Improving your research with simulation

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Resources

- power simulation workshop materials

  https://dalejbarr.github.io/kcl-orss

- RStudio (if you already have it installed) OR

- webR (if you don't have RStudio installed)

  https://webr.r-wasm.org/latest

```
install.packages(c("dplyr", "tibble", "purrr", "tidyr", "broom"))
```

Simulation: The what and the why

Knowing the ground truth

In psychology & neuroscience, we perform empirical studies to investigate unknown truths. These studies involve a series of decisions in design and analysis. It is critical to understand how these decisions and tools impact the conclusions that we draw, and how we operate as a science.

Monte Carlo* simulation

- Complex systems can be difficult to predict and analyze
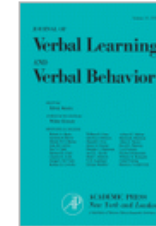
- We can better understand a system by simulating it

*Named after the *"Monte Carlo casino"* in Monaco. Image Source: https://commons.wikimedia.org/wiki/File:Real_Monte_Carlo_Casino.jpg

Evaluating a statistical method

More on the language-as-fixed-effect fallacy: Monte Carlo estimates of error rates for F_1, F_2, F', and $min F'$

K.I. Forster, R.G. Dickinson

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Evaluating experiment design choices

Better Power by Design: Permuted-Subblock Randomization Boosts Power in Repeated-Measures Experiments

Jinghui Liang and Dale J. Barr
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Abstract

During an experimental session, participants adapt and change due to learning, fatigue, fluctuations in attention, or other physiological or environmental changes. This temporal variation affects measurement, potentially reducing statistical power. We introduce a restricted randomization algorithm, permuted-subblock randomization (PSR), that boosts power by balancing experimental conditions over the course of an experimental session. We used Monte Carlo simulations to explore the performance of PSR across four scenarios of time-dependent error: exponential decay (learning effect), Gaussian random walk, pink noise, and a mixture of the previous three. PSR boosted power by about 13% on average, with a range from 4% to 45% across a representative set of study designs, while simultaneously controlling the false positive rate when time-dependent variation was absent. An R package, `explan`, provides functions to implement PSR during experiment planning.

Evaluating software tools

PNAS

Cluster failure: Why fMRI inferences for spatial extent have inflated false-positive rates

Anders Eklund ✉ , Thomas E. Nichols, and Hans Knutsson   Authors Info & Affiliations

Multiverse analysis

Increasing Transparency Through a Multiverse Analysis

Sara Steegen, Francis Tuerlinckx, [...], and Wolf Vanpaemel ✉ (+1) View all authors and affiliations

Contents | PDF / ePub

Abstract

Empirical research inevitably includes constructing a data set by processing raw data into a form ready for statistical analysis. Data processing often involves choices among several reasonable options for excluding, transforming, and coding data. We suggest that instead of performing only one analysis, researchers could perform a multiverse analysis, which

Agent-based models

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Research article

The natural selection of bad science

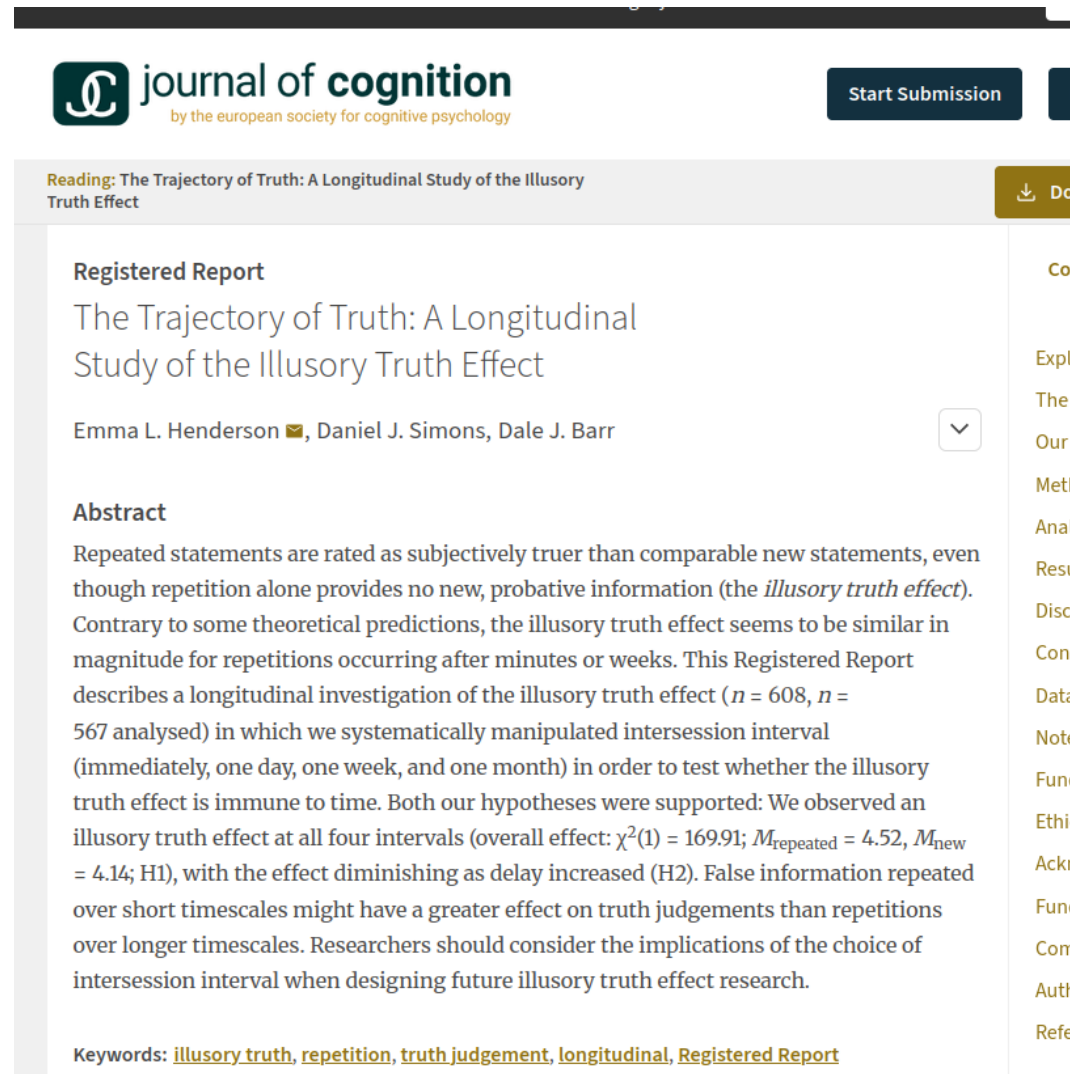Paul E. Smaldino ✉ and Richard McElreath

✎ This article has a Correction

Study planning: Power analysis

Start Submission

Reading: The Trajectory of Truth: A Longitudinal Study of the Illusory Truth Effect

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Co

Registered Report

The Trajectory of Truth: A Longitudinal Study of the Illusory Truth Effect

Emma L. Henderson ✉, Daniel J. Simons, Dale J. Barr

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Abstract

Repeated statements are rated as subjectively truer than comparable new statements, even though repetition alone provides no new, probative information (the *illusory truth effect*). Contrary to some theoretical predictions, the illusory truth effect seems to be similar in magnitude for repetitions occurring after minutes or weeks. This Registered Report describes a longitudinal investigation of the illusory truth effect ($n = 608$, $n = 567$ analysed) in which we systematically manipulated intersession interval (immediately, one day, one week, and one month) in order to test whether the illusory truth effect is immune to time. Both our hypotheses were supported: We observed an illusory truth effect at all four intervals (overall effect: $\chi^2(1) = 169.91$; $M_{repeated} = 4.52$, $M_{new} = 4.14$; H1), with the effect diminishing as delay increased (H2). False information repeated over short timescales might have a greater effect on truth judgements than repetitions over longer timescales. Researchers should consider the implications of the choice of intersession interval when designing future illusory truth effect research.

Keywords: illusory truth, repetition, truth judgement, longitudinal, Registered Report

https://github.com/dalejbarr/truthiness

Basic workflow

do_once(parameters)

generate_data(parameters)
   take parameters as input
   and randomly generate data frame
   based on current RNG state

analyze_data(data)
   take data frame as input
   and fit a model, returning
   model object (mobj) as output

extract_stats(mobj)
   take model object as input and
   extract information, return it in a table

repeat
nmc
times