Which Came First: An Empirical Test of the Time-Reversal Heuristic

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Introduction

Does the order of presentation of scientific evidence affect belief in the conclusions? Normative models of how to combine scientific evidence (such as meta-analytic synthesis or Bayesian updating) are indifferent to the ordering of studies when all else is equal. However, numerous cognitive biases (anchoring, motivated reasoning, confirmation bias) may lead to anchoring belief on an initial positive finding and ignoring new conflicting evidence. Gelman (2016) recommended, as a precaution against these biases, that one should imagine the order of the studies were reversed—which he termed the *time-reversal heuristic*. This research tests the efficacy of this heuristic by examining the effect of actually reversing the order of the evidence on levels of subjective belief in the findings.

Preregistered Hypotheses

H1: **Anchoring**: The order of presentation of the hypothetical studies will affect final level of belief in effect.

H2: **Rational updating:** In the real-world condition, belief in the effect will decrease after reading large null finding.

H3: **Positive salience:** In the time-reversal condition, belief in the effect will increase after reading small-positive effect finding.

*Note: These hypotheses are not mutually exclusive.

Methods

Power Analysis:

A power analysis indicated 264 participants were required to detect an effect of δ = 0.4 with alpha = .05 and power = .90. Allowing for ~ 15% attrition rate, we collected data from 320 participants for each study.

Participants:

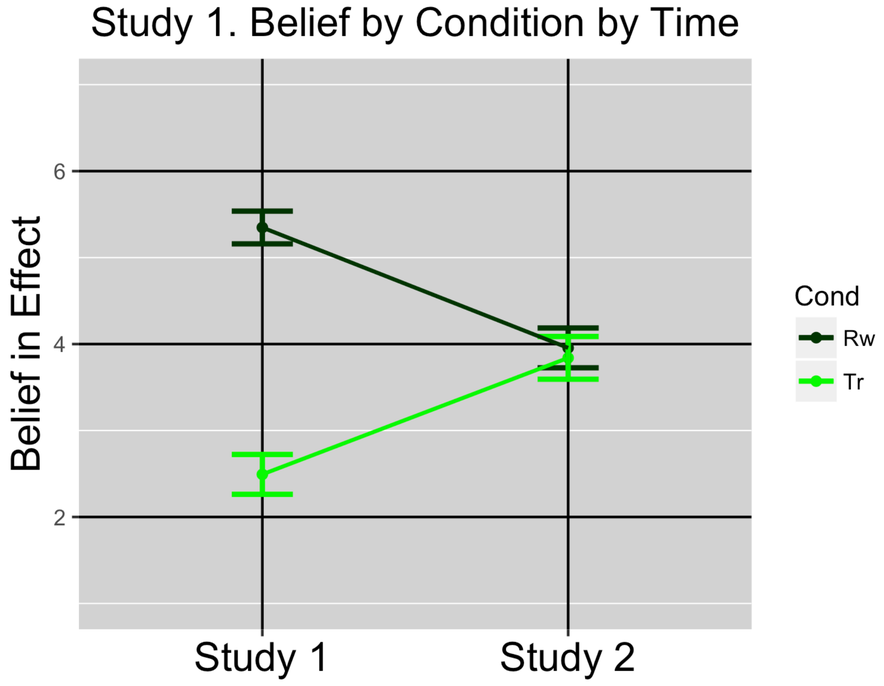
Study 1 – *N* = 302

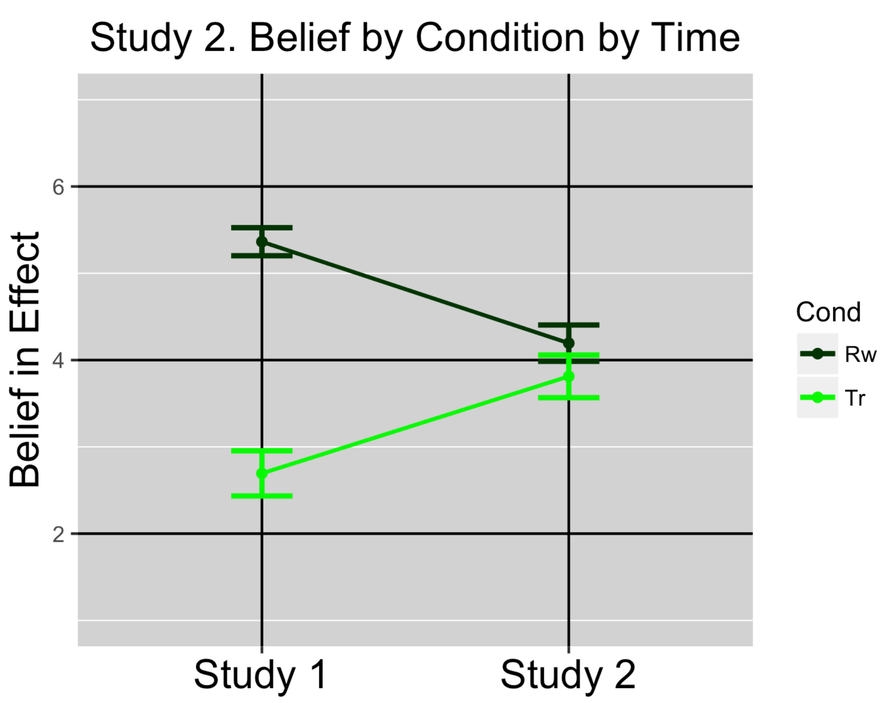
(160 female, *age: M* = 38.64 ,*SD* = 11.81)

Study 2 – *N* = 298

(148 female, age: *M* = 37.08 ,*SD* = 11.95)

Results





Methods

Conditions:

Real-world (Rw): Participants were presented with a vignette about a small-N (*N* = 60, 20 per condition), positive-effect study that shows listening to a genre of music (aggressive, mellow) improves negotiation ability, followed by vignette about a large-N (*N* = 450, 150 per condition), null-result replication study.

Time-reversal (Tr): The same two vignettes were presented in the opposite order (i.e., the small-N, positive effect study was presented second as the replication attempt).

Procedure:

Study 1: Participants read first hypothetical study and indicated belief. Next they read the second study and indicated final belief.

Study 2: Identical to Study 1 with added "buy-in" manipulation. After first study, participants drafted an email to a friend, who may find it interesting/useful, about the findings.

Results

Study 1:

H1: t(298) = -1.17, p = .242, d = .078, 95% CI [-.15, .30])
H2: t(157) = -13.35, p < .001, d = -1.04, 95% CI [-1.27, -.80]
H3: t(143) = 11.34, p < .001, d = .93, 95% CI [.68, 1.17]

Study 2:

H1: t(294) = -1.63, p = .105, d = .27, 95% CI [-.15, .30])
H2: t(153) = -12.22, p < .001, d = -1.0, 95% CI [-1.23, -.76]
H3: t(143) = 8.44, p < .001, d = .73, 95% CI [.49, .97]

After being presented with all of the information, participants in both conditions (in both studies) indicated nearly identical levels of final belief. Further analysis revealed that absolute change in belief was also nearly identical across conditions (s1: *t*(298) = .148, p > .05, s2: *t*(294) = 1.37, *p* > .05), providing evidence the large-N, null study was not weighted more strongly.

Discussion

We conclude that judgments show no order effect, but instead reflect a mix of partial rational updating and overweighting of positive results. The planned next study will use fully crossed conditions (i.e., adding small-null and large-positive vignettes), and a manipulation to test presentation style as a possible boundary condition for order effects.