

Psychometric Properties of the Scientific Reasoning Scale



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scientific reasoning
a set of specialized **groups of cognitive processes** within the realm of thinking (Díaz et al., 2023)

a **process consisting of** (a) problem identification, (b) question identification, (c) hypothesis generation, (d) artifact construction, (e) evidence generation, (f) evidence evaluation, (g) drawing conclusions, and (h) communicating results (Fischer et al., 2014)

SR scale

Scientific Reasoning Scale (SRS - Drummond & Fischhoff, 2017), validated in the US and Turkey (Muslu Kaygisiz et al., 2018), is a valuable multidisciplinary tool that measures an **individual's ability to evaluate scientific evidence**. Using an interdisciplinary approach building on research in behavioral decision research, cognitive developmental psychology, and public understanding of science, the authors define SR skills and measure them with a **11 true/false** item that requires participants to apply their reasoning skills to **brief scientific scenarios**.

item's concepts

1. Blind / Double Blind
2. Causality
3. Confounding Variables
4. Construct Validity
5. Control Group
6. Ecological Validity
7. History
8. Maturation
9. Random Assignment to Condition
10. Reliability
11. Response Bias

item's example

Subjects in an experiment must press a button whenever a blue dot flashes on their computer screen. At first, the task is easy for subjects. But as they continue to perform the task, they make more and more errors.
True or False? The blue dot must flash more quickly as the task progresses.



aim and method

To facilitate generalisation across diverse populations, it is important to validate this scale in different cultural contexts.

Our aim is to validate the SRS in the Italian context using the **unified view of validity approach** (Zumbo, 2005). We will employ a psychometric methodology that **integrates Classical Test Theory** (CTT; Novick, 1966; Spearman, 1904) and **Item Response Theory** (IRT; Birnbaum, 1986), as proposed by Bean and Bowen (2021).

pre-registered on OSF



measures

Participants were asked to complete an anonymous online survey that includes:

- Demographic variables;
- Scientific Reasoning Scale (SRS);
- Some convergent measures;
- Some criterion measures.

Could you find more detailed information on the variables and scales included in the survey in the **research's codebook**, uploaded among the materials on OSF.

sample

The sample comprised **337** adult Italian participants (**61,7% female**; 36,5% male; 1,8% other), aged **20-77** years ($M=37$, $SD=13.64$). Regarding education level, the majority of the sample had attained a **master's degree (50.6%)**, 30.7% had completed a high school diploma, 12% had a bachelor's degree, 4.3% had a Ph.D., and 2.4% had an education level below a high school diploma.

On average, participants **answered 6.9 of the 11 SRS item correctly** ($SD=2.2$). Specifically, the percentage of correct responses for each item:

| | |
|---------|--------|
| item 1 | 57.00% |
| item 2 | 69.10% |
| item 3 | 71.20% |
| item 4 | 56.10% |
| item 5 | 66.20% |
| item 6 | 70.90% |
| item 7 | 66.80% |
| item 8 | 75.40% |
| item 9 | 65.30% |
| item 10 | 40.70% |
| item 11 | 49.00% |

results

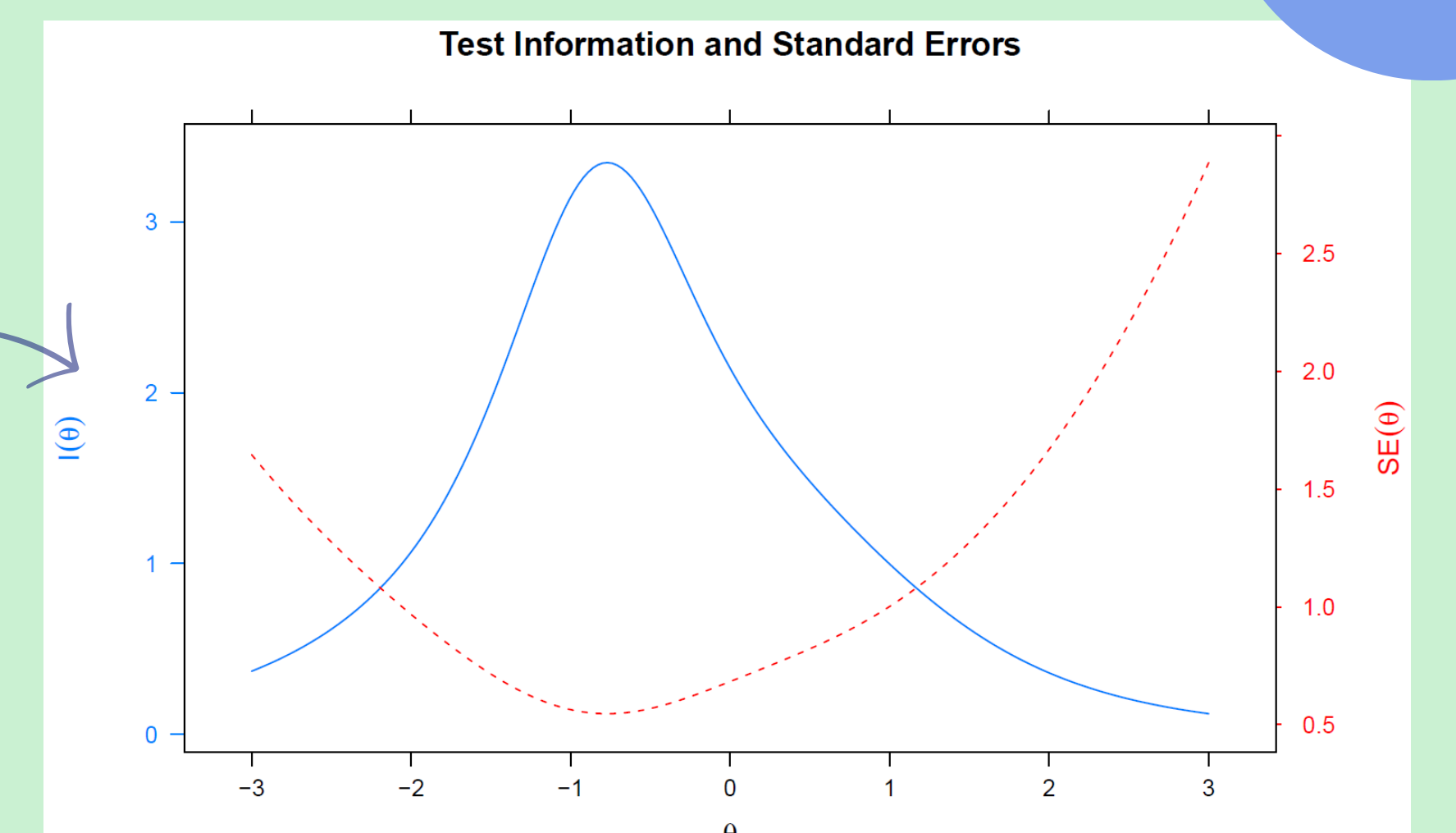
We checked whether the assumptions of unidimensionality were met. Items 1, 3, 5, 7 and 11 did not sufficiently saturate the factor ($<.3$). We run the data without these items. After confirming the unidimensionality of the scale, unidimensional IRT analyses were conducted. The **2PL model** was tested, the fit statistics indicated adequate fit ($M^2(9) = 5.148$, $p = 0.821$; $RMSEA = 0$, 95% CI [0 - 0], $TLI = 1.027$, $CFI = 1$). Each item showed a non-significant $S-\chi^2$ value, thereby indicating that all items fit under the 2PL unidimensional model.

Discrimination parameter (a): from 0.645 to 2.78. According to Baker and Kim (2004), item 4 has low-to-moderate discrimination; items 2, 6, and 9 have moderate discrimination; item 10 has high discrimination; and item 8 has very high discrimination.

Difficulty parameter (b), item 6 is the most difficult, while item 10 is the easiest.

Item Information Functions (IIF): items 2, 4, 6, 7, 8, and 9 are informative for medium-low trait levels, while items 10 is informative for medium-high.

Test Information Function (TIF), it emerges that, overall, the SRS is suitable for detecting medium-low levels of scientific reasoning (information is most informative in the trait range between $-.1$ logits and -0.5 logits).

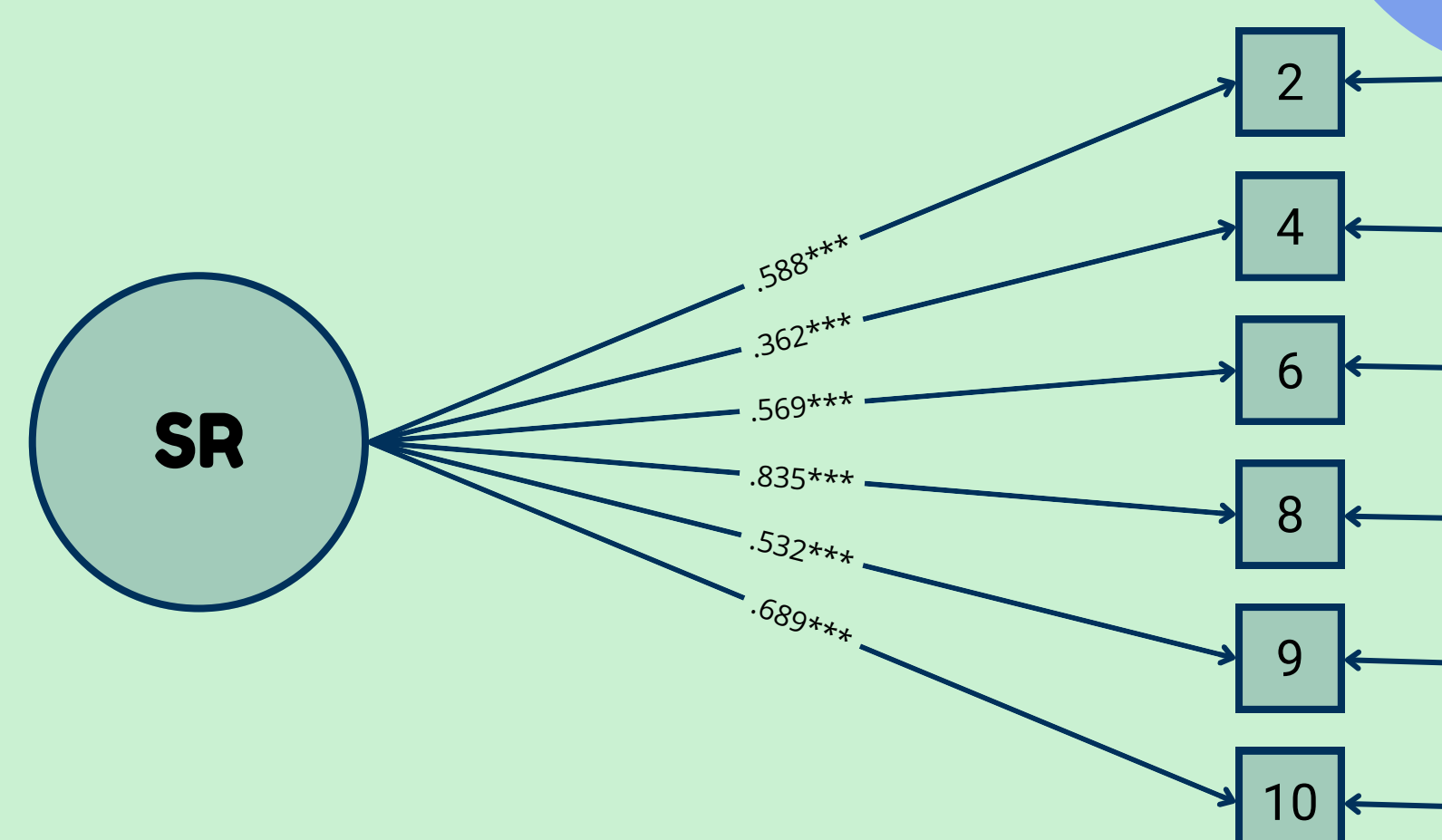


IRT

results

The mono-factorial structure of the SRS was tested with **CFA**. Fit indices for this model were good: [$\chi^2(9) = 4.734$, $p = .856$]; $RMSEA = .000$ (.000 - .033), $p = .987$; $CFI = 1.000$; $WRMR = .402$], confirming the monofactorial structure of the scale. However, compared to the original version, items 1, 3, 5, 7, 11 not appear to saturate the latent factor sufficiently ($<.3$). For this reason we performed CFA without these items. Now, the factor loadings were all $>.362$ and significant ($p \leq .001$).

$\omega = .615$; percentage of correct responses: **3.8** ($SD=1.6$).



CTT

discussion

As suggested by Bean and Bowen (2021), a model that integrates CTT and IRT offers a comprehensive assessment: some information derived from both approaches providing a **triangulated evaluation of item quality**, some aspects are **unique** to each method:

- CFA indicated that the original scale, developed in the USA, does not adequately fit the Italian data. Therefore, we considered the scale as consisting of 6 out of 11 items.
- IRT, similarly, allowed us to exclude the same items from our sample and identified the difficulty and discrimination parameters for each item: most of them discriminate for a low-to-moderate level of scientific reasoning, while only one item discriminates for a high level.

Overall, this scale seems to work in Italy by using 6 items aimed at measuring a low-to-moderate level of scientific reasoning.



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PLEASE, FOR ANY QUESTION, WRITE TO
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scan me to the poster

