Examining cognition within and across studies

Introducing CLOSER's online cognitive measures guide

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CLOSER webinar

11th November 2020

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Outline

- Aims and objectives
- Guide to the cognitive measures
- Assessment and retrospective harmonisation
  - Learnings
  - Testing for equivalence - example
  - Example of using harmonised measures in research
- Conclusions

Aims and objectives

Overall aim:

To assess and harmonise the cognitive measures in five British birth cohorts (across and within cohorts)

- NSHD – MRC National Survey of Health and Development 1946
- NCDS – National Child Development Study 1958
- BCS70 – British Cohort Study 1970
- ALSPAC – The Avon Longitudinal Study of Parents and Children 1991
- MCS – Millennium Cohort Study 2000-01

A guide to the cognitive measures in five British birth cohorts

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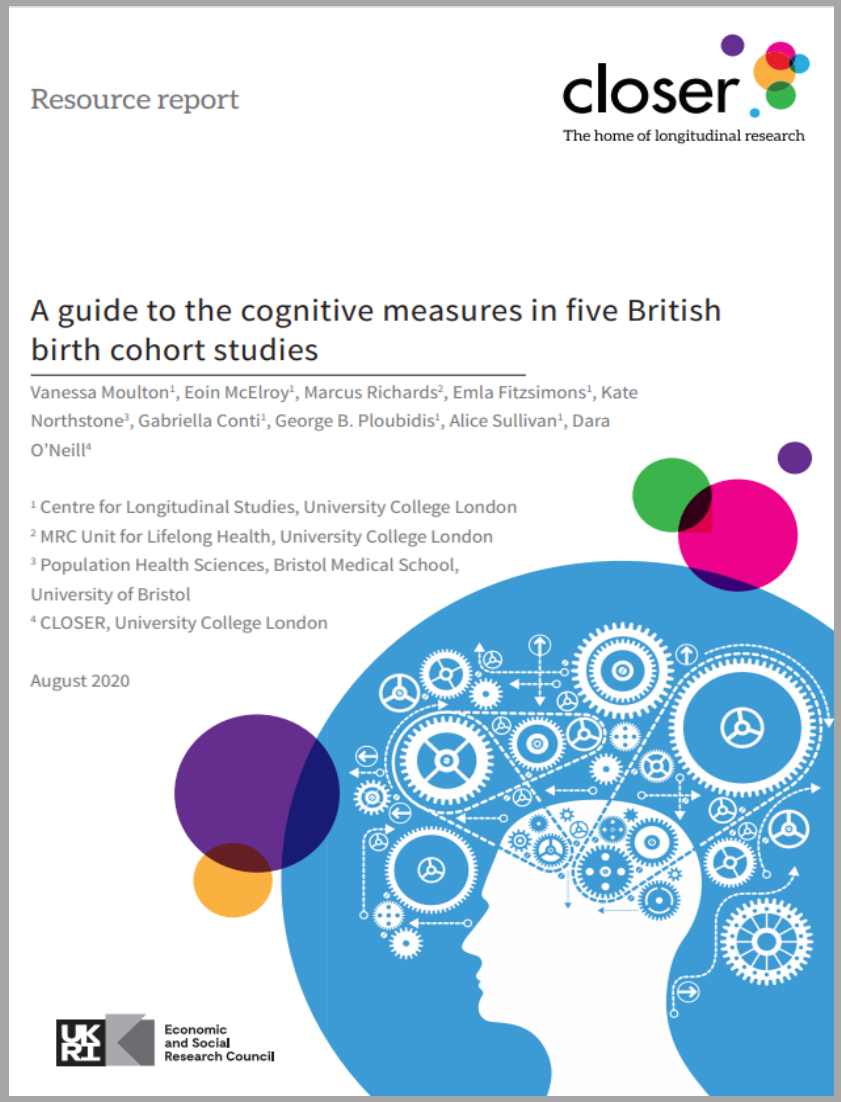

https://www.closer.ac.uk/cognitive-measures-guide/

Moulton, V., McElroy, E., Richards, M., Fitzsimons, E., Northstone, K., Conti, G., Ploubidis, G.B., Sullivan, A., & O'Neill, D. (2020). A guide to the cognitive measures in five British birth cohort studies. London, UK: CLOSER.

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Learnings from assessment and preparation for retrospective harmonisation

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Features in the available tests

- Tests were period specific:
  - In the older cohorts:
    - the tests tended to reflect the curricula of the period,
    - administered using a traditional pen and paper approach,
    - and were often developed specifically for the cohort in question
  - In the younger cohorts:
    - use of standardised and well established tests,
    - and variety of modes
- Tests were devised for specific populations, with age of the subject particularly important
- Domains tested in adulthood very different from those featured in childhood
- Gaps in testing in 20's to early 40's (except for basic numeracy and literacy skills)

Overview of same test completed by CM and repeated across cohorts

Test	NSHD	NCDS	BCS	ALSPAC	MCS
General ability test (NFER)	11 (128- 137)	11 (130 - 152)			
BAS similarities (word or verbal)			10 (117-139) [BAS]		11 (122-148) [BAS II]
Copying Designs Test (CDT)		7 (82 - 93) 11 (130-152)	5 (60-77)		
Human Figure Drawing (HFD)		7 (82-93)	5 (60-77)		
APU Vocabulary test			16 (189-212) 42 (500-517)		14 (157-184)
Verbal Learning/Word List Recall	43 (514-533) 53 (636-650) 60-64 (724-780) 68-70 (828-848)	50 (598-614)	46 (542-578)		
Timed Letter Search/Letter Cancellation	43 (514-533) 53 (636-650) 60-64 (724-780) 68-70 (828-848)	50 (598-614)	46 (542-578)		
Verbal Fluency (animal naming)	53 (636-650)	50 (598-614)	46 (542-578)		

Age administered in years and (age range in months) in parentheses

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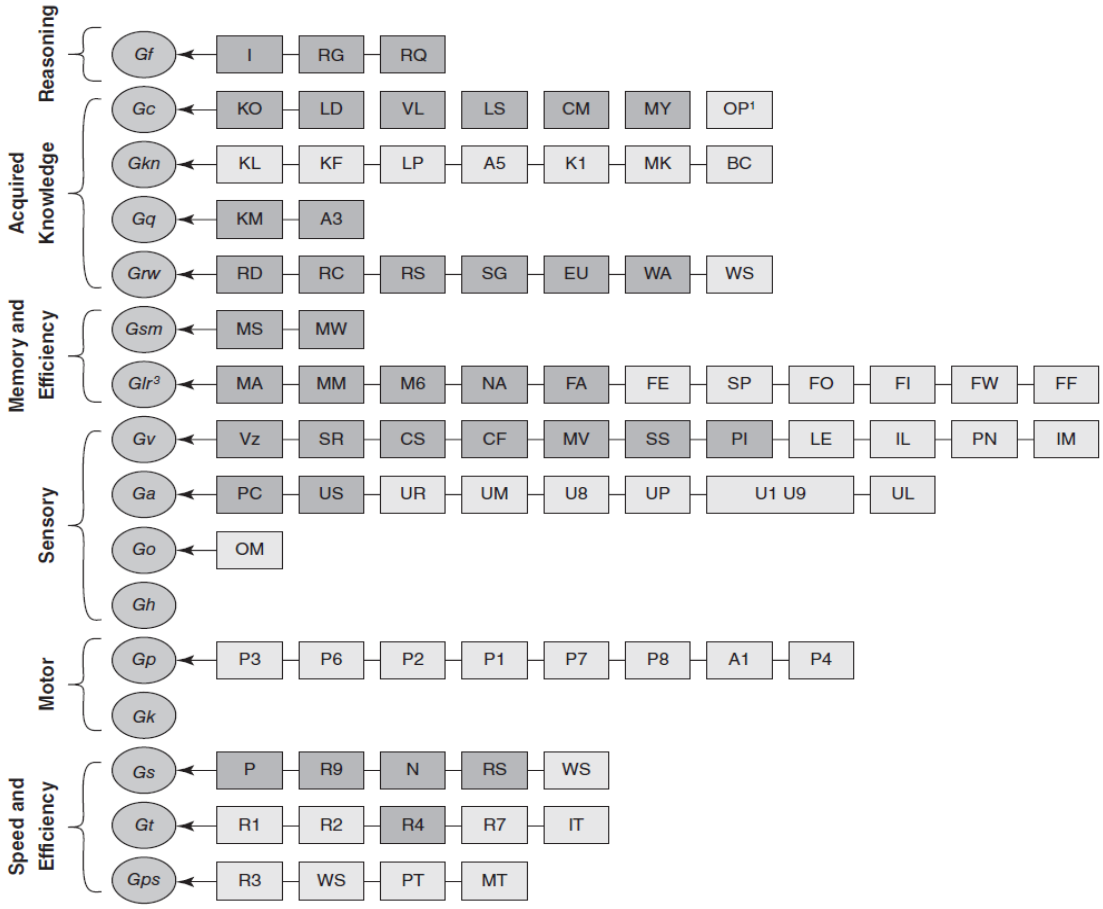
Conceptualising cognitive 'ability' and attainment



CHC theory of cognitive abilities. Source: Flanagan & McGrew (1997)

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Same ‘concepts’ repeated across cohorts at age 10/11

	NSHD (Age 11)	NCDS (Age 11)	BCS70 (Age 10)	ALSPAC (Age 10*/11)	MCS (Age 11)
Gc (Crystallised ability)	General ability (NFER) Verbal Test Vocabulary	General ability (NFER) Verbal Test	Pictorial Language Comprehension Test (PLCT) (Word) Similarities (BAS) Word Definitions (BAS)		Verbal similarities (BAS II)
Gc/Grw	Word Reading	Reading Comprehension test (NFER)	Edinburgh Reading Test (ERT) Spelling Dictation Task (SDT)		
Gf (Fluid ability)	General ability (NFER) Non-Verbal Test	General ability (NFER) Non-verbal Test	Matrices (BAS)	Higher Conceptual Reasoning (Bike Drawing)	
Gsm (Working Memory)			Recall of Digits (BAS)	Working Memory (Counting Span Task)* (TEACh) – Sky task and Dividing Attention: Dual Task	Spatial working memory (CANTAB)
Gq (Quantitative Knowledge)	Arithmetic Test (NFER)	Mathematics Test	Friendly Maths Test (ERT)		
Gv (Visual Processing)		Copying Designs Test (CDT)			
Gt (Decision Speed)				Inhibition (Stop Signal Task)*	Cambridge Gambling Task (CANTAB)
Gs (processing speed)				(TEACh) – Attentional control: Opposite Worlds	

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Same ‘concepts’ repeated within BCS70

Age in years: / Test:	5	10	16	42	46-7
(Schonell) Reading test	Gc/Grw				
English Picture Vocabulary Test (EPVT)/ Pictorial Language Comprehension Test (PLCT)	Gc	Gc			
Copying Designs Test (CDT)	Gv				
Human Figure Drawing (HFD)	Gv				
Complete a Profile test (CPT)	Gv				
Edinburgh Reading Test (SV-ERT)		Gc/Grw	Gc/Grw		
Friendly Maths Test		Gq			
Spelling Dictation task (SDT)		Grw			
(Word) Similarities (BAS)		Gc			
Word Definitions (BAS)		Gc			
Recall of Digits (BAS)		Gsm			
Matrices (BAS)		Gf	Gf		
Vocabulary test (APU)			Gc	Gc	
Arithmetic test (APU)			Gq		
Spelling test			Grw		
Verbal Fluency (Animal Naming)					Glr
Verbal Learning / Word List Recall					Glr
Timed Letter Search / Letter Cancellation					Gv/Gs

Gc (Crystallised ability), Grw (reading/writing), Gf (fluid ability), Gv (visual processing), Gq (quantitative knowledge), Gs (speed), Gsm (short-term memory), Glr (long-term retrieval)

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Same ‘concepts’ repeated within MCS

Age in years: Test:	3	5	7	11	14	17
Naming Vocabulary (BAS II)	Gc	Gc				
Bracken School Readiness	Gc (Gq/Gv)					
Pattern Construction (BAS II)		Gv	Gv			
Picture Similarities (BAS II)		Gf				
Word Reading (BAS II)			Gc/Grw			
Progress in Maths (NFER, adapted)			Gq			
Verbal Similarities (BAS II)				Gc		
Cambridge Gambling Task (CGT; CANTAB)				Gt/Gs	Gt/Gs	
Spatial Working Memory Task (SWM; CANTAB)				Gsm		
Vocabulary test (Applied Psychological Unit (APU))					Gc	
Number Analogies test (CAT3)						Gq

Gc (Crystallised ability), Grw (reading/writing), Gf (fluid ability), Gv (visual processing), Gq (quantitative knowledge), Gt(dec/reaction time), Gs (speed), Gsm (short-term memory)

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Age of test completion

Age range:	NSHD	NCDS	BCS	ALSPAC	MCS
Age 4/5	-	-	60-77 m=62 SD=1.3	48 – 51 m=49 SD=0.4	53-74 m=63 SD=3
Age 7/8	8 years 6 months	82 – 93 m=85 SD=1.6	-	89 – 127 m=104 SD=3.9	76 – 98 m=87 SD=3
Age 10/11	128 - 137 m=130 SD=1.1	130 – 152 m=134 SD=1.7	117-139 m=122 SD=2.7	125 - 164 m=141 SD=2.9	122 – 148 m=134 SD=4
Age 14/16	172 - 182 m=175 SD=2.1	190 – 201 m=193 SD=1.4	189-212 m=197 SD=4.5	171 - 212 m=186 SD=4.2	157 - 184 m=171 SD=4.1

Age at time of interview not available. 8 years 6 months is a best estimate based on date of interview.

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Scores and scales

- Heterogenous scoring systems and scales
- Types of scales
  - Most treated as interval scales (each item correct is worth the same when calculating the total)
  - Scales which include item difficulty
  - Ratio scales (with meaningful zeros)
- Scores
  - Dichotomous (right/wrong)
  - Counts
  - Speed of completion / reaction times
  - Adjusted for difficulty/item discrimination
  - Norm referencing
- Derived total scores:
  - Total raw score
  - Z-scores (M=zero, SD=1)
  - T-score scale
    - M=50, SD=10
    - M=100, SD=15
- Inconsistency in how tests deposited
  - No item level data available
  - Item level only (and no derived)
  - Standardised total scores only

Harmonisation: Approach and example

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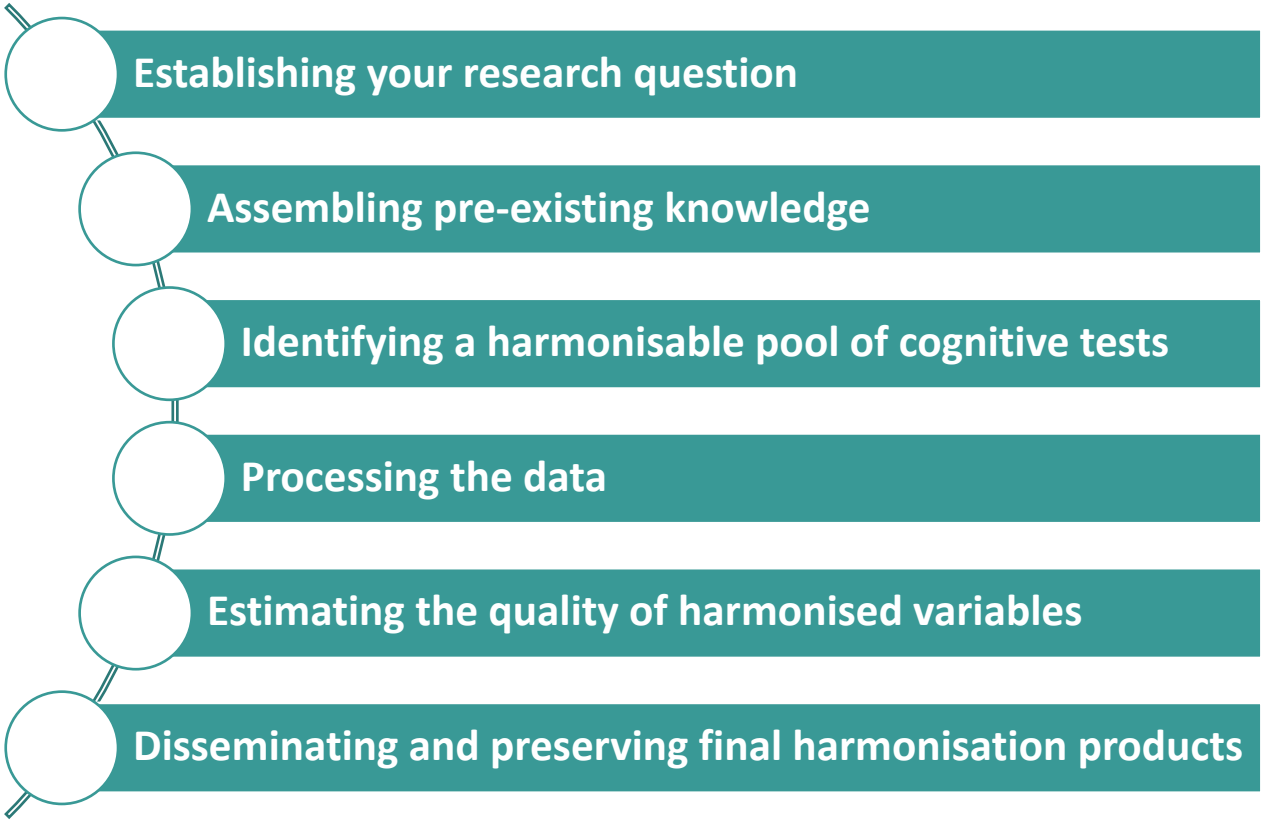
Approach to harmonisation



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(Fortier et al., 2017)

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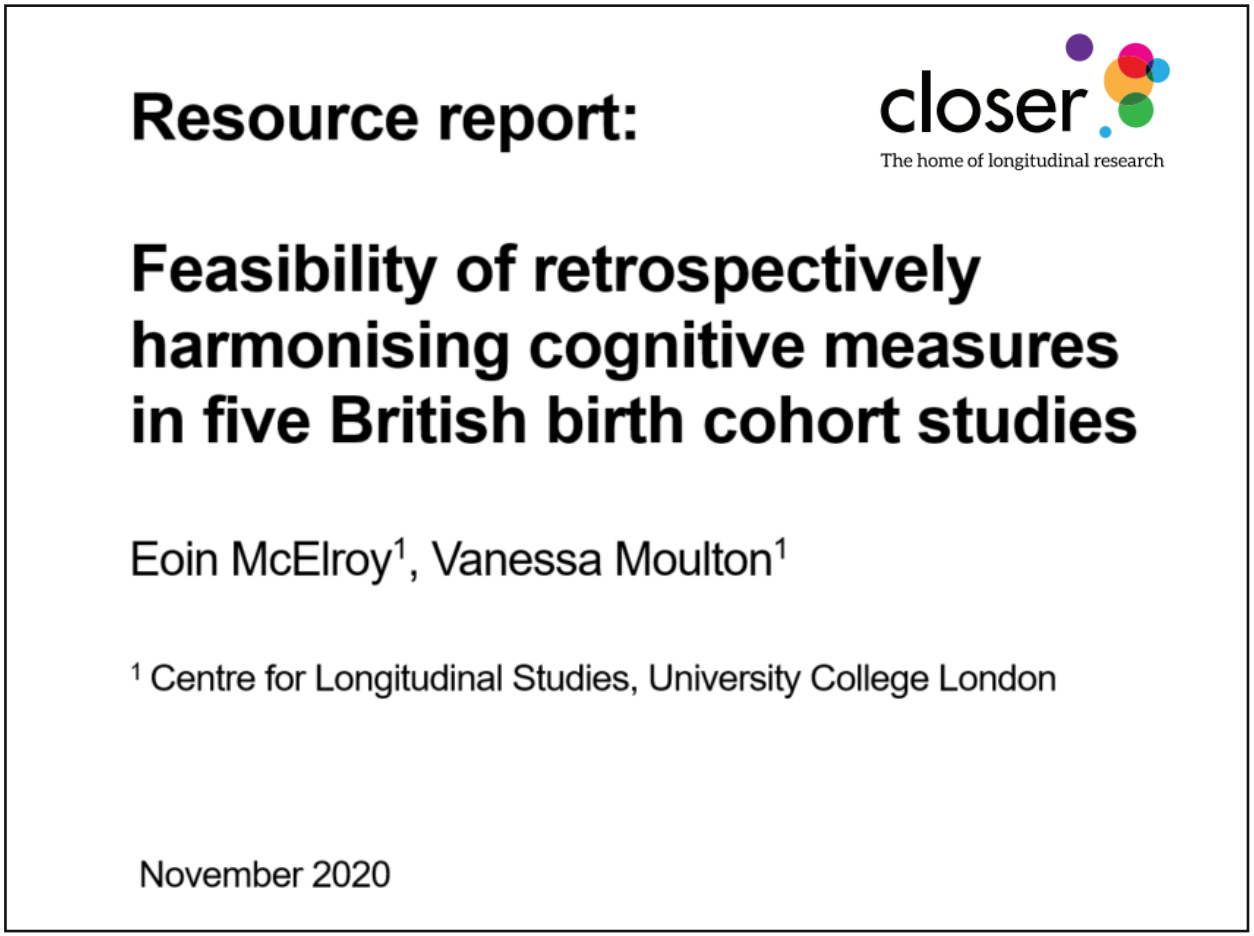
Step 2 - Assembling pre-existing knowledge (1)



Resource report:

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Feasibility of retrospectively harmonising cognitive measures in five British birth cohort studies

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November 2020

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Step 2 – Assembling pre-existing knowledge (2)

Test: \ Age in years:	8	11	15	26	43	53	60-64	68-70
Reading Comprehension	Gc/Grw							
Word Reading	Grw	Grw						
Vocabulary	Gc	Gc						
Picture Intelligence	Gf							
General Ability Test (verbal and non-verbal)		G/Gc/Gf						
Arithmetic Test		Gq						
Alice Heim Group Ability Test			G/Gc/Gf					
Watts-Vernon Reading Test			Gc/Grw	Gc/Grw				
Mathematics Test			Gq					
Verbal Learning/Word List Recall					Glr	Glr	Glr	Glr
Long Term Recall					Glr			
Visual Memory					Glr/Gv			
Timed Letter Search/Letter Cancellation					Gv/Gs	Gv/Gs	Gv/Gs	Gv/Gs
Motor Speed and Praxis					Gp			
National Adult Reading Test (NART)						Gc/Grw		
Verbal Fluency (animal naming)						Glr		
Prospective Memory						NA		
Delayed Verbal Memory						Glr		
Reaction Time Test							Gt	
Finger Tapping Test								Gp
Addenbrooke's Cognitive Examination (5 domains)								G

Step 3 - Identifying a harmonisable pool of cognitive tests (1)

	NSHD - 1946	NCDS - 1958	BCS - 1970
Age 43/46	(Age 43)		(Age 46)
	Word list recall test		Word list recall test
	Letter cancellation test		Letter cancellation test
	Visual memory		Verbal fluency (animal naming) test
	Long-term recall		
	Motor speed and praxis		
Age 50/53	(Age 53)	(Age 50)	
	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Verbal Fluency (animal naming)	Verbal fluency (animal naming) test	
	National Adult Reading Test (NART)		
	Prospective memory		
	Delayed verbal memory		
60-64	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Simple and choice reaction time	Verbal fluency (animal naming) test	
	Balance/coordination		
68-70	Word list recall test		
	Letter cancellation test		
	Finger tapping		

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Step 3 - Identifying a harmonisable pool of cognitive tests (2)

	NSHD - 1946	NCDS - 1958	BCS - 1970
Age 43/46	(Age 43)		(Age 46)
	Word list recall test		Word list recall test
	Letter cancellation test		Letter cancellation test
	Visual memory		Verbal fluency (animal naming) test
	Long-term recall		
	Motor speed and praxis		
Age 50/53	(Age 53)	(Age 50)	
	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Verbal Fluency (animal naming)	Verbal fluency (animal naming) test	
	National Adult Reading Test (NART)		
	Prospective memory		
	Delayed verbal memory		
60-64	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Simple and choice reaction time	Verbal fluency (animal naming) test	
	Balance/coordination		
68-70	Word list recall test		
	Letter cancellation test		
	Finger tapping		

Step 3 – Identifying a harmonisable pool of cognitive tests (3)

	NSHD - 1946	NCDS - 1958	BCS - 1970
Age 43/46	(Age 43)		(Age 46)
	Word list recall test		Word list recall test
	Letter cancellation test		Letter cancellation test
	Visual memory		Verbal fluency (animal naming) test
	Long-term recall		
	Motor speed and praxis		
Age 50/53	(Age 53)	(Age 50)	
	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Verbal Fluency (animal naming)	Verbal fluency (animal naming) test	
	National Adult Reading Test (NART)		
	Prospective memory		
	Delayed verbal memory		
60-64	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Simple and choice reaction time	Verbal fluency (animal naming) test	
	Balance/coordination		
68-70	Word list recall test		
	Letter cancellation test		
	Finger tapping		

Step 3 - Identifying a harmonisable pool of cognitive tests (4)

	NSHD - 1946	NCDS - 1958	BCS - 1970
Age 43/46	(Age 43)		(Age 46)
	Word list recall test		Word list recall test
	Letter cancellation test		Letter cancellation test
	Visual memory		Verbal fluency (animal naming) test
	Long-term recall		
	Motor speed and praxis		
Age 50/53	(Age 53)	(Age 50)	
	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Verbal Fluency (animal naming)	Verbal fluency (animal naming) test	
	National Adult Reading Test (NART)		
	Prospective memory		
	Delayed verbal memory		
60-64	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Simple and choice reaction time	Verbal fluency (animal naming) test	
	Balance/coordination		
68-70	Word list recall test		
	Letter cancellation test		
	Finger tapping		

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Step 3 - Identifying a harmonisable pool of cognitive tests (5)

	NSHD - 1946	NCDS - 1958	BCS - 1970
Age 43/46	(Age 43)		(Age 46)
	Word list recall test		Word list recall test
	Letter cancellation test		Letter cancellation test
	Visual memory		Verbal fluency (animal naming) test
	Long-term recall		
	Motor speed and praxis		
Age 50/53	(Age 53)	(Age 50)	
	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Verbal Fluency (animal naming)	Verbal fluency (animal naming) test	
	National Adult Reading Test (NART)		
	Prospective memory		
	Delayed verbal memory		
60-64	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Simple and choice reaction time	Verbal fluency (animal naming) test	
	Balance/coordination		
68-70	Word list recall test		
	Letter cancellation test		
	Finger tapping		

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Step 3 - Identifying a harmonisable pool of cognitive tests (6)

	NSHD - 1946	NCDS - 1958	BCS - 1970
Age 43/46	(Age 43)		(Age 46)
	Word list recall test		Word list recall test
	Letter cancellation test		Letter cancellation test
	Visual memory		Verbal fluency (animal naming) test
	Long-term recall		
	Motor speed and praxis		
Age 50/53	(Age 53)	(Age 50)	
	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Verbal Fluency (animal naming)	Verbal fluency (animal naming) test	
	National Adult Reading Test (NART)		
	Prospective memory		
	Delayed verbal memory		
60-64	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Simple and choice reaction time	Verbal fluency (animal naming) test	
	Balance/coordination		
68-70	Word list recall test		
	Letter cancellation test		
	Finger tapping		

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Step 3 – Identifying a harmonisable pool of cognitive tests (7)

	NSHD - 1946	NCDS - 1958	BCS - 1970
Age 43/46	(Age 43)		(Age 46)
	Word list recall test		Word list recall test
	Letter cancellation test		Letter cancellation test
	Visual memory		Verbal fluency (animal naming) test
	Long-term recall		
	Motor speed and praxis		
Age 50/53	(Age 53)	(Age 50)	
	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Verbal Fluency (animal naming)	Verbal fluency (animal naming) test	
	National Adult Reading Test (NART)		
	Prospective memory		
	Delayed verbal memory		
60-64	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Simple and choice reaction time	Verbal fluency (animal naming) test	
	Balance/coordination		
68-70	Word list recall test		
	Letter cancellation test		
	Finger tapping		

Step 3 – Identifying a harmonisable pool of cognitive tests (8)

	NSHD	NCDS	BCS
Age 43/46	(Age 43)		(Age 46)
	Word list recall test		Word list recall test
	Letter cancellation test		Letter cancellation test
	Visual memory		Verbal fluency (animal naming) test
	Long-term recall		
	Motor speed and praxis		
Age 50/53	(Age 53)	(Age 50)	
	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Verbal Fluency (animal naming)	Verbal fluency (animal naming) test	
	National Adult Reading Test (NART)		
	Prospective memory		
	Delayed verbal memory		
60-64	Word list recall test	Word list recall test	
	Letter cancellation test	Letter cancellation test	
	Simple and choice reaction time	Verbal fluency (animal naming) test	
	Balance/coordination		
68-70	Word list recall test		
	Letter cancellation test		
	Finger tapping		

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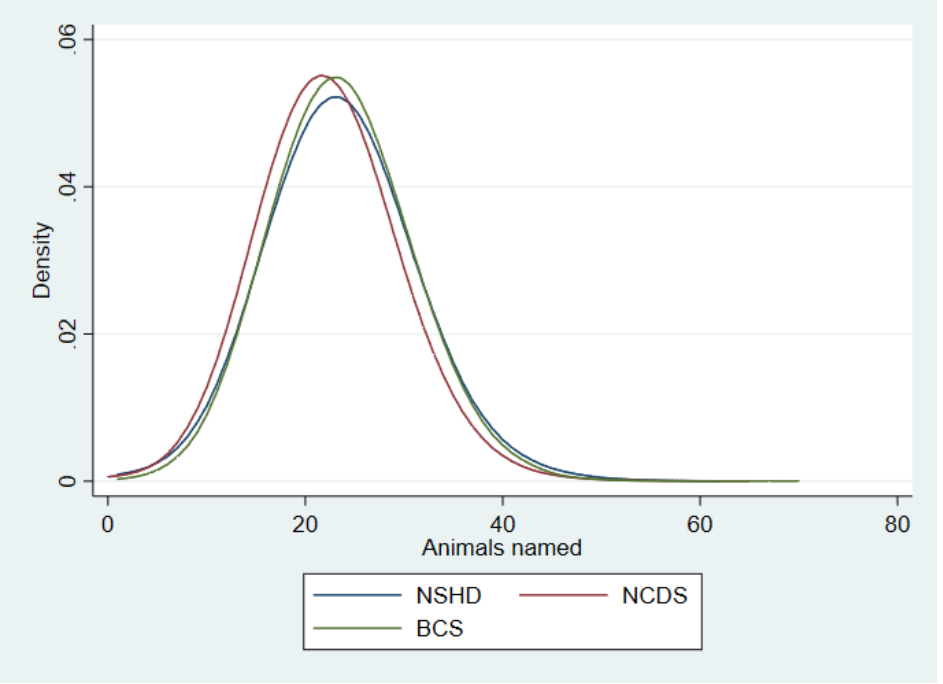
Step 4 - Processing the data (1)

CHECK CF1

CFANIST
Now I would like you to name as many different animals as you can think of. You have one minute to do this. The computer voice will tell you when to stop.
Ready, go!

INTERVIEWER: Only if the participant asks for clarification, explain that animals include birds, insects, fish etc.



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Step 4 - Processing the data (2)

108.Now for something different. I want to see how well you remember a list of fifteen words. I will show you one word at a time and when I reach the end of the list you have one minute to write down as many words as you can. Please write the words in any order you like. It is best not to talk to anyone while you are doing this. *Nurse: Hand over the paper test booklet at page 3 and make sure the cohort member has a pencil. Code one only.*

Word tests administered	1	
Test not attempted - respondent has difficulty reading/writing	2→Q109	± WLREF
Word lists refused	3→Q109	

CFLSINT
For the next task the computer will 'read' a list of words which I will ask you to recall. First I'd like to check that you will be able to hear the computer voice.
Please listen to this short message.

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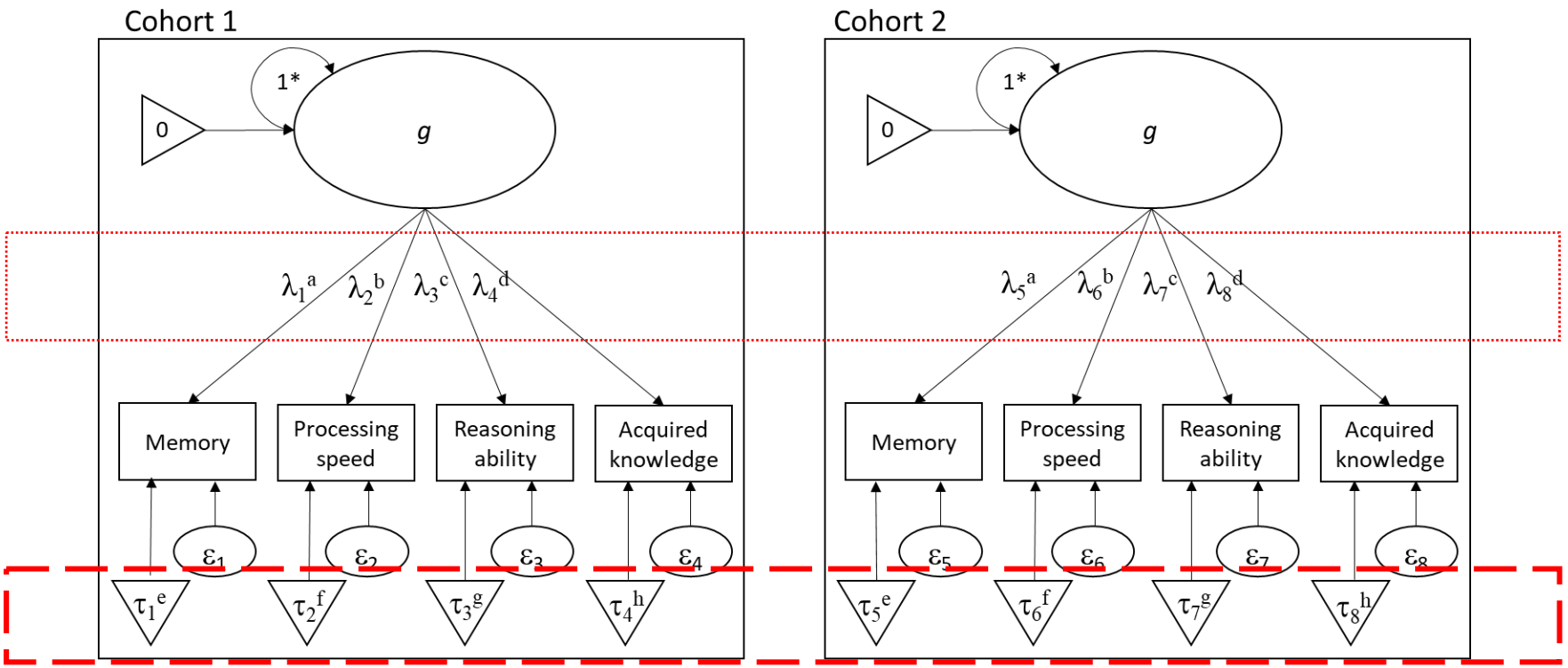
Step 4 - Processing the data (3)

Measure	Cohort	Variable	Harmonisation	N	Mean (SD)	Range
Word List Recall Test	NSHD	wlt199 (immediate memory – 1st trial)	Scores > 10 recoded to a value of 10	2,909	5.80 (2.01)	0-10
		wlt499 (delayed memory – 1st trial)	Scores > 10 recoded to a value of 10	2,292	7.99 (2.05)	0-10
	NCDS	N8CFLISN (immediate)	-	9,648	6.54 (1.48)	0-10
		N8CFLISD (delayed)	-	9,591	5.41 (1.84)	0-10
	BCS	B10CFLISN (immediate)	-	8,501	6.61 (1.44)	0-10
		B10CFLISD (delayed)	-	8,494	5.47 (1.81)	0-10
Animal naming	NSHD	anin	-	2,949	23.56 (6.91)	1-62
	NCDS	N8CFANI	-	9,648	22.28 (6.30)	0-65
	BCS	B10CFANI	-	8,498	23.63 (6.19)	1-70
Letter cancellation	NSHD	CANSP99 (Search speed)	-	2,932	281.07 (76.08)	64-591
	NCDS	N8CFRC (Search speed)	-	9,442	334.10 (88.83)	84-780
	BCS	B10CFRC (Search speed)	-	8,242	346.45 (84.77)	28-780

Step 4 - Processing the data (4)

Measure	Cohort	Variable	Harmonisation	N	Mean (SD)	Range
Word List Recall Test	NSHD	wlt199 (immediate memory – 1st trial)	**Scores > 10 recoded to a value of 10**	2,909	5.80 (2.01)	**0-10**
		wlt499 (delayed memory – 1st trial)	**Scores > 10 recoded to a value of 10**	2,292	7.99 (2.05)	**0-10**
	NCDS	N8CFLISN (immediate)	-	9,648	6.54 (1.48)	0-10
		N8CFLISD (delayed)	-	9,591	5.41 (1.84)	0-10
	BCS	B10CFLISN (immediate)	-	8,501	6.61 (1.44)	0-10
		B10CFLISD (delayed)	-	8,494	5.47 (1.81)	0-10
Animal naming	NSHD	anin	-	2,949	23.56 (6.91)	1-62
	NCDS	N8CFANI	-	9,648	22.28 (6.30)	0-65
	BCS	B10CFANI	-	8,498	23.63 (6.19)	1-70
Letter cancellation	NSHD	CANSP99 (Search speed)	-	2,932	281.07 (76.08)	64-591
	NCDS	N8CFRC (Search speed)	-	9,442	334.10 (88.83)	84-780
	BCS	B10CFRC (Search speed)	-	8,242	346.45 (84.77)	28-780

Step 5 - Estimating the quality of harmonised variables (1)



Metric Invariance

Scalar Invariance

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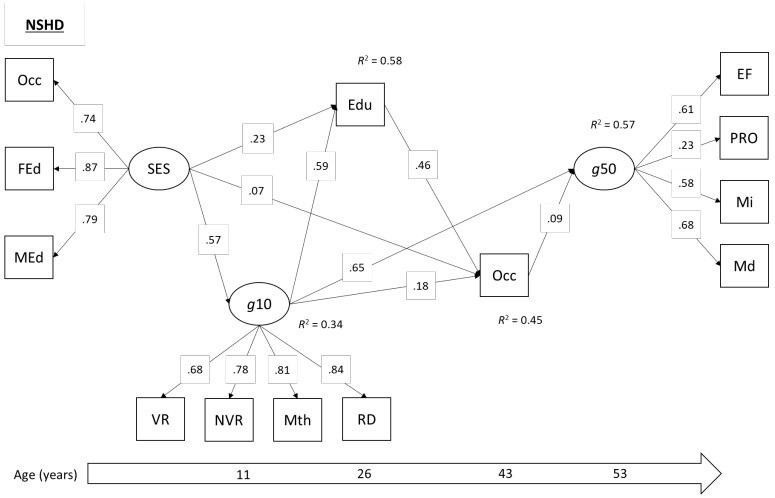
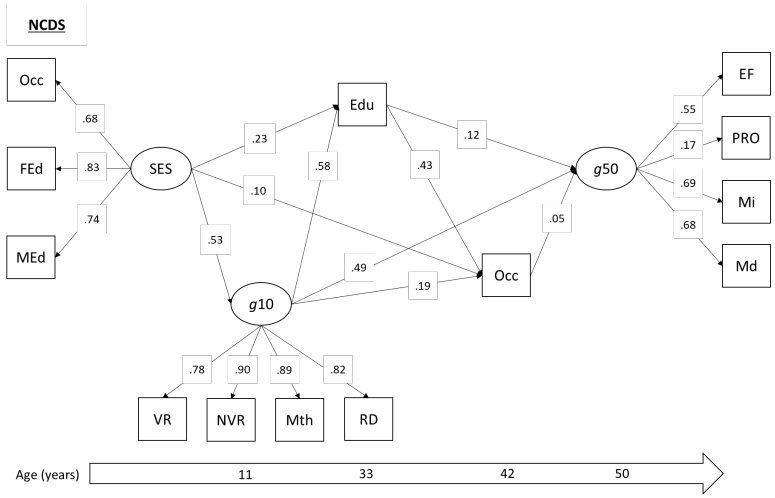
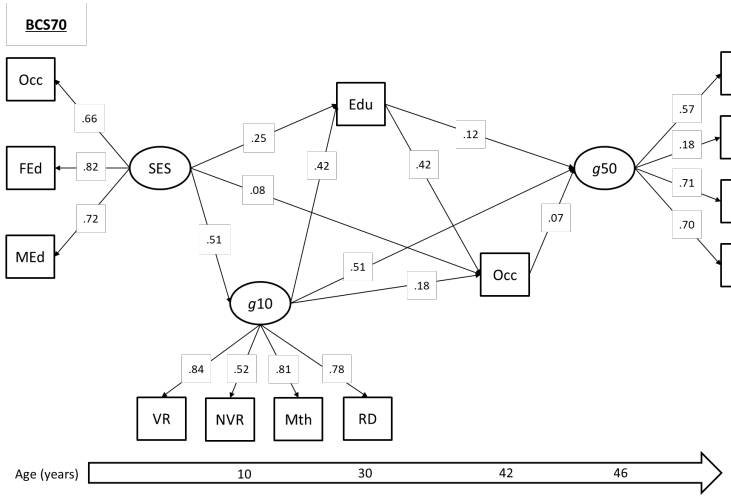
Step 5 - Estimating the quality of harmonised variables (2)

Model	RMSEA	CFI	TLI
Configural	0.077	0.980	0.939
Metric	0.057	0.974	0.967
Scalar	0.179	0.595	0.669
Partial scalar 1	0.123	0.827	0.844
Partial scalar 2	0.089	0.918	0.918
Partial scalar 3	0.069	0.956	0.951
Partial scalar 4	0.082	0.961	0.930

Step 6 - Disseminating and preserving final harmonisation products







(McElroy et al., under review)

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Failing to support measurement invariance (1)

CHC	Measure	Cohort	Variable	Harmonisation	N	Mean (SD)	Range
Gc [1]	Verbal Ability (NFER)	NSHD	V1157	Metric transformed to (0-50)	4,032	21.61 (7.50)	0-40
	Verbal Ability (NFER)	NCDS	n914	Metric transformed to (0-50)	14,131	22.06 (9.36)	0-40
	(Word) Similarities	BCS	i3575-i3616 (example group correct (sum))	Metric transformed to (0-50)	11,482	12.06 (2.61)	0-21
Gf	Non-verbal Ability (NFER)	NSHD	NV1157	Metric transformed to (0-50)	4,032	23.40 (9.17)	0-40
	Non-verbal Ability (NFER)	NCDS	n917	Metric transformed to (0-50)	14,131	20.88 (7.61)	0-40
	Matrices (BAS)	BCS	I3617-i3644 (sum)	Metric transformed to (0-50)	11,494	15.35 (5.40)	0-28
Gq	Arithmetic Test (NFER)	NSHD	A1157	-	4,025	26.39 (11.74)	0-50
	Mathematics Test	NCDS	n926	Metric transformed to (0-50)	14,126	16.63 (10.35)	0-40
	Friendly Maths Test	BCS	BD3MATHS	Metric transformed to (0-50)	11,633	43.95 (12.32)	0-72
Gc[2]	Vocabulary	NSHD	VOC1157	-	4,027	29.99 (7.45)	0-50
	Reading Comprehension (NFER)	NCDS	n923	Metric transformed to (0-50)	14,130	15.98 (6.29)	0-35
	Pictorial Language Comprehension Test	BCS	I8-i62, i66-i110 (sum)	Metric transformed to (0-50)	12,790	61.10 (10.69)	0-100

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Failing to support measurement invariance (2)

CHC	Measure	Cohort	Variable	Harmonisation	N	Mean (SD)	Range
Gc [1]	Verbal Ability (NFER)	NSHD	V1157	Metric transformed to (0-50)	4,032	21.61 (7.50)	0-40
	Verbal Ability (NFER)	NCDS	n914	Metric transformed to (0-50)	14,131	22.06 (9.36)	0-40
	(Word) Similarities	BCS	i3575-i3616 (example group correct (sum))	Metric transformed to (0-50)	11,482	12.06 (2.61)	0-21
Gf	Non-verbal Ability (NFER)	NSHD	NV1157	Metric transformed to (0-50)	4,032	23.40 (9.17)	0-40
	Non-verbal Ability (NFER)	NCDS	n917	Metric transformed to (0-50)	14,131	20.88 (7.61)	0-40
	Matrices (BAS)	BCS	I3617-i3644 (sum)	Metric transformed to (0-50)	11,494	15.35 (5.40)	0-28
Gq	Arithmetic Test (NFER)	NSHD	A1157	-	4,025	26.39 (11.74)	0-50
	Mathematics Test	NCDS	n926	Metric transformed to (0-50)	14,126	16.63 (10.35)	0-40
	Friendly Maths Test	BCS	BD3MATHS	Metric transformed to (0-50)	11,633	43.95 (12.32)	0-72
Gc [2]	Vocabulary	NSHD	VOC1157	-	4,027	29.99 (7.45)	0-50
	Reading Comprehension (NFER)	NCDS	n923	Metric transformed to (0-50)	14,130	15.98 (6.29)	0-35
	Pictorial Language Comprehension Test	BCS	I8-i62, i66-i110 (sum)	Metric transformed to (0-50)	12,790	61.10 (10.69)	0-100

Failing to support measurement invariance (3)

CHC	Measure	Cohort	Variable	Harmonisation	N	Mean (SD)	Range
Gc [1]	Verbal Ability (NFER)	NSHD	V1157	Metric transformed to (0-50)	4,032	21.61 (7.50)	0-40
	Verbal Ability (NFER)	NCDS	n914	Metric transformed to (0-50)	14,131	22.06 (9.36)	0-40
	(Word) Similarities	BCS	i3575-i3616 (example group correct (sum))	Metric transformed to (0-50)	11,482	12.06 (2.61)	0-21
Gf	Non-verbal Ability (NFER)	NSHD	NV1157	Metric transformed to (0-50)	4,032	23.40 (9.17)	0-40
	Non-verbal Ability (NFER)	NCDS	n917	Metric transformed to (0-50)	14,131	20.88 (7.61)	0-40
	Matrices (BAS)	BCS	I3617-i3644 (sum)	Metric transformed to (0-50)	11,494	15.35 (5.40)	0-28
Gq	Arithmetic Test (NFER)	NSHD	A1157	-	4,025	26.39 (11.74)	0-50
	Mathematics Test	NCDS	n926	Metric transformed to (0-50)	14,126	16.63 (10.35)	0-40
	Friendly Maths Test	BCS	BD3MATHS	Metric transformed to (0-50)	11,633	43.95 (12.32)	0-72
Gc [2]	Vocabulary	NSHD	VOC1157	-	4,027	29.99 (7.45)	0-50
	Reading Comprehension (NFER)	NCDS	n923	Metric transformed to (0-50)	14,130	15.98 (6.29)	0-35
	Pictorial Language Comprehension Test	BCS	I8-i62, i66-i110 (sum)	Metric transformed to (0-50)	12,790	61.10 (10.69)	0-100

Failing to support measurement invariance (4)

CHC	Measure	Cohort	Variable	Harmonisation	N	Mean (SD)	Range
Gc [1]	Verbal Ability (NFER)	NSHD	V1157	Metric transformed to (0-50)	4,032	21.61 (7.50)	0-40
	Verbal Ability (NFER)	NCDS	n914	Metric transformed to (0-50)	14,131	22.06 (9.36)	0-40
	(Word) Similarities	BCS	i3575-i3616 (example group correct (sum))	Metric transformed to (0-50)	11,482	12.06 (2.61)	0-21
Gf	Non-verbal Ability (NFER)	NSHD	NV1157	Metric transformed to (0-50)	4,032	23.40 (9.17)	0-40
	Non-verbal Ability (NFER)	NCDS	n917	Metric transformed to (0-50)	14,131	20.88 (7.61)	0-40
	Matrices (BAS)	BCS	I3617-i3644 (sum)	Metric transformed to (0-50)	11,494	15.35 (5.40)	0-28
Gq	Arithmetic Test (NFER)	NSHD	A1157	-	4,025	26.39 (11.74)	0-50
	Mathematics Test	NCDS	n926	Metric transformed to (0-50)	14,126	16.63 (10.35)	0-40
	Friendly Maths Test	BCS	BD3MATHS	Metric transformed to (0-50)	11,633	43.95 (12.32)	0-72
Gc [2]	Vocabulary	NSHD	VOC1157	-	4,027	29.99 (7.45)	0-50
	Reading Comprehension (NFER)	NCDS	n923	Metric transformed to (0-50)	14,130	15.98 (6.29)	0-35
	Pictorial Language Comprehension Test	BCS	I8-i62, i66-i110 (sum)	Metric transformed to (0-50)	12,790	61.10 (10.69)	0-100

Failing to support measurement invariance (5)

CHC	Measure	Cohort	Variable	Harmonisation	N	Mean (SD)	Range
Gc [1]	Verbal Ability (NFER)	NSHD	V1157	Metric transformed to (0-50)	4,032	21.61 (7.50)	0-40
	Verbal Ability (NFER)	NCDS	n914	Metric transformed to (0-50)	14,131	22.06 (9.36)	0-40
	(Word) Similarities	BCS	i3575-i3616 (example group correct (sum))	Metric transformed to (0-50)	11,482	12.06 (2.61)	0-21
Gf	Non-verbal Ability (NFER)	NSHD	NV1157	Metric transformed to (0-50)	4,032	23.40 (9.17)	0-40
	Non-verbal Ability (NFER)	NCDS	n917	Metric transformed to (0-50)	14,131	20.88 (7.61)	0-40
	Matrices (BAS)	BCS	I3617-i3644 (sum)	Metric transformed to (0-50)	11,494	15.35 (5.40)	0-28
Gq	Arithmetic Test (NFER)	NSHD	A1157	-	4,025	26.39 (11.74)	0-50
	Mathematics Test	NCDS	n926	Metric transformed to (0-50)	14,126	16.63 (10.35)	0-40
	Friendly Maths Test	BCS	BD3MATHS	Metric transformed to (0-50)	11,633	43.95 (12.32)	0-72
Gc [2]	Vocabulary	NSHD	VOC1157	-	4,027	29.99 (7.45)	0-50
	Reading Comprehension (NFER)	NCDS	n923	Metric transformed to (0-50)	14,130	15.98 (6.29)	0-35
	Pictorial Language Comprehension Test	BCS	I8-i62, i66-i110 (sum)	Metric transformed to (0-50)	12,790	61.10 (10.69)	0-100

Failing to support measurement invariance (6)

Model	RMSEA	CFI	TLI	ΔRMSEA	ΔCFI	ΔTLI
Configural	.114	.991	.959			
Metric	.159	.955	.920	0.045	-0.036	-0.039
Scalar	.269	.797	.771	0.155	-0.194	-0.188

Recommendations

- Establish your research question
  - Impact all subsequent steps, in particular level of harmonisation required
- Assemble pre-existing knowledge
  - e.g. A guide to the cognitive measures in five British birth cohort studies
- Identify a harmonisable pool of cognitive tests
  - Use tests which are as similar as possible (based on research question):
    - Same test
    - Same domain / conceptually similar
- Processing the data
  - Perhaps converting to a similar metric
- Estimating the quality of harmonised variables using latent variable approach (or item response theory for individual test comparisons).
  - Test for measurement equivalence – are they assessing the same underlying construct to the same degree

Conclusions

- Few tests were the same or similar across and/or within cohorts
  - Therefore items or tests could not be “chained” together

- As a first step we used measurement invariance to test for equivalence of ‘g’:
  - Partial invariance:
    - Mid-life cognitive measures (NSHD,NCDS and BCS)
    - Age 10/11: NSHD and NCDS
    - NSHD in adulthood
  - Equivalence not found when conceptually similar (but not the same) tests used

- Limitations of approach:
  - Could not test individual measures
  - Need a number of measures within each sweep
  - Equivalence is the most conservative approach

- Need to explore other approaches to harmonise other cognitive measures
  e.g. external information to link/calibrate tests

Thank you for listening

Any questions???

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