# Development and Validation of the Scientific Reasoning Scale

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## Abstract:

The ability to evaluate scientific evidence is important to many decisions in individuals' lives as consumers, patients, and citizens. We develop an individual difference measure of scientific reasoning skills, defined as the skills needed to evaluate scientific findings. Participants with higher scores on the Scientific Reasoning Scale (SRS) are more likely to have beliefs consistent with the scientific consensus, above and beyond demographics and extant scientific literacy measures, and perform better on a task requiring analysis of scientific information. Our results suggest that the SRS provides a theoretically informed contribution to decoding lay responses to scientific results and controversies.

## Introduction:

### What is scientific reasoning?

- The ability to "think like a scientist" when assessing the quality of scientific evidence [1].

### Why study scientific reasoning?

- Science is widespread, but not all science is accepted by the public [2, 3]. Can doubters assess the quality of scientific evidence?

## General Methods

### Participants

- All studies conducted on Mechanical Turk workers. Workers were prevented from taking more than one survey.

### Procedures

- Participants always took the SRS first, followed by measures of convergent and predictive validity, and demographic questions.

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## Item Development

### Defining the Domain

- Extracted 20 concepts key to research validity from research methods textbooks

### Writing Scale items

- One-to-three sentence scientific scenario
- True or False Statement

### Editing Questions for Clarity

- Elicited qualitative feedback on items

## Sample SRS Item:

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.

## Scale Development

### Exploratory Factor Analysis (*N* = 270)

- Parallel analysis indicated one-factor solution
- Retained 11 items loading on one factor

### Confirmatory Factor Analysis (*N* = 345)

- Confirmed one-factor solution ($\chi2(44) = 136$, $p < 0.001$; RMSEA= 0.078; SRMR = 0.046; CFI= 0.91)

## Results: Correlational

### Convergent Measures

- Positively correlated with CRT scores, education, numeracy, actively open-minded thinking, and scientific literacy measures

### Demographic Measures

- Unrelated to religiosity, liberalism, gender

## Quick Facts about the SRS:

- **Reliability:** α=0.70
- **Length:** 11 items
- **Mean Score:** 6.7 (SD = 2.6)
- **Administration Time:** ≈10 min

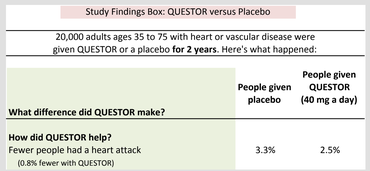
## SRS Scores Predict Consensus Beliefs on Controversial Issues

| *Correlation with SRS →* / *Strength of Belief in Consensus* | | *Sample 1 (N= 270)* | *Sample 2 (N = 294)* |
|---|---|---|---|
| Composite Measure | | 0.32*** | 0.29*** |
| Global Warming |  | 0.01 | 0.08 |
| GM Food Safety |  | 0.32*** | 0.19** |
| Vaccine Safety |  | 0.29*** | 0.19*** |
| Human Evolution |  | 0.21*** | 0.26*** |
| The Big Bang |  | 0.06 | 0.16** |

*Note.* We report partial correlations controlling for political conservatism, self-reported education, and religiosity. All beliefs were elicited on a 5-point scale, with 5 indicating strong belief in the consensus. *$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

## SRS Scores Predict Ability to Use Scientific Information

- Positively correlated with scores on a drug facts box task [4], $r = 0.44$, $p < 0.001$.



Study Findings Box: QUESTOR versus Placebo

20,000 adults ages 35 to 75 with heart or vascular disease were given QUESTOR or a placebo **for 2 years**. Here's what happened:

| What difference did QUESTOR make? | People given placebo | People given QUESTOR (40 mg a day) |
|---|---|---|
| **How did QUESTOR help?** Fewer people had a heart attack (0.8% fewer with QUESTOR) | 3.3% | 2.5% |

True or False? 0.8% fewer people had heart attacks with QUESTOR than with placebo.

## Discussion

- The SRS can be used to decode lay responses to scientific evidence and controversies
- Future research will use the SRS to better understand rejection of science

## References

[1] Drummond, C. & Fischhoff, B. (2015). Development and Validation of the Scientific Reasoning Scale. *Journal of Behavioral Decision Making*. doi: 10.1002/bdm.1906.
[2] Funk, C., & Rainie, L. (2015). Public and scientists' views on science and society. Washington, D.C.: Pew Research Center Retrieved from http://www.pewinternet.org/2015/01/29/public-and-scientists-views-on-science-and-society/, accessed on March 10, 2015.
[3] Fiske, S. T., & Dupree, C. (2014). Gaining trust as well as respect in communicating to motivated audiences about science topics. *Proceedings of the National Academy of Sciences*, **111**(Supplement 4), 13593–13597.
[4] Woloshin, S., & Schwartz, L. (2011). Communicating Data About the Benefits and Harms of Treatment. Annals of Internal Medicine, 155(2), 87–96.