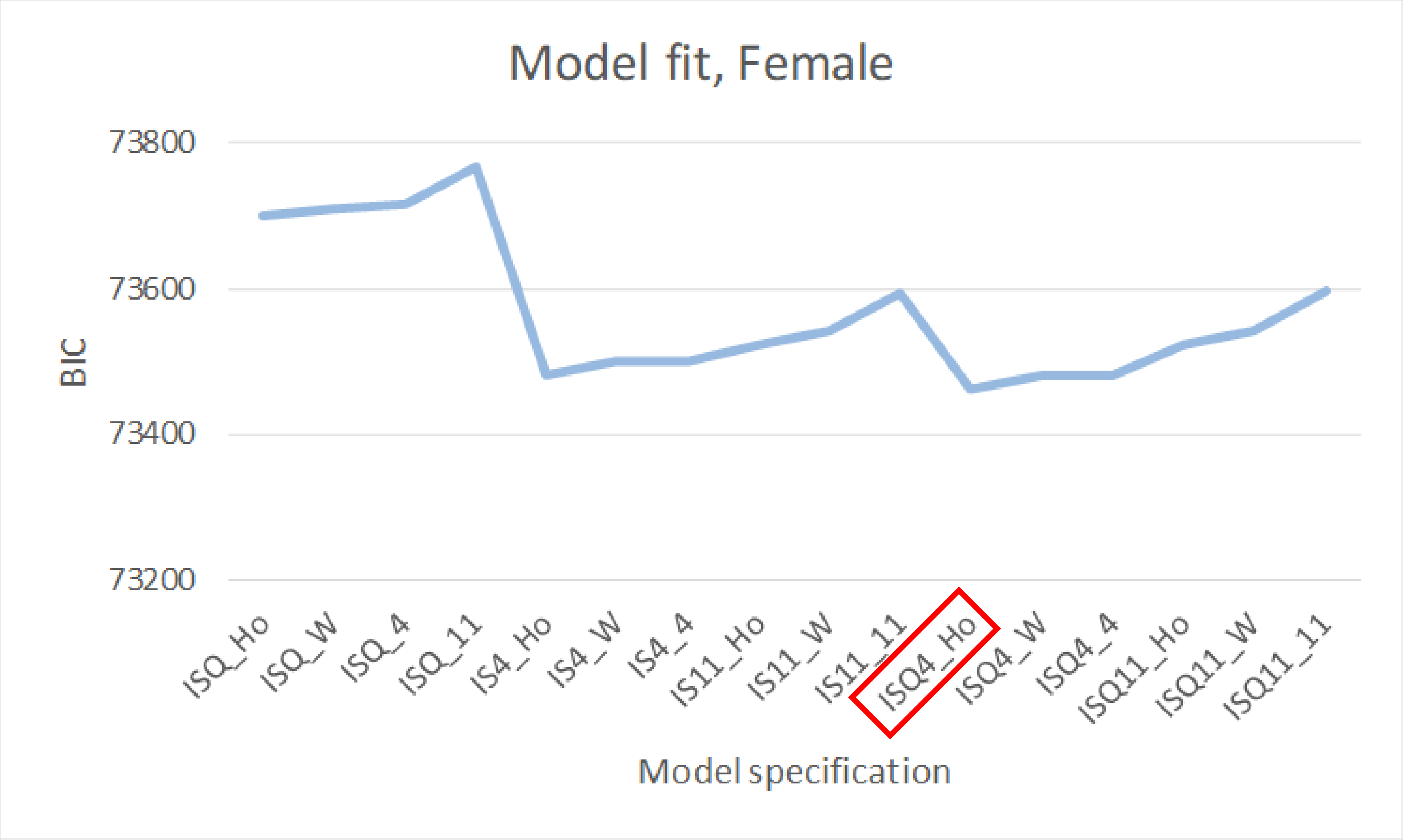
ISQ = **I**ntercept, linear **S**lope, **Q**uadratic Slope

ISQ4 = I, S, Q means free over 4-category cohort

ISQ11 = I, S, Q means free over 11-category cohort

Occasion-specific variance

_Ho = **ho**moscedastic
_W = heteroscedastic by **w**ave
_4 = heteroscedastic by **4**-category cohort
_11 = ... by 1**1**-category cohort



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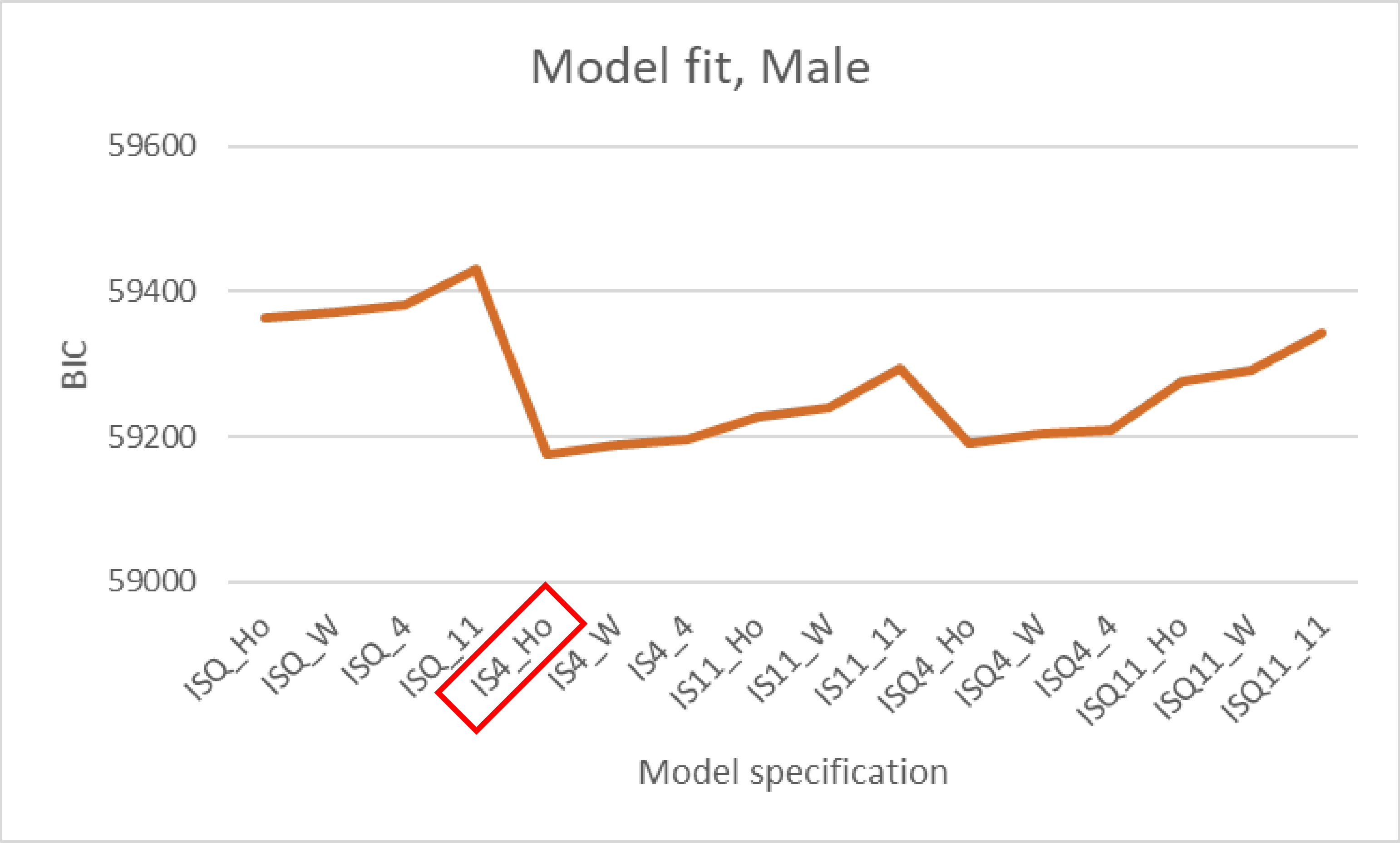
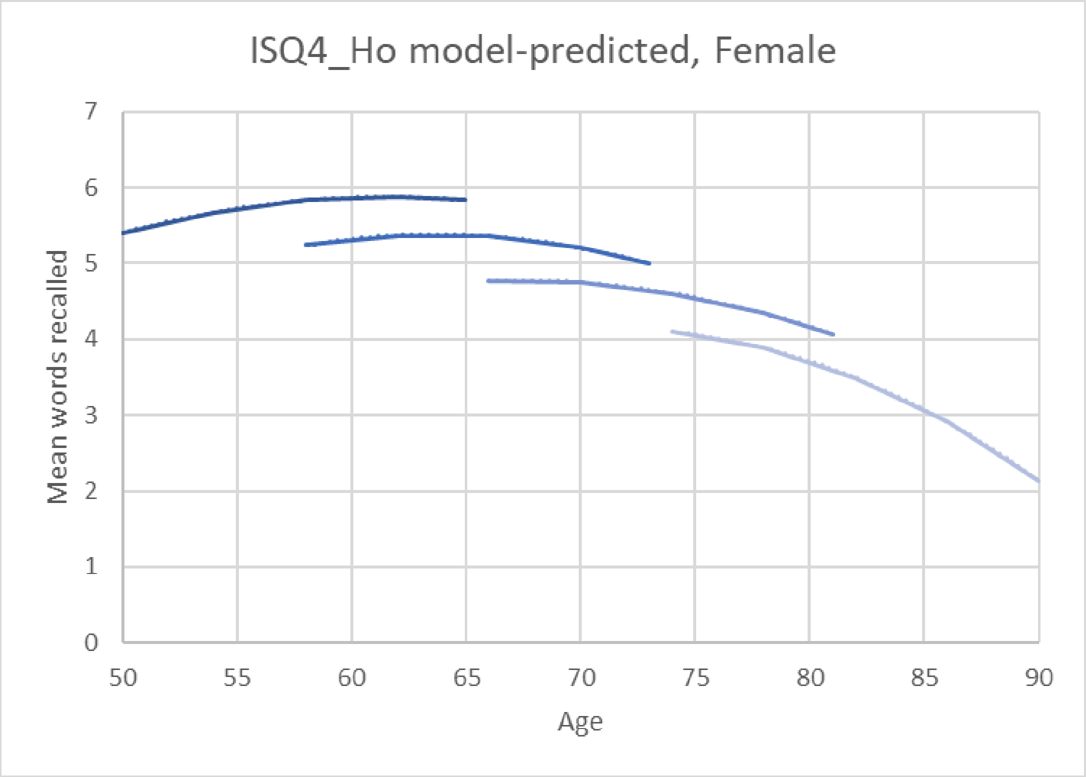
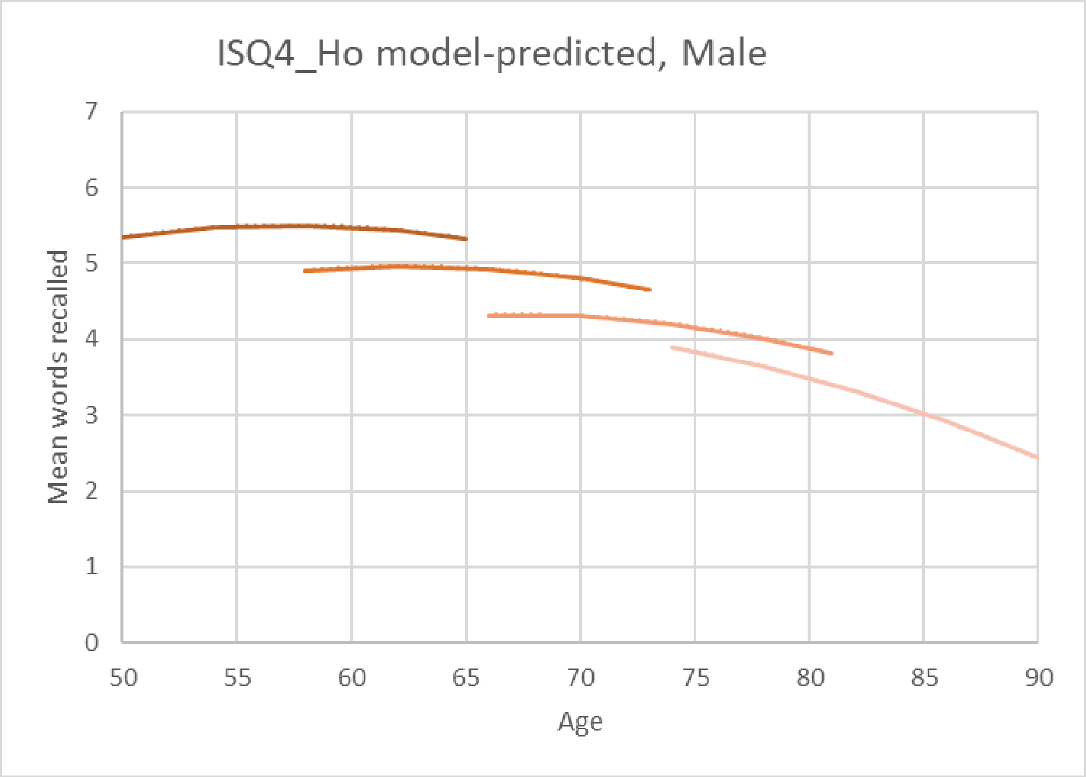


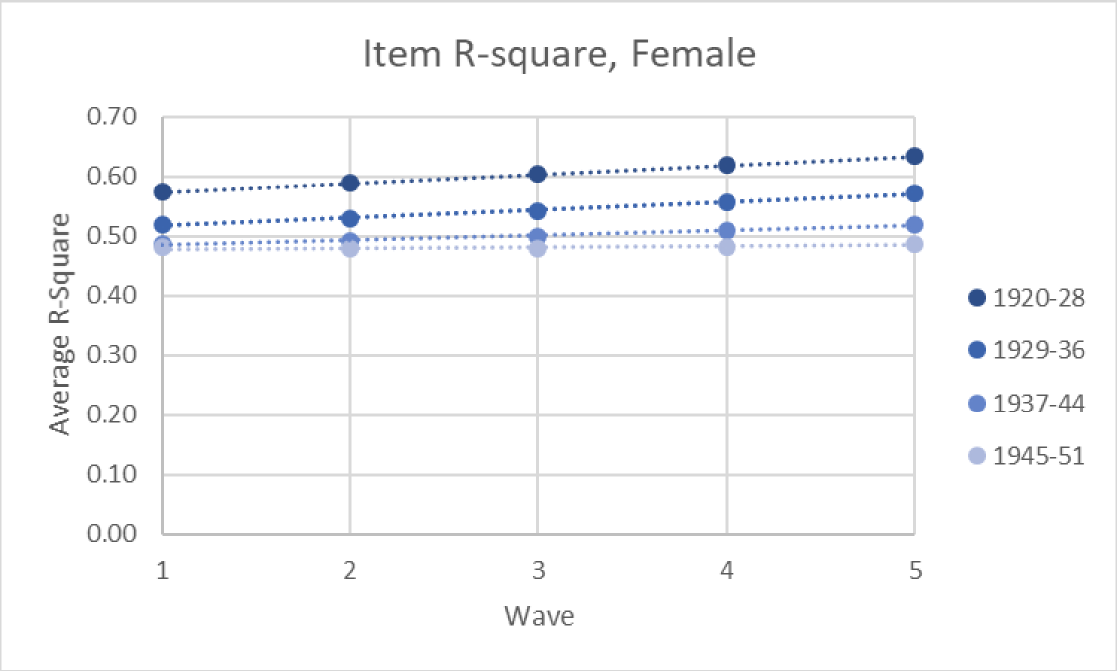
Latent Growth Trajectories

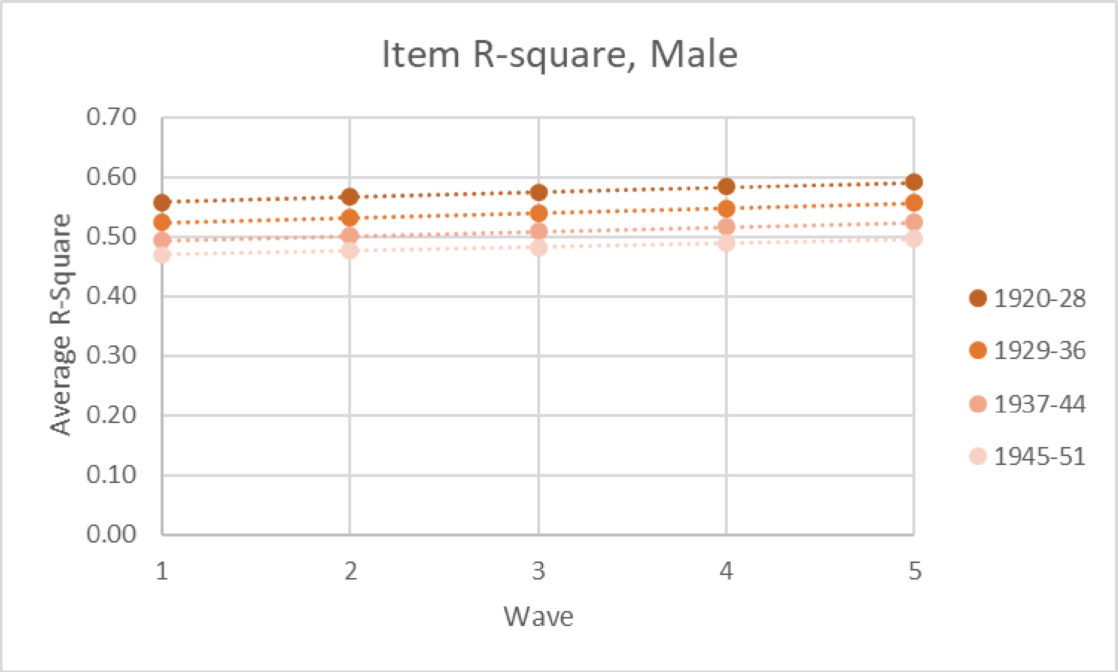




Within-person, ageing-related decline only really kicks in in later years. Appears to be worse for women!
Cohort differences are large (cf. the “Flynn” effect, where IQ observed to be increasing with cohort)

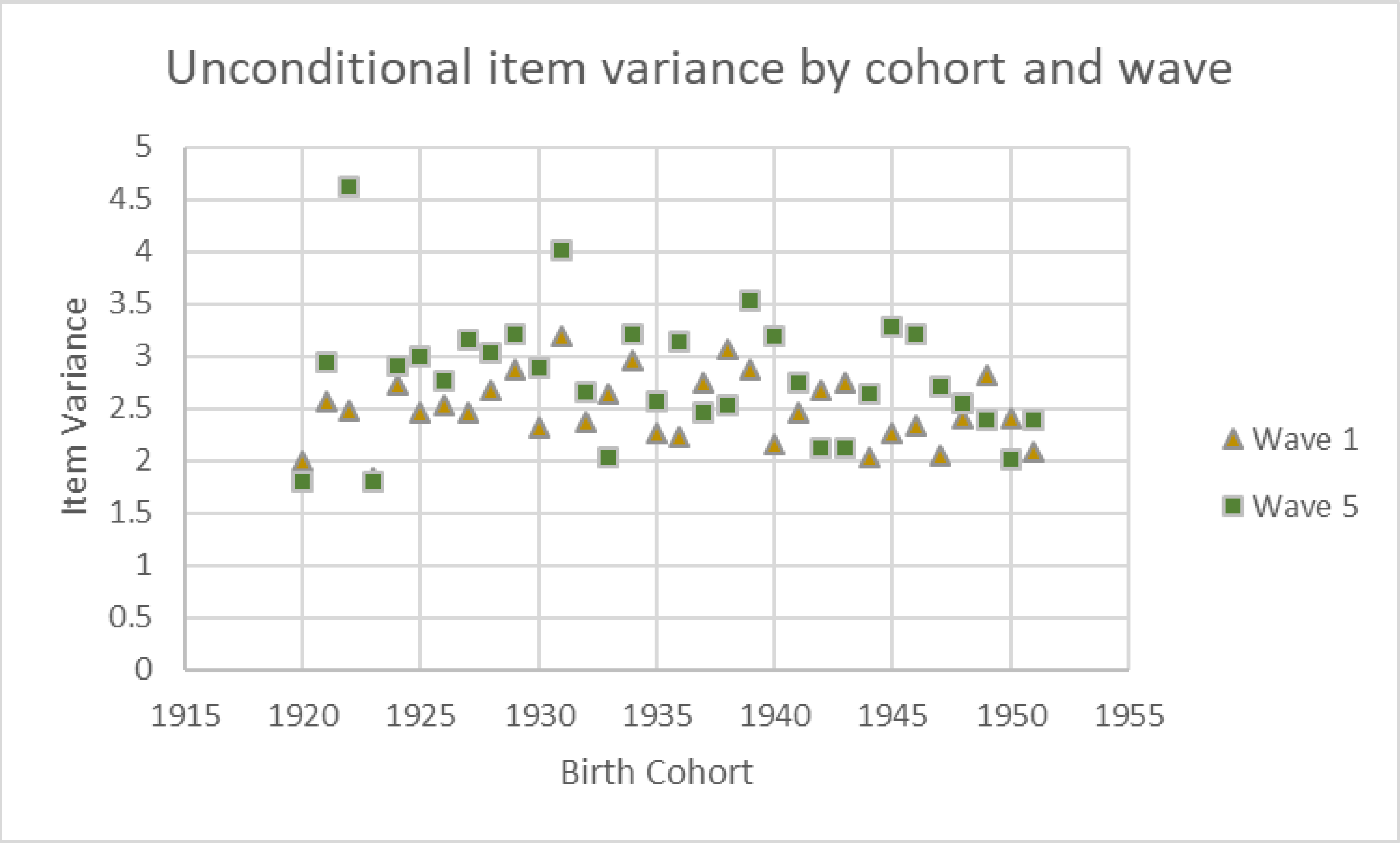
Item reliabilities



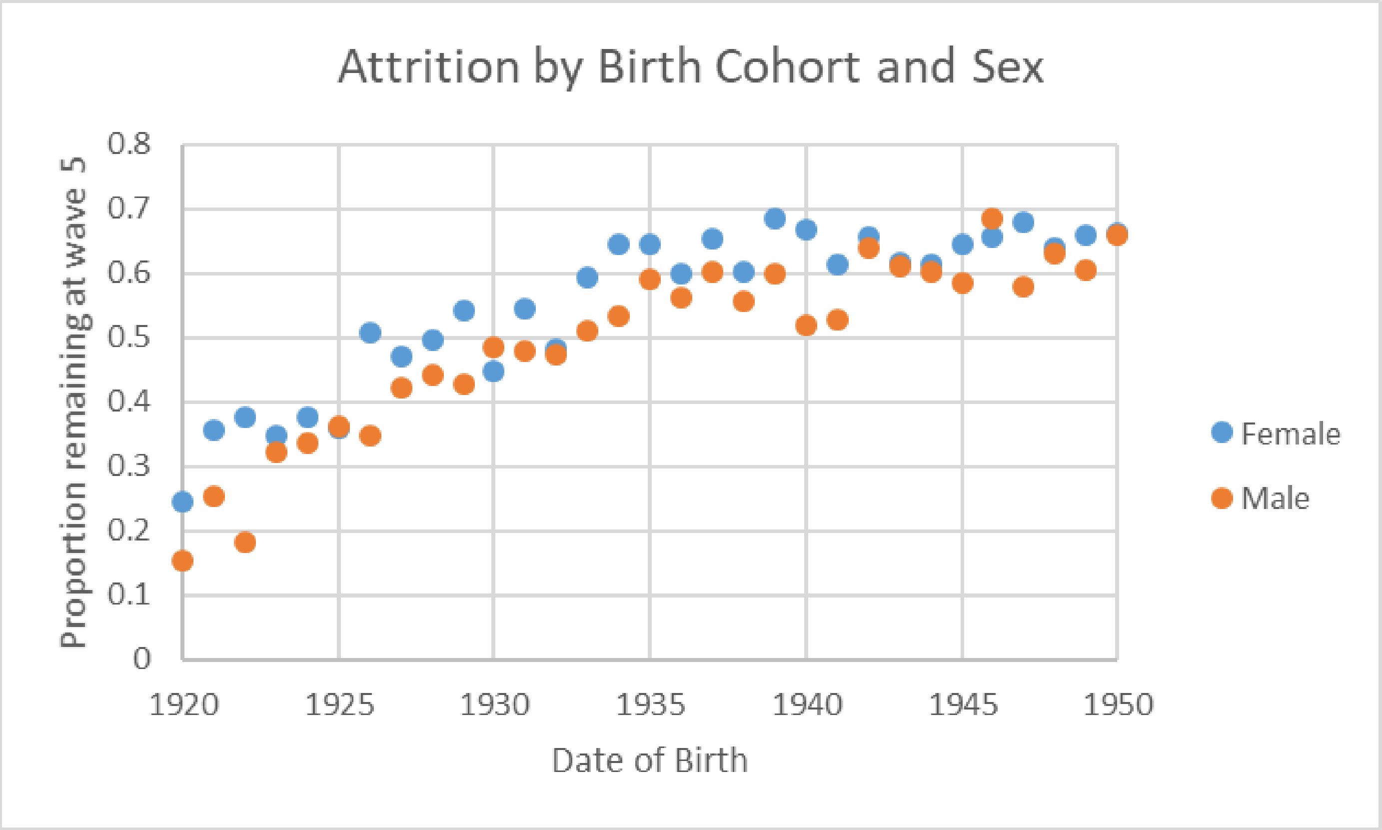


Reliability increases with wave and decreases with date of birth cohort.
I.e. the birth cohorts with the worst memory scores had the highest reliabilities.

There isn't (much) restriction in range across waves and cohorts



Attrition or practice?



Attrition is very high for older cohorts.
Missing At Random (MAR) assumption may be plausible for older cohorts?

Conclusions

- Measurement error is model-dependent, by definition.
  - So estimates of data quality really depend on model ‘quality’ too.
- Reliability differences over time and across cohort are counterintuitive (to me) and question the MAR assumption
- Need a good theory of missingness to specify plausible models
  - Assuming Not Missing At Random (NMAR) attrition?
  - Avoiding over-correction, e.g. due to death.
- Need to account for practice effects
  - But practice very confounded with attrition
  - Compare different patterns of intermittent drop-out (small Ns)? Compare immediate vs. delayed recall?

Bibliography

McCarrey, A. C., An, Y., Kitner-Triolo, M. H., Ferrucci, L., & Resnick, S. M. (2016). Sex differences in cognitive trajectories in clinically normal older adults. *Psychology and Aging*, 31(2), 166–175.

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