

Research activity, interests and beyond

Ottavia M. Epifania, Ph.D.



Università di Trento
Rovereto, Italia

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Item Response Theory and Rasch modeling

(TITLE-ABS-KEY ("Item response theory") OR TITLE-ABS-KEY ("Rasch"))
AND PUBYEAR > 1959 AND PUBYEAR < 2025 AND (LIMIT-TO (DOCTYPE , "ar"))

$n = 18,661$ documents (May, 17th 2024) on Scopus:

Some fields of application:



Some reasons for their application:

Measure validation

Measure refinement

Item selection

Computerized adaptive testing

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Rasch revised & beyond
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IRT and short test forms
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Measurement theory
oooo

Teaching Activity
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Rasch modeling of complex data structures

Rasch revised & beyond
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IRT and short test forms
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Measurement theory
○○○○

Teaching Activity
○○



A_{Bart}



A_{Lisa}



A_{Bart}

Q1

$$4 + 5 = ?$$

d_{q1}

Q2

$$\frac{3}{2}x^2 + \frac{5}{4}x = ?$$

d_{q2}



A_{Lisa}



Q1

$$4 + 5 = ?$$

$$d_{q1}$$

A_{Bart}

Q2

$$\frac{3}{2}x^2 + \frac{5}{4}x = ?$$

$$d_{q2}$$

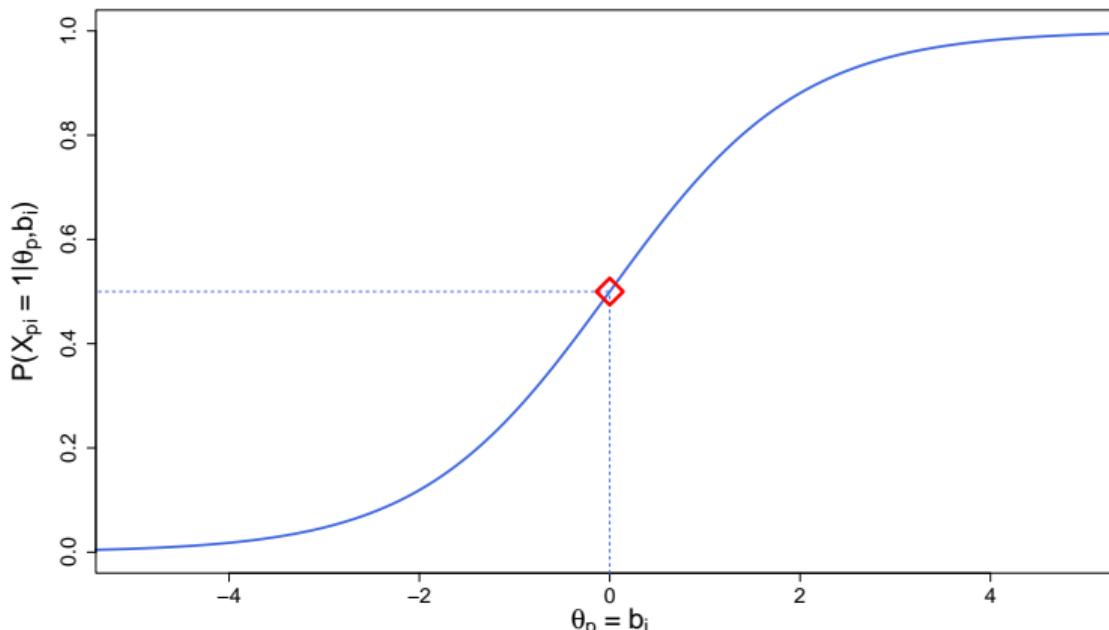


A_{Lisa}

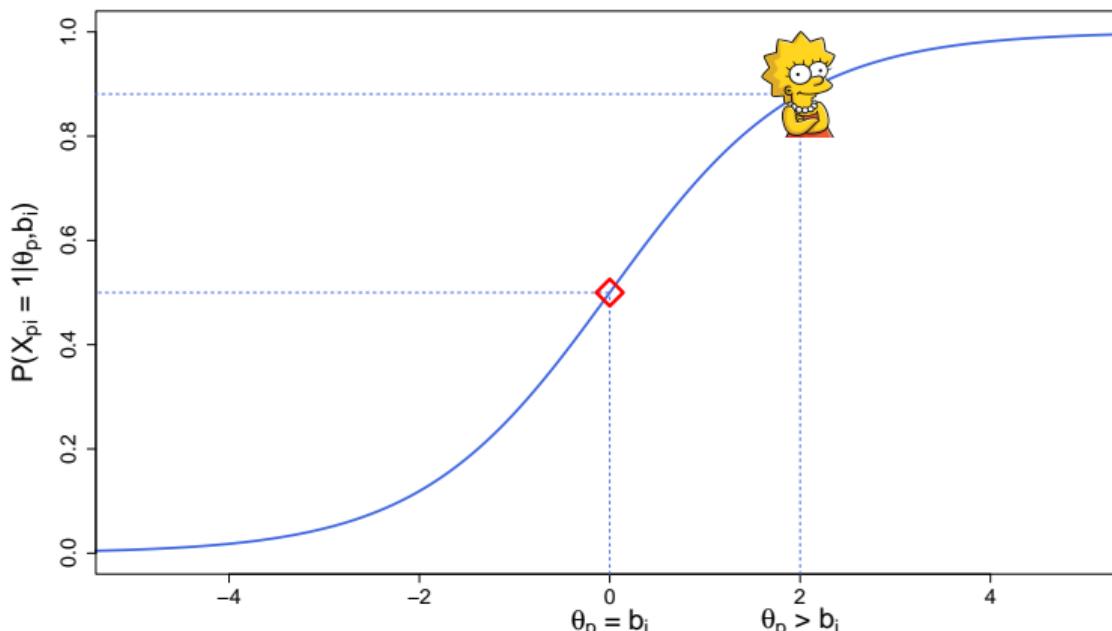
$$P(X_{pi} = 1) = \frac{\frac{A_p}{d_i}}{1 + \frac{A_p}{d_i}}$$

$$P(X_{pi} = 1 | \theta_p, b_i) = \frac{\exp(\theta_p - b_i)}{1 + \exp(\theta_p - b_i)}$$

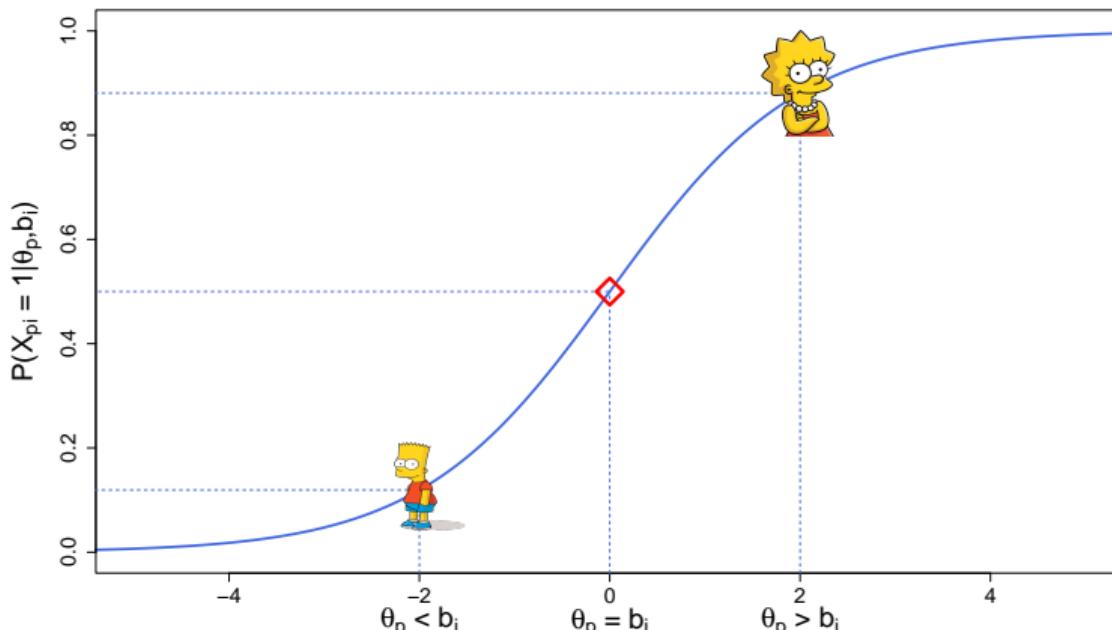
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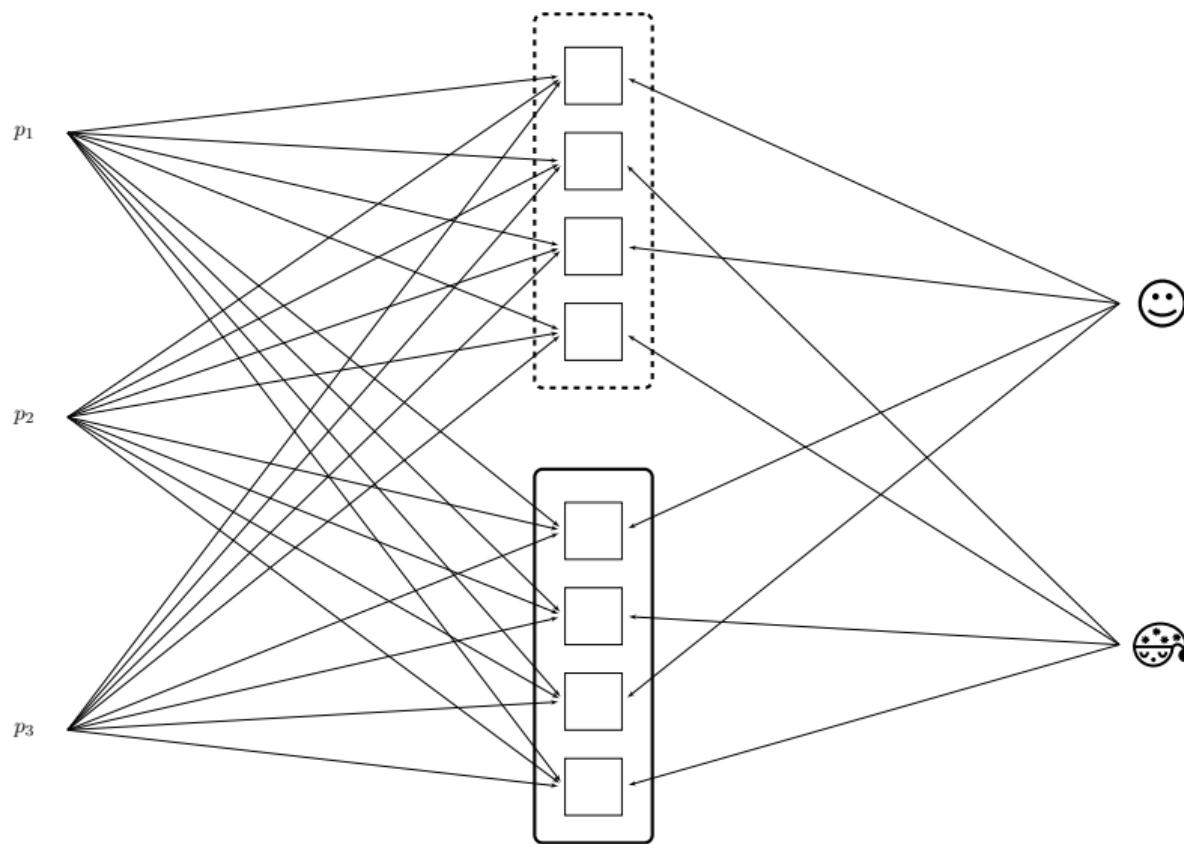


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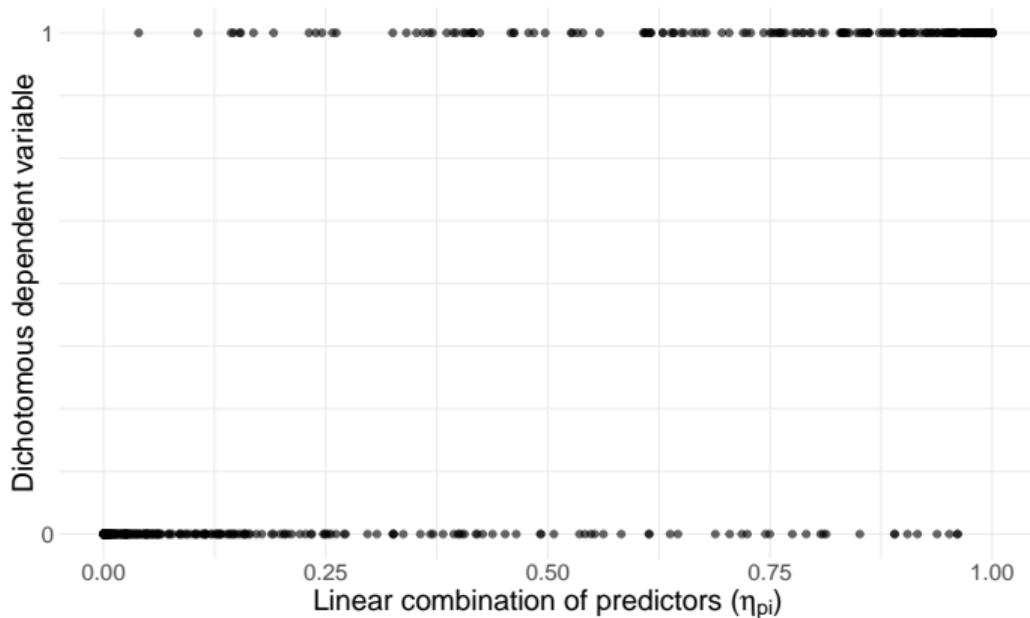


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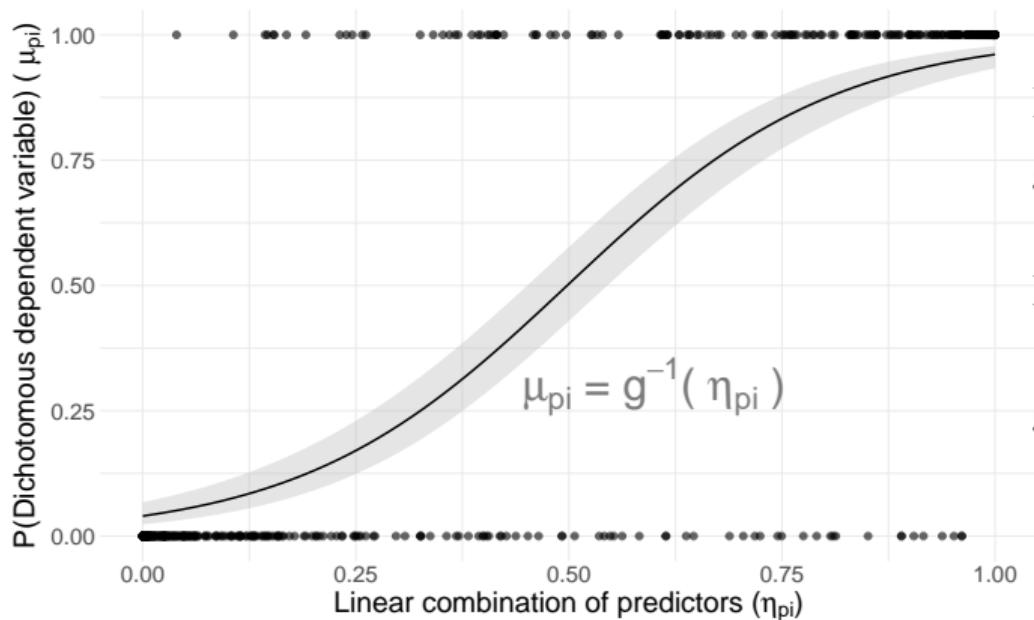




Generalized linear model (GLM) for dichotomous responses



Generalized linear model (GLM) for dichotomous responses



Logit link function g :
$$g(\eta_{pi}) = \log\left(\frac{\mu_{pi}}{1-\mu_{pi}}\right)$$

Inverse g^{-1}

$$g^{-1} = \frac{\exp(\eta_{pi})}{1+\exp(\eta_{pi})}$$

Random effects and random factors

Linear combination of predictors in a Linear Model:

$$\eta = X\beta,$$

where β indicates the coefficients of the fixed intercept and slope(s), and X is the model-matrix.

Linear combination of predictors in a Linear Mixed-Effects Model (LMM):

$$\eta = X\beta + Zd,$$

where Z is the matrix and d is the vector of the random effects (not parameters!)

Best Linear Unbiased Predictors

Future lines and developments

Application to data from experiments typically used in different fields of study, such:

- Go/No-Go in addiction studies
- SNARC effect in cognitive psychology
- ...

Integration between the information obtained from the accuracy responses and the response times

Rasch revised & beyond
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IRT and short test forms
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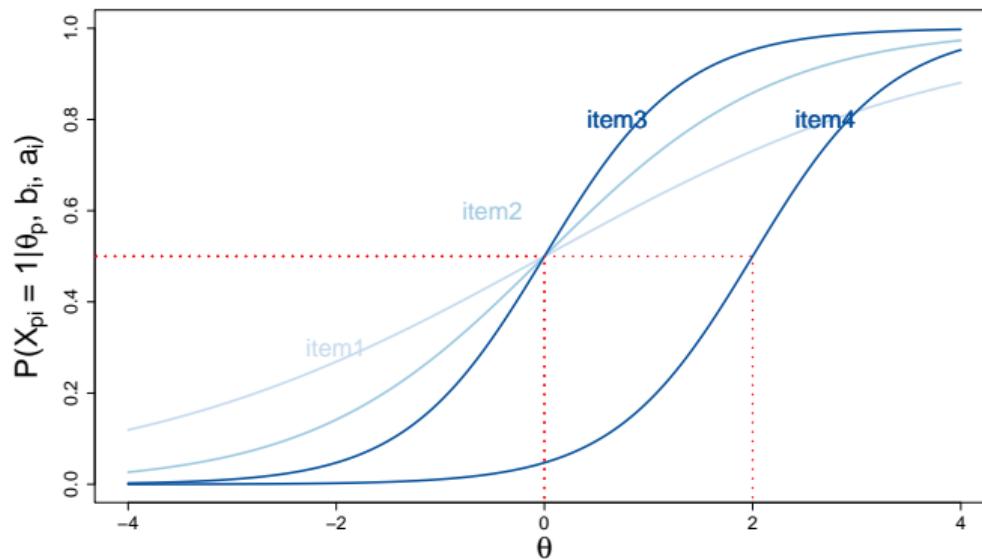
Measurement theory
oooo

Teaching Activity
oo

Item Response Theory and short test forms development

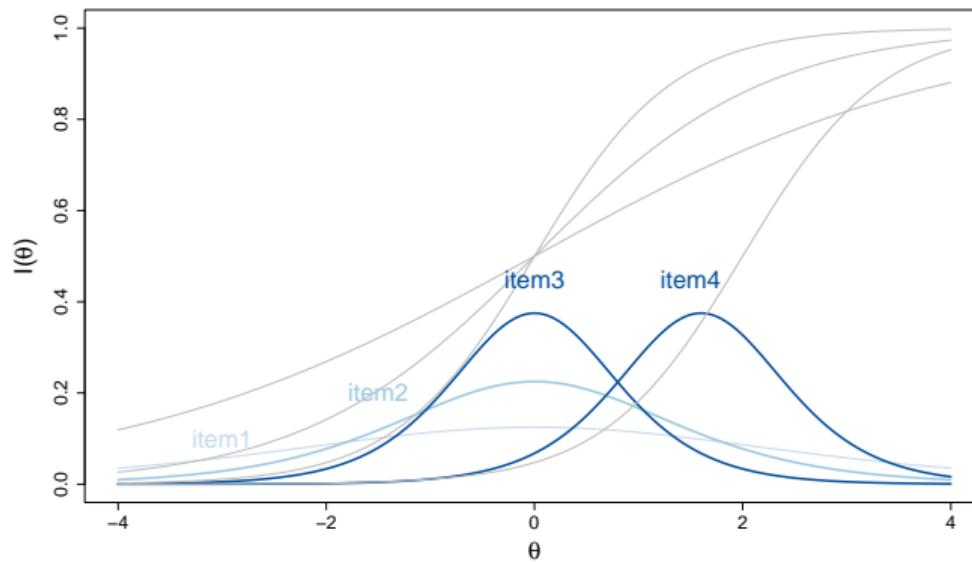
2-Parameter Logistic Model

Item Response Function: $P(x_{pi} = 1 | \theta_p, b_i, a_i) = \frac{\exp[a_i(\theta_p - b_i)]}{1 + \exp[a_i(\theta_p - b_i)]}$



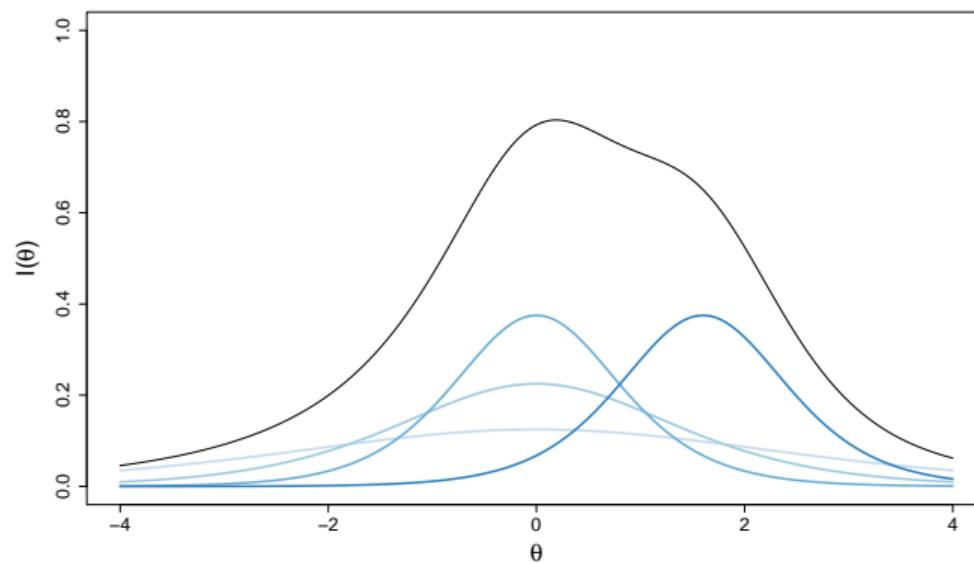
2-Parameter Logistic Model

Item Information Function: $I_i(\theta) = a_i^2 P_i(\theta, b_i, a_i)[1 - P_i(\theta, b_i, a_i)]$



2-Parameter Logistic Model

Test Information Function: $I(\theta) = \sum_{i=1}^I I_i(\theta)$



θ -target procedure

Selected items → items with highest *IIFs* with respect to θ targets (θ')

e.g.: *3-item short form from 10-item full-length test*

item	θ'_1	θ'_2	θ'_3
1	-2.67	0.01	2.67
2			
3			
4			
5			
6			
7			
8			
9			
10			

θ -target procedure

Selected items → items with highest *IIFs* with respect to θ targets (θ')

e.g.: *3-item short form from 10-item full-length test*

item	θ'_1	θ'_2	θ'_3
1	0.04	0.12	0.08
2	0.09	0.33	0.03
3	0.01	0.01	0.02
4	0.73	0.06	0.01
5	0.04	0.03	0.02
6	0.01	0.06	0.59
7	0.05	0.06	0.03
8	0.01	0.04	0.69
9	0.03	0.05	0.04
10	0.02	0.03	0.02

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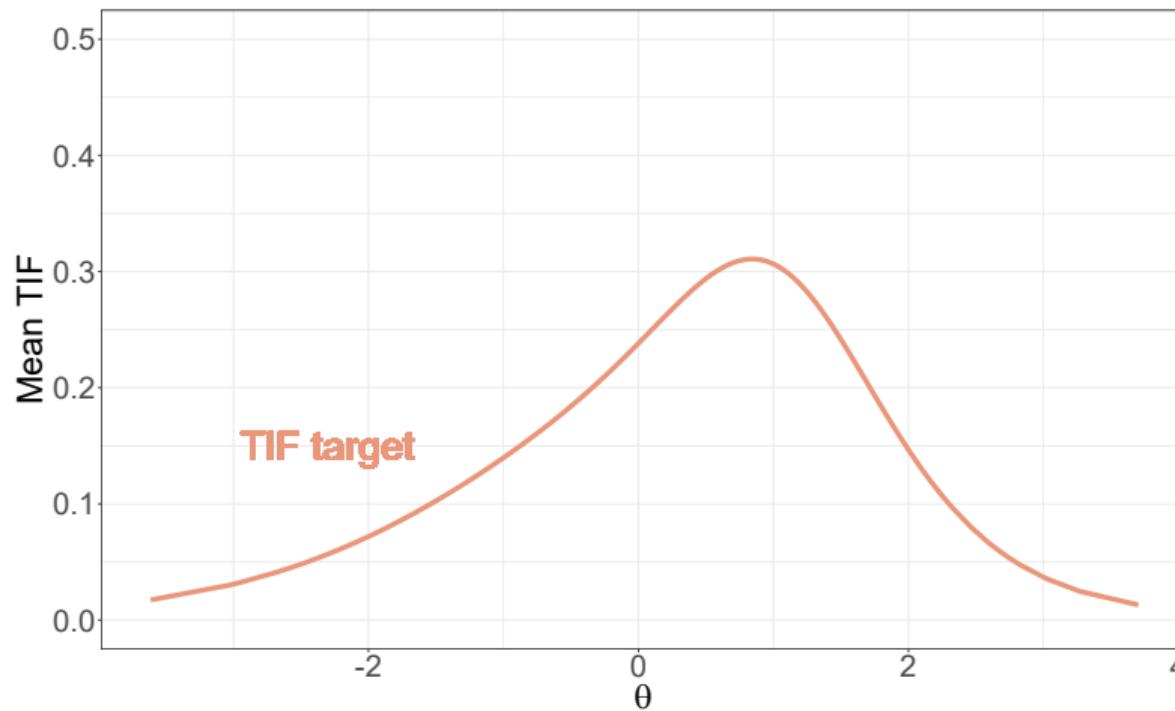
θ -target procedure

Selected items → items with highest *IIFs* with respect to θ targets (θ')

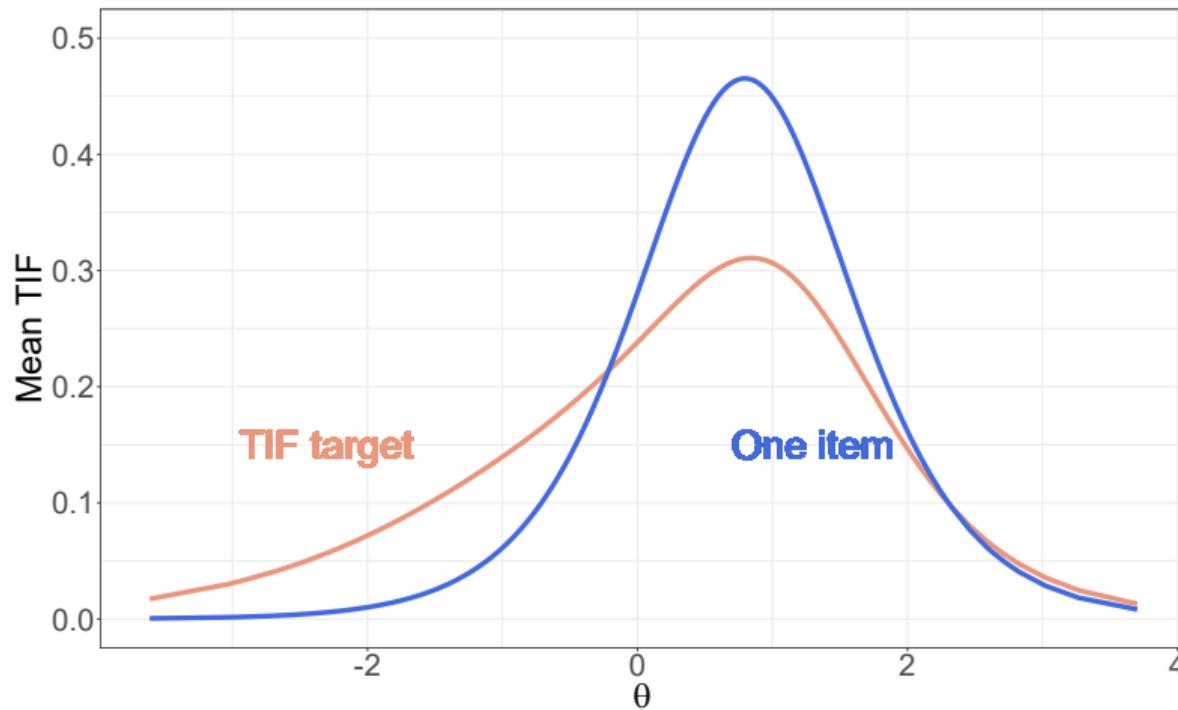
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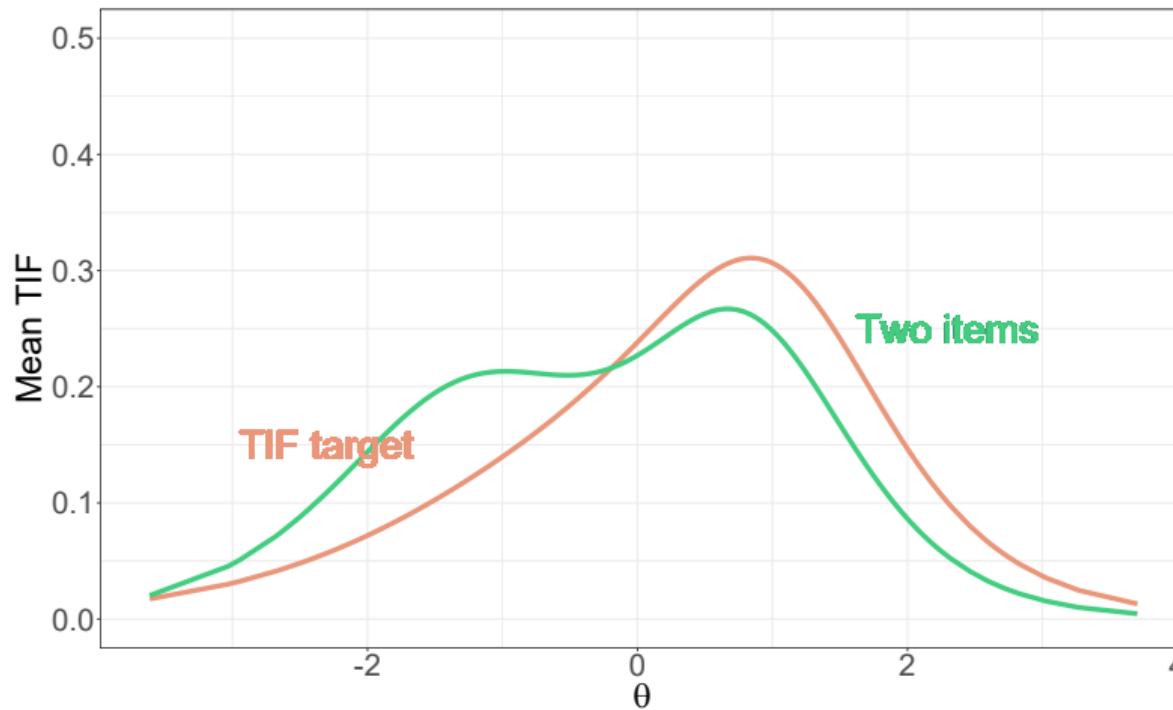
The other way around



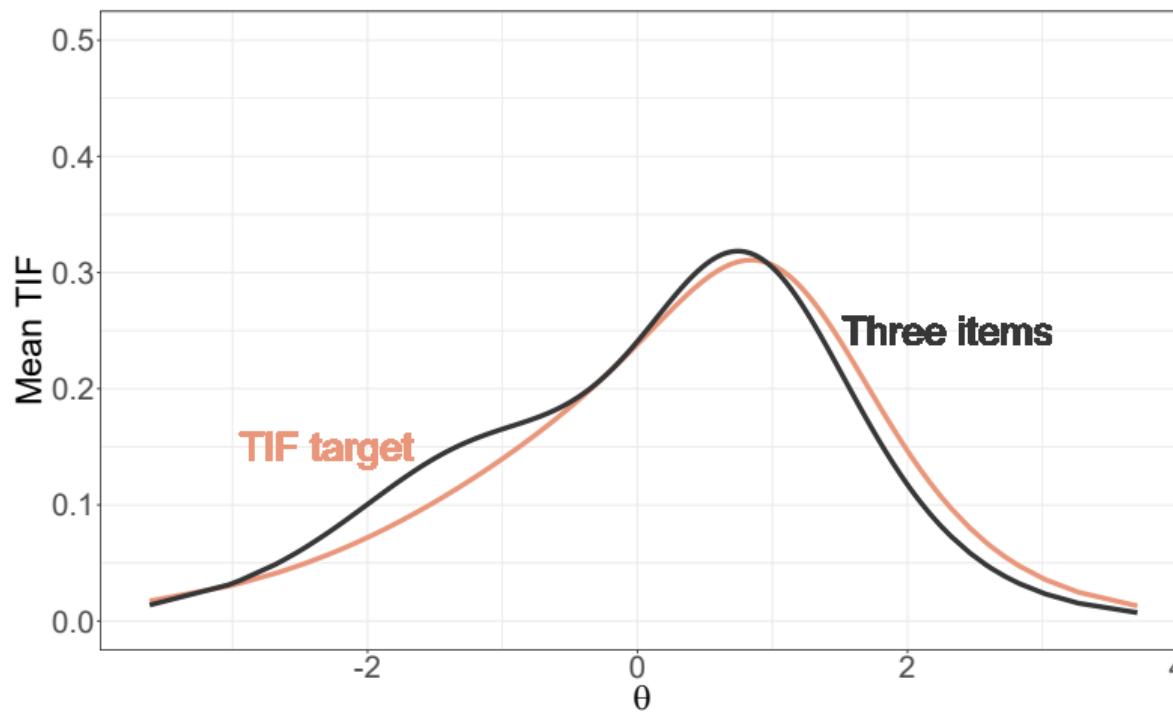
The other way around



The other way around



The other way around



Future lines and directions

- Development of short test forms for the diagnosis of clinically relevant constructs (e.g., addiction) → Focused on specific regions of the latent trait
- Extension to multidimensional/bifactor latent structures (e.g., content balancing) and to polytomous data

Rasch revised & beyond
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IRT and short test forms
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Measurement theory
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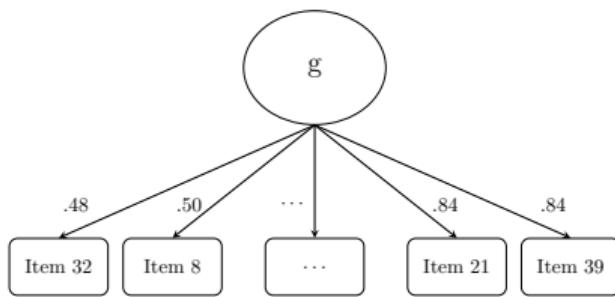
Teaching Activity
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Measurement theory

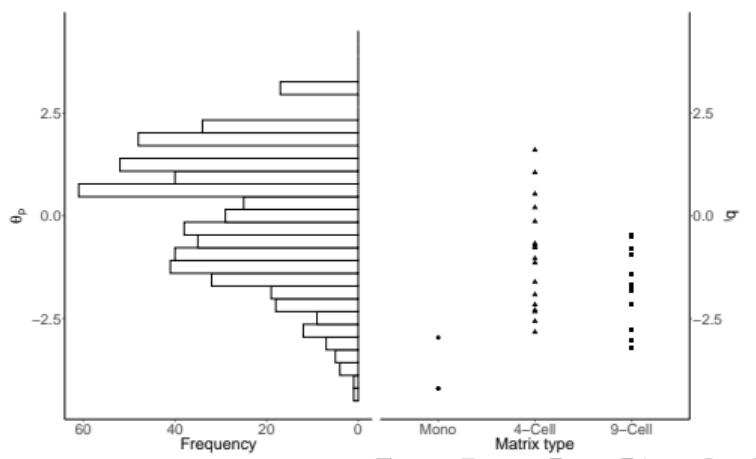
Measuring fluid intelligence

Raven-like measure for the assessment of fluid intelligence in children and adults:
From stimulus generation to measure validation under three different approaches

Classical Test Theory
Factorial solution



Rasch modeling
Wright map



The meaningfulness of Psychological Measures

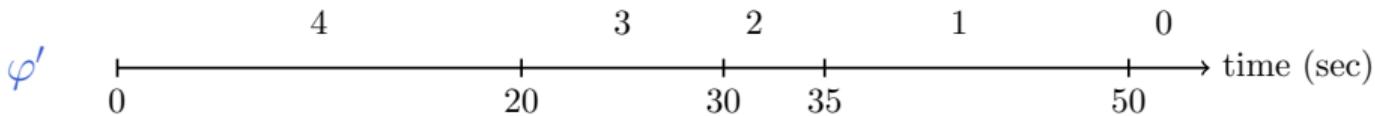
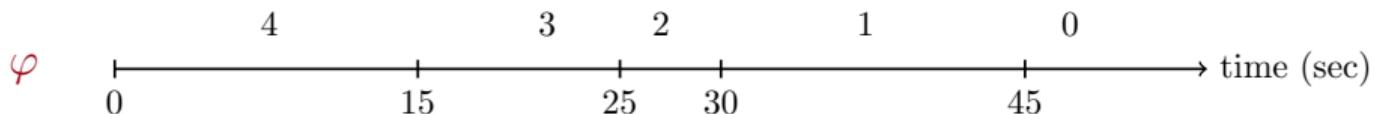
The ratio between the measures of a and b is constant and independent of the measurement unit:

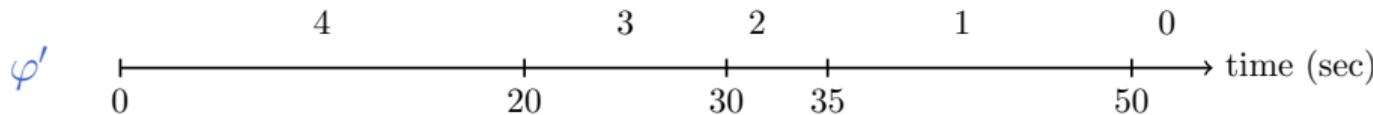
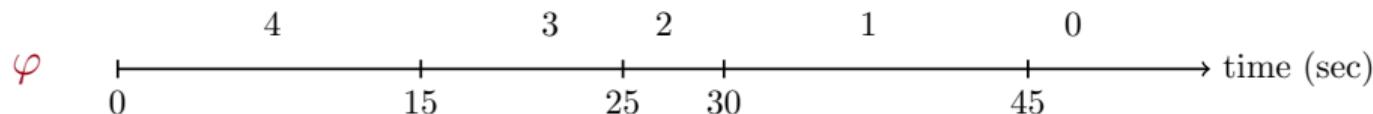
$$\frac{\varphi(a)}{\varphi(b)} = \frac{\varphi'(a)}{\varphi'(b)},$$

where φ and φ' are two different scales of measurement of the same variable.

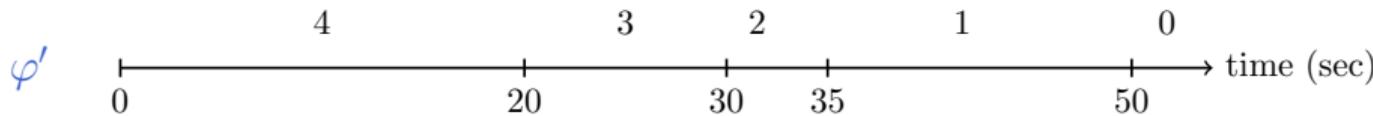
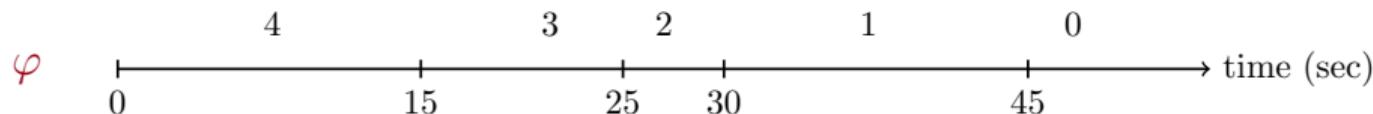
Meaningful comparisons

The comparison between a and b is meaningful if it is invariant under all the unit transformations.

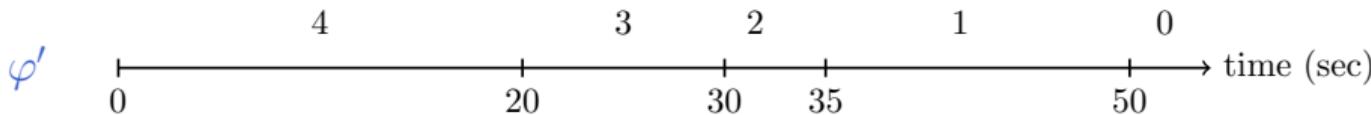
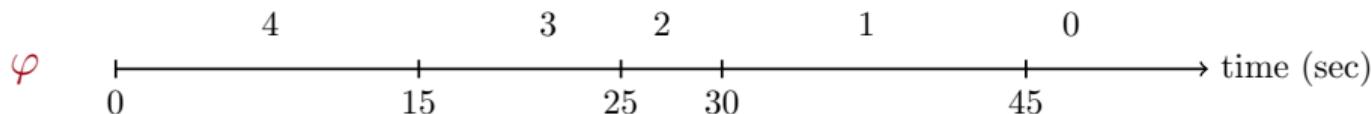




Item	t_A	t_B	φ_A	φ_B	φ'_A	φ'_B
1	14	17	4	3	4	4
2	26	19	2	3	3	4
3	31	18	1	3	2	4
4	47	33	0	1	1	2
5	17	47	3	0	4	1
Sum scores			10	10	14	15



Item	t_A	t_B	φ_A	φ_B	φ'_A	φ'_B
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Rasch revised & beyond
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IRT and short test forms
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Measurement theory
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Teaching Activity
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Teaching Activity

From theory...

Psychometrics

Statistics, data analysis, and experiment design in Social Sciences

Measurement Theory and Measurement models in Psychology

Rasch modeling and Item Response Theory

...to practice

R for beginneRs

RMarkdown in an Open Science perspective

Developing web applications with shiny

Implementing experiments in Inquisit

Thank you!

