

Can cognitive reflection measurement be improved?

Erceg, Galić, Ružojčić, Palanović

What is CRT?

- Cognitive reflection test (Frederick, 2005) measures the ability or disposition to resist reporting the response that first comes to mind
 - A bat and a ball cost \$1.10. The bat costs \$1.00 more than the ball. How much does the ball cost? ____ cents
 - If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? _____ minutes
 - In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? _____ days

What is CRT?

- What does CRT measure?
 - Cognitive reflection / miserly processing
 - Cognitive ability
 - Numeracy
 - Cognitive styles / thinking dispositions
- What does CRT predict?
 - (Un)susceptibility to heuristic and biases
 - Resistance to epistemically suspect beliefs
 - Science based beliefs
 - Lower religiosity
 - Utilitarian moral judgments

The problems with CRT

- Too short / low reliability
- Quite hard
- Well known



Najkraći IQ test na svijetu od samo tri pitanja puno je teži nego se čini

Our study

- Our goal was to develop and validate a longer and more reliable CRT measure
 - a) Adding additional items (Thomson & Oppenheimer, 2016; Toplak, West, & Stanovich, 2014)
 - Luka's father has three sons. The two of them are called April and May. What is the name of the third son?
 - A dozen of kuna coins consists of twelve 1 kuna coins. How many 2 kunas coins are there in a dozen of kuna coins?
 - In athletics team, tall members are three times more likely to win a medal than short members. This year, the team has won 60 medals so far. How many of these have been won by short athletes?
 - b) Validation
 - IRT analysis
 - Convergent validity

Our study

- N = 253 college students
- F = 71%; M = 29%
- $M_{\text{age}} = 20.83$ (SD = 2.31; min = 18; max = 31)
- Belief-bias syllogisms – 8 items

Premises:

- All flowers have petals.
- Roses have petals.

Conclusion:

- Roses are flowers

Premises:

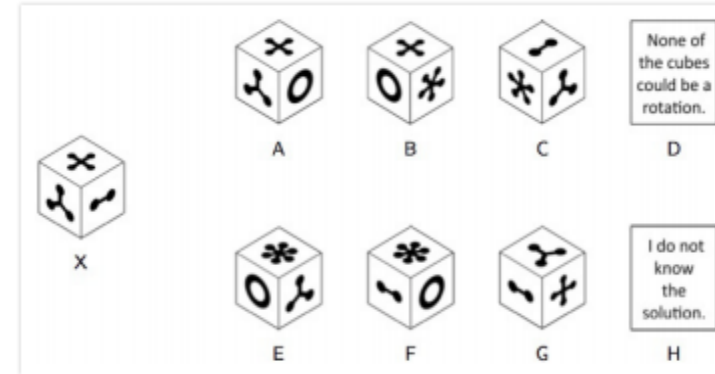
- All four-legged animals are dangerous.
- Poodles are not dangerous.

Conclusion

- Poodles do not have four legs.

Our study

- Icar – 16 items
 - The International Cognitive Ability Resource Team (2014)
 - Verbal reasoning
 - Letter and number series
 - Matrix reasoning
 - Rotations
- Berlin Numeracy Test (Cokely et al., 2012) – 4 items
 - Imagine we are throwing a five-sided die 50 times. On average, out of these 50 throws how many times would this five-sided die show an odd number (1, 3 or 5)?
- AOT (Campitelly & Labollita, 2010) – 15 items
 - A change of thought is a sign of weakness.
 - It is a noble thing when someone holds same beliefs as his/her parents.



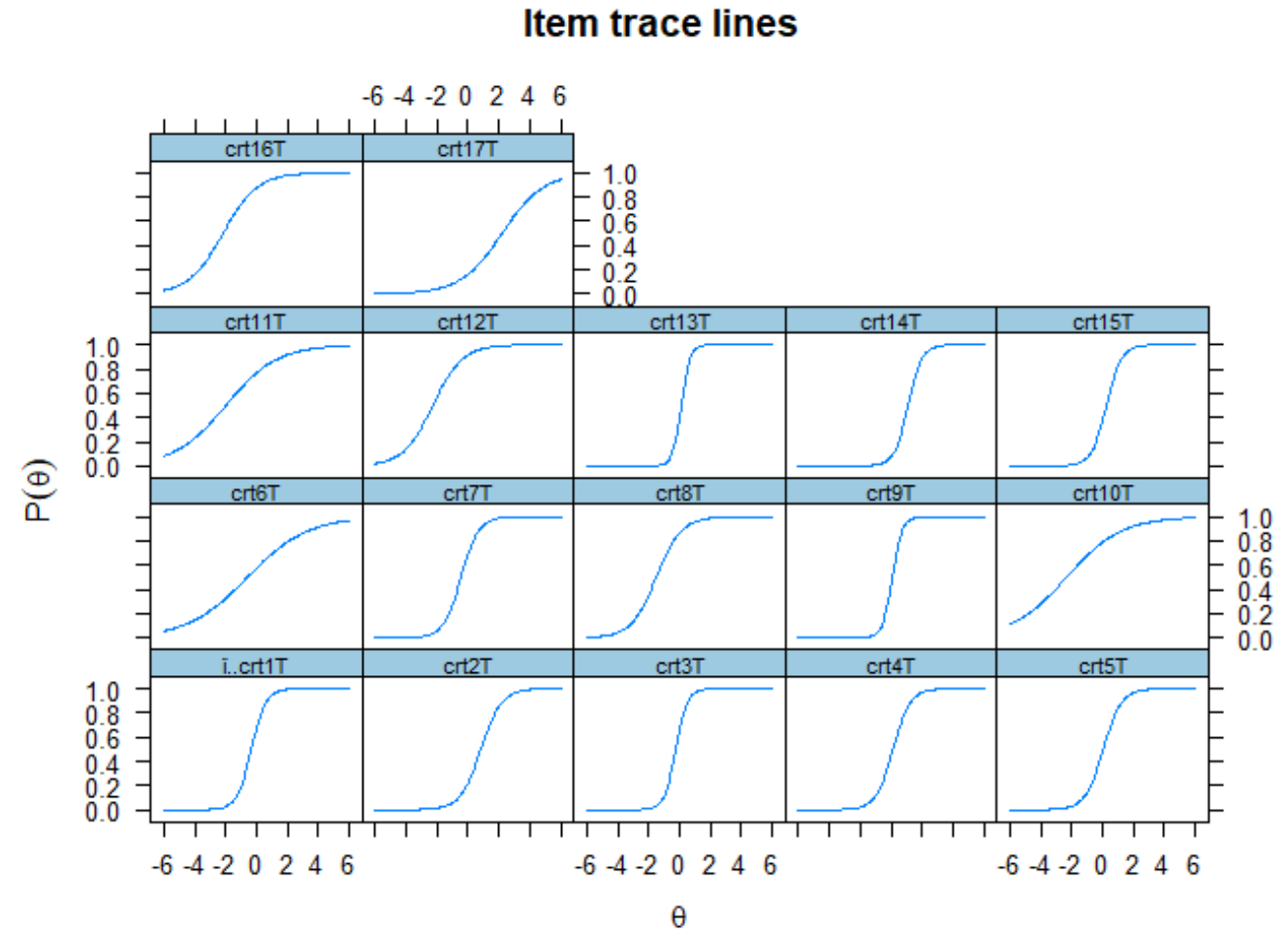
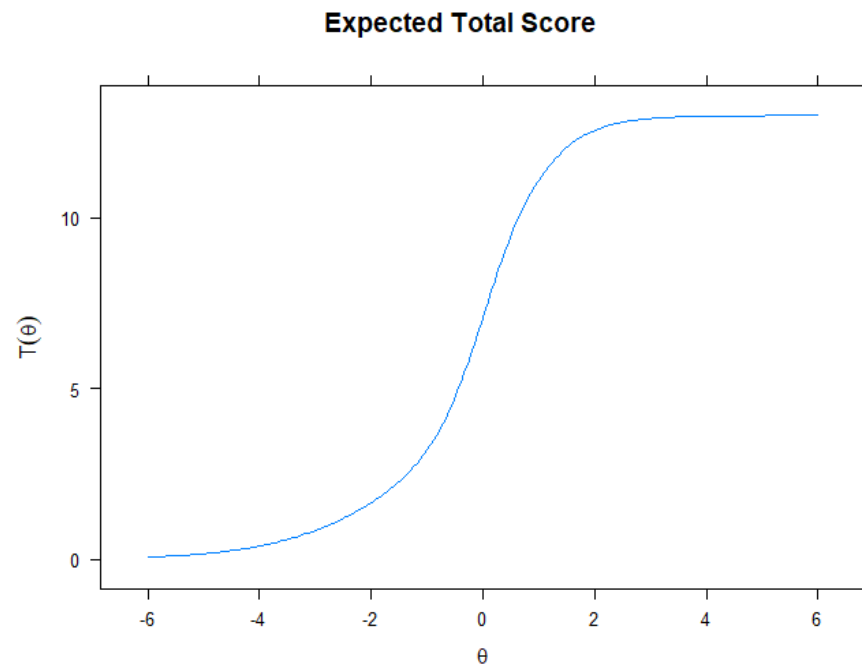
- Item descriptive statistics

Item	% Correct	% Intuitive	% Other
1	60	36	4
2	29	45	26
3	58	30	12
4	46	16	38
5	49	28	23
6	57	27	16
7	63	31	6
8	81	16	3
9	47	43	10
10	78	10	12
11	75	20	5
12	88	12	0
13	46	45	9
14	19	46	35
15	42	40	18
16	85	14	1
17	19	26	55

- IRT analysis
- 2 parameter model fits the data well
- $\chi^2(119) = 151.9, p = .02$
- RMSEA = .033
- CFI = .985

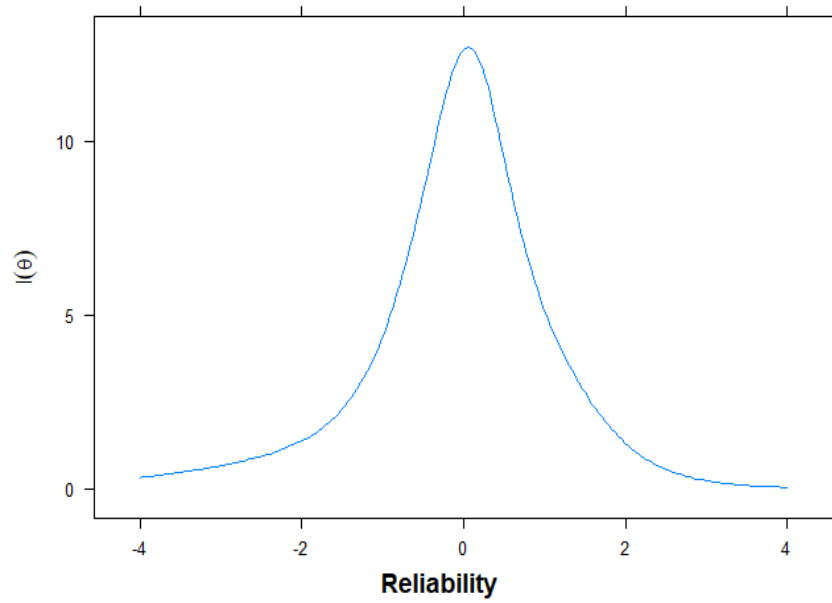
Item	a	b	RMSEA
1	2.17	-0.32	0.00
2	1.50	0.84	0.06
3	2.70	-0.24	0.10
4	1.80	0.13	0.00
5	1.71	0.05	0.04
6	0.52	-0.57	0.00
7	1.78	-0.44	0.03
8	1.23	-1.50	0.00
9	3.17	0.09	0.00
10	0.57	-2.33	0.00
11	0.60	-1.98	0.00
12	1.05	-2.27	0.08
13	3.62	0.12	0.00
14	2.26	1.11	0.03
15	2.07	0.26	0.06
16	0.90	-2.17	0.00
17	0.75	2.20	0.00

Test and items characteristic curves

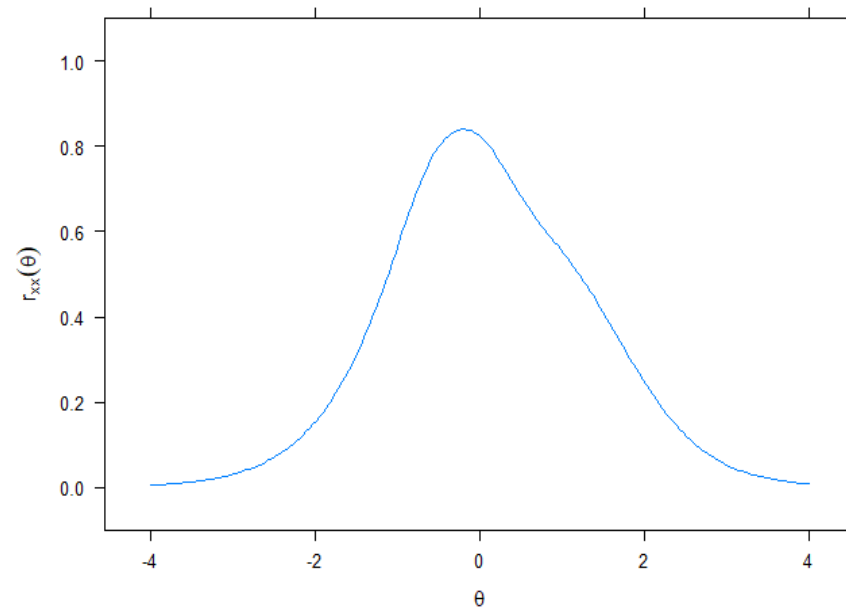
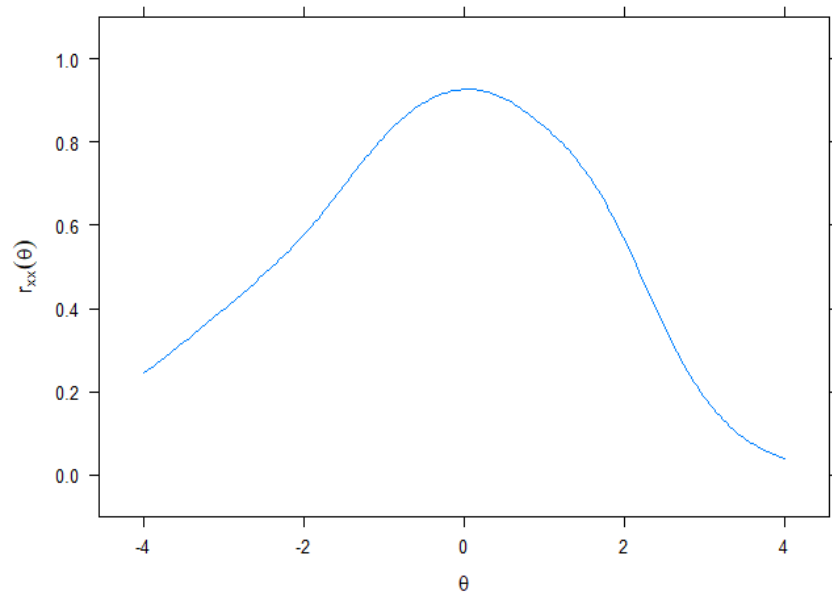
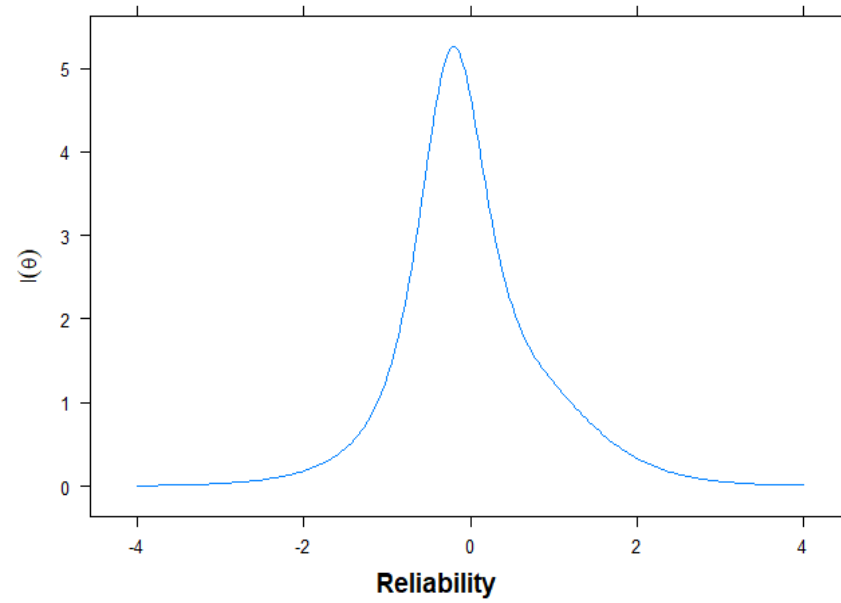


- CRT 13 vs. CRT 3

Test Information



Test Information



CRT 13 vs. CRT 3

	CRT13	CRT3	CRT13 retest	CRT3 retest
N	253	253	66	66
Mean	7.10	1.46	8.86 (7.95)	1.94 (1.74)
Median	7	2	9.50	2
min	0	0	2	0
max	13	3	13	3
SD	3.60	1.11	3.45	1.14
Cronbach alpha	.86	.66	.86	.72
Test-retest	.87	.82	/	/

Convergent validity

- Correlations among the variables
 - Medium to high positive correlations are expected

	CRT13	CRT3	ICAR	NUM	AOT	SIL
CRT13	1					
CRT3	.85	1				
ICAR	.62	.53	1			
NUM	.67	.53	.44	1		
AOT	.20	.19	.24	.15	1	
SIL	.58	.51	.51	.43	.31	1

- Regression analysis with belief-bias syllogisms as an outcome and Icar, Numeracy, AOT and CRT 13 (at T1 and T2) as predictors

Convergent validity

	T1 (N = 253)	T2 (N = 66)
Predictor	Beta	Beta
ICAR	.38**	.43**
NUM	.23**	.16
AOT	.18**	.14
R	.59	.53
R ²	.35**	.28**
ICAR	.23**	.26*
NUM	.05	.00
AOT	.17**	.02
CRT13	.37**	.44**
R	.64	.62
R ²	.41**	.38**
ΔR^2	.06**	.10**

Conclusion

- CRT 13 is more reliable and precise for a wider range of the measured trait than CRT 3
- CRT 13 might measure reflection – predicts belief-bias syllogism results even after controlling for intelligence, numeracy and active-openminded thinking

Problems and future research

- Not all people need reflection to be able to correctly solve CRT items – CRT might measure different constructs for different people
- Might be good to develop harder and easier versions
- CRT is too saturated with numeric ability – need for development of „purer” measure of reflection

Thank you