

# L'importanza di essere significante: Un esempio basato sul test della Torre di Londra

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La psicometria tra oggi e domani:  
Sfide e nuovi orizzonti

20 Giugno 2024



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  $\varphi$  and  $\varphi'$  are two different scales of measurement of the same variable<sup>1</sup>.

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## Meaningful comparisons 2.0

Given that there is a difference between  $a$  and  $b$ , is this difference significant (or not) regardless of the scales of measurement?

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Admissible and non-admissible transformations

$$\varphi(P) = [0, 1, 2, 3]$$

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	$q_1$	$q_2$	$q_3$	$q_4$	$q_5$	$q_6$	$q_7$	$q_8$	$q_9$
$\varphi$									
Joe	0	1	2	2	2	3	3	3	3
Jane	0	2	2	2	3	3	3	3	3
Max	0	1	0	2	3	3	3	3	3
$\varphi'$									
Joe	0	2	4	4	4	10	10	10	10
Jane	0	4	4	4	10	10	10	10	10
Max	0	2	0	4	10	10	10	10	10
$\epsilon$									
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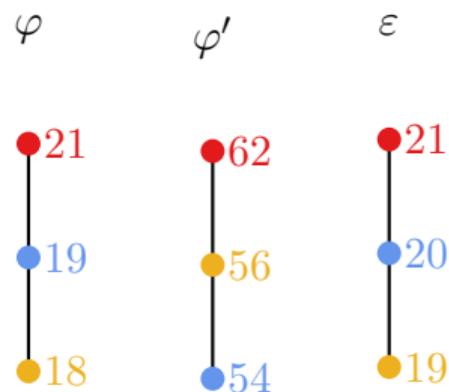
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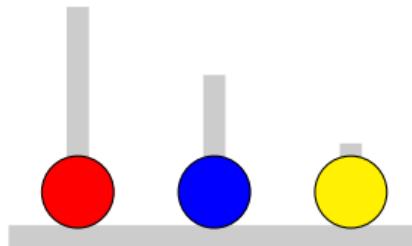
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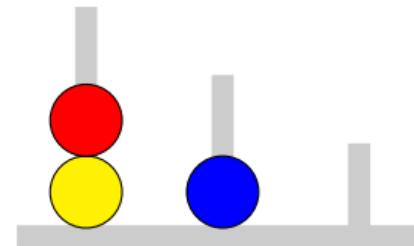
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## The Tower of London Test (ToL Test)

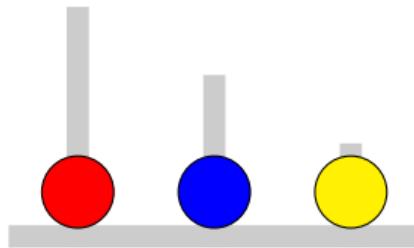


Starting configuration

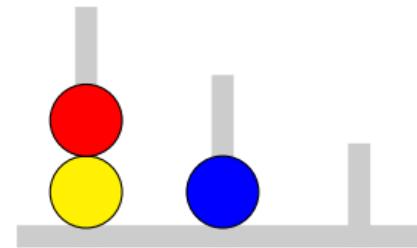


Goal configuration

## The Tower of London Test (ToL Test)



Starting configuration



Goal configuration

Problem Example	Minimum moves	Alternative paths
1	2	1
2	2	1
3	3	2
4	3	1
5	4	2
6	4	1
7	4	1
8	4	1
9	5	2
10	5	1
11	5	1
12	5	2

## Attempt-based SMs

Scoring system	First attempt	Second attempt	Third attempt	Fourth on	Total sum score
KR	3	2	1	0	0 – 36
SH1	1		0		0 – 12

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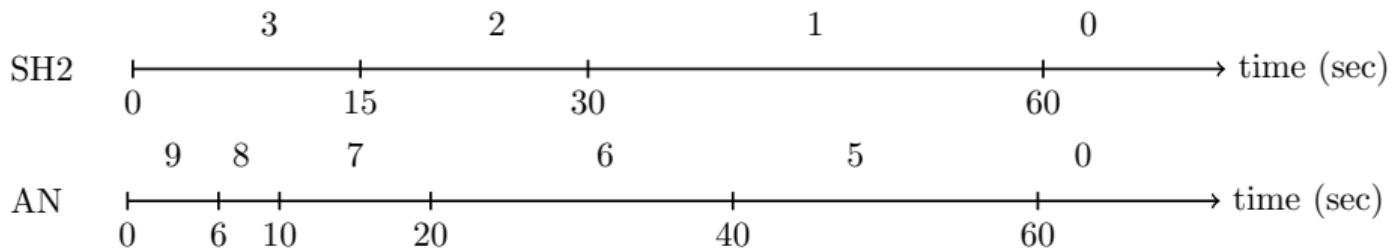
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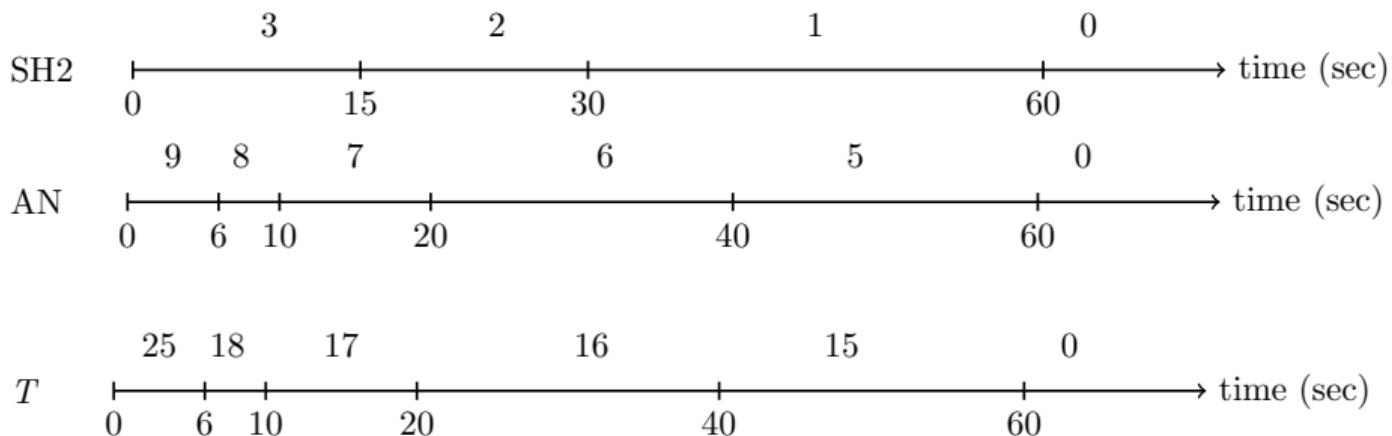
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## Latency-based SMS

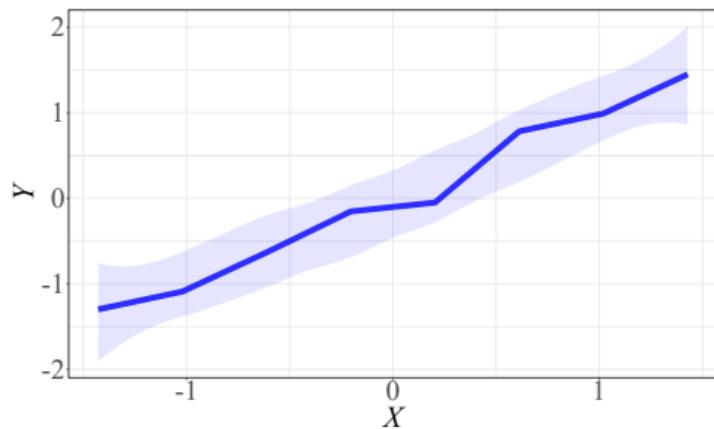


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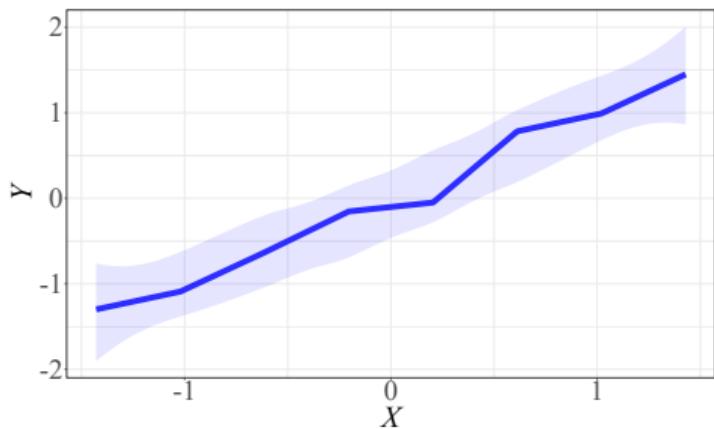
Methods: Individual differences

## Monotonic relation

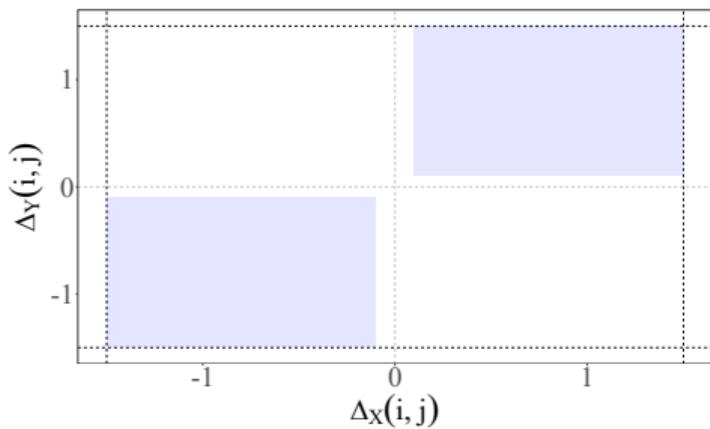


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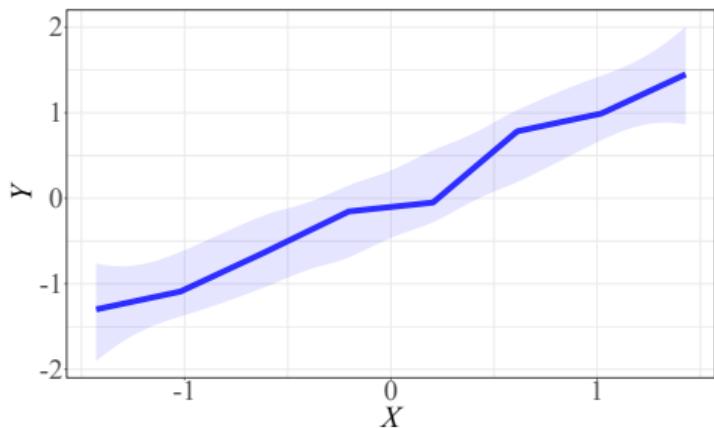


## Distances and inversions

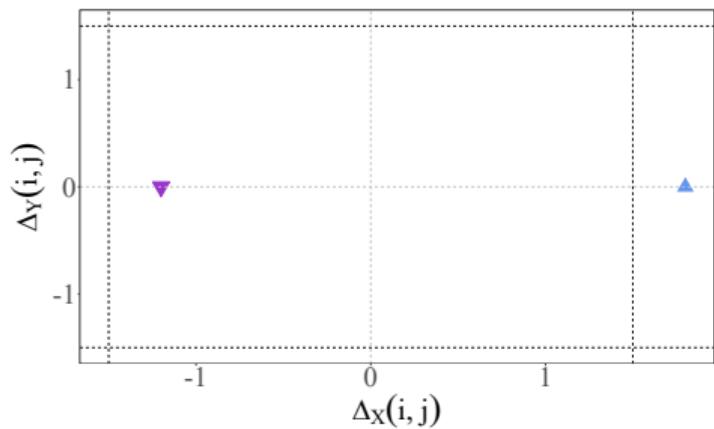


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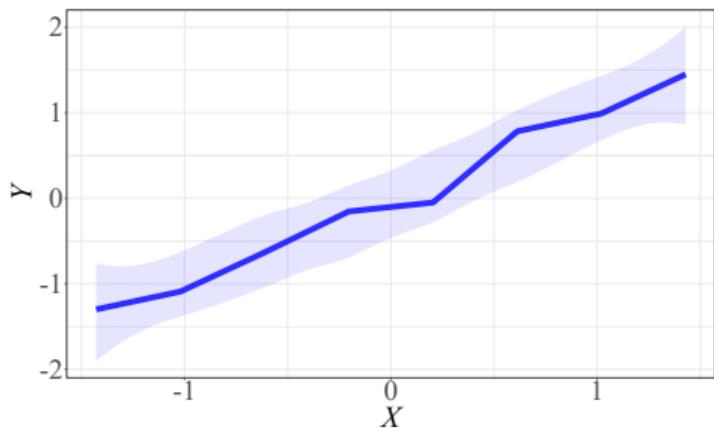


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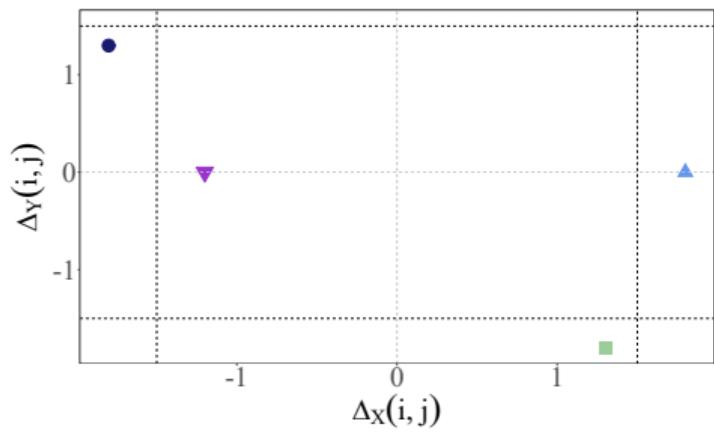


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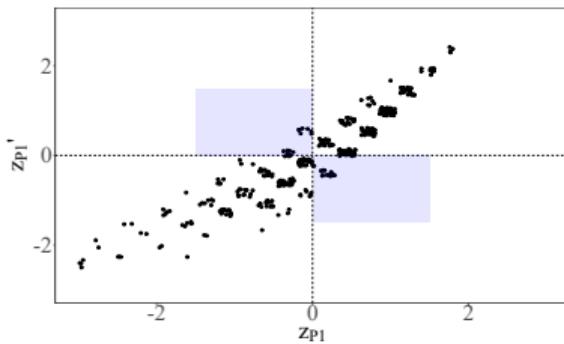
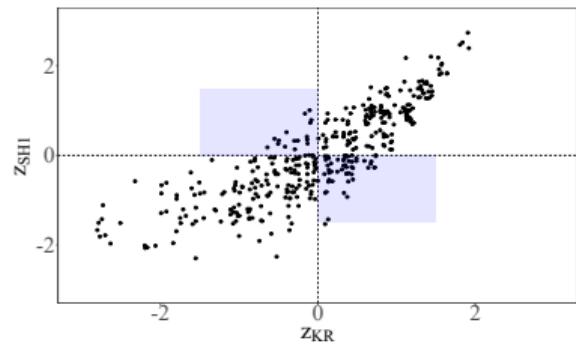


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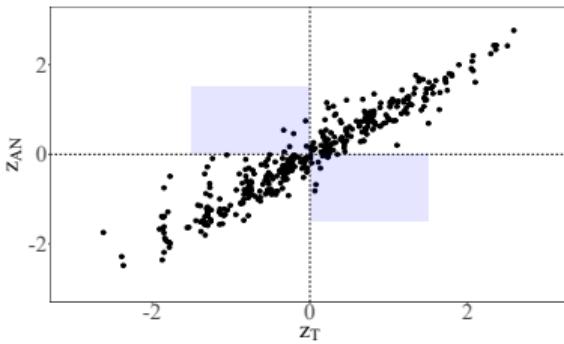
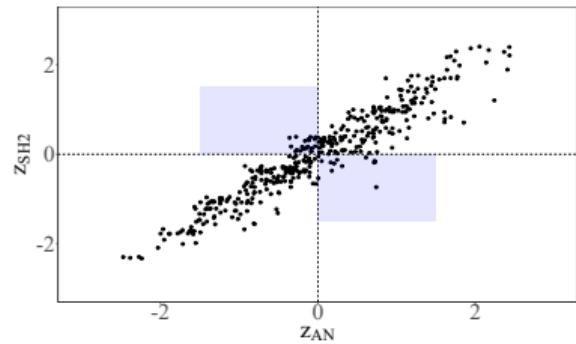


Results: Monotonic relation

## Attempt-based SMs

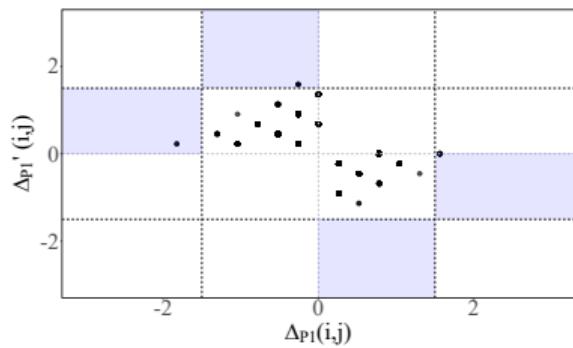
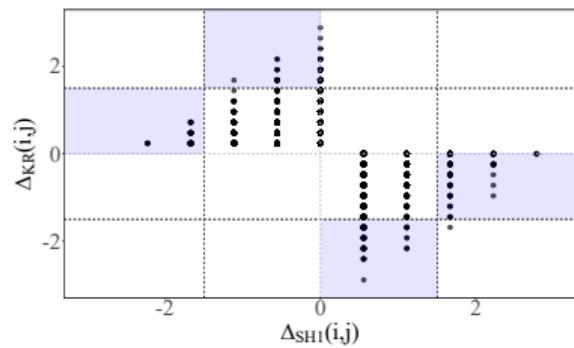


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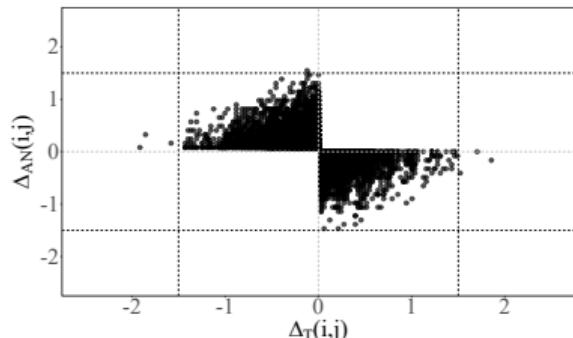
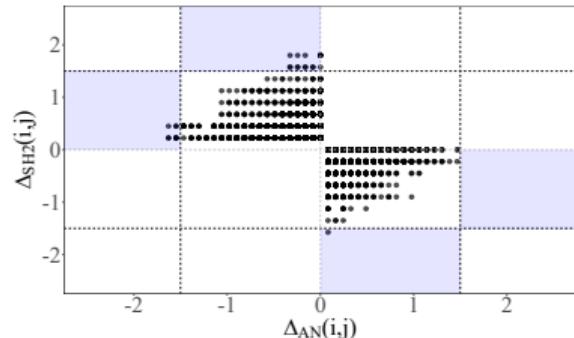


Results: Differences and distances

## Attempt-based SMs



## Latency-based SMs



## Methods: Group differences

$$H_0: \mu_{g1} - \mu_{g2} = 0$$

$$H_1: \mu_{g1} - \mu_{g2} \neq 0$$

*t*-test on the standardized scores considering different grouping variables:

Grouping variable	$n_1$	$n_2$
Gender	199	196
Administration order	202	193
Administration modality	211	184
Schooling years	171	224

## Results: Attempt-based SM

	KR	SH1	P1	P1'
	<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>
Gender	1.84	2.11*	1.69	2.03*
	0.19	0.21	0.17	0.20
Test order	-0.15	0.80	-0.48	0.28
	-0.01	0.08	-0.05	0.03
Adm. Modality	-2.85**	-1.93	-2.69**	-2.35*
	-0.29	-0.19	-0.27	-0.24
Schooling	3.95***	3.56***	3.82***	3.85***
	0.39	0.36	0.38	0.39

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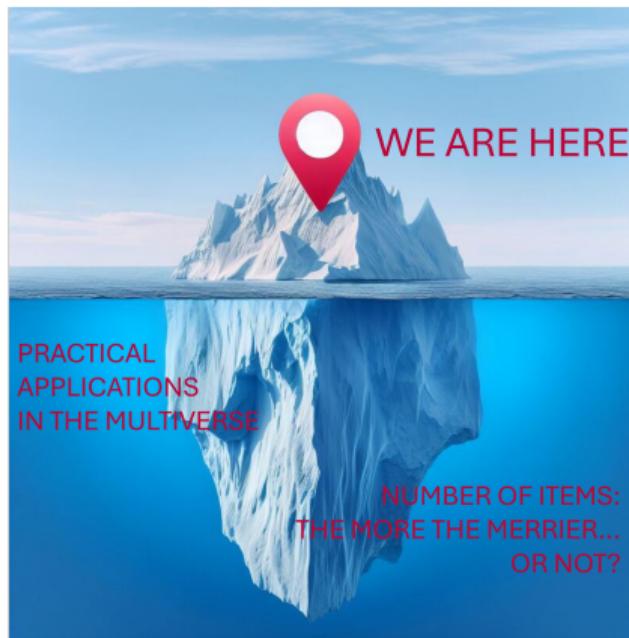
	SH2	AN	T
	<i>d</i>	<i>d</i>	<i>d</i>
Gender	1.64	1.88	2.10*
	0.17	0.19	0.21
Test order	0.37	0.99	0.95
	0.04	0.10	0.10
Adm. Order	-2.90**	-2.33*	-2.84**
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Schooling	5.52***	5.32***	5.13***
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<https://doi.org/10.1007/s11336-024-09964-7>



RECOGNIZE THE VALUE OF THE SUM SCORE, PSYCHOMETRICS' GREATEST  
ACCOMPLISHMENT

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Sum scores of ordinal data bring to a multiverse of contrasting results



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Increasing the number of items does not solve the issue.... it worsens it!

Meaningfulness of psychological measures and reproducibility are interlaced

Research founded by the project “Computerized, Adaptive and Personalized Assessment of Executive Functions and Fluid Intelligence” (PRIN 2020, Prot. 20209WKCLL, P.I. Prof. Luca Stefanutti)



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### Bright side:

Sum scores of truly dichotomous data (i.e., true vs. false, correct vs. incorrect) are meaningful

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