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

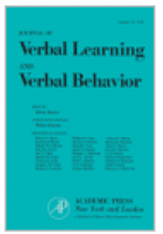
* Named after the *"Monte Carlo casino"* in Monaco. Image Source: https://commons.wikimedia.org/wiki/File:Real_Monte_Carlo_Casino.jpg

Evaluating a statistical method

ELSEVIER

Journal of Verbal Learning and Verbal Behavior

Volume 15, Issue 2, April 1976, Pages 135-142



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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https://doi.org/10.1016/0022-5371(76)90014-1

Evaluating experiment design choices

AMERICAN PSYCHOLOGICAL ASSOCIATION

Psychological Methods

ISSN: 1082-989X

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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

RESEARCH ARTICLE | NEUROSCIENCE |

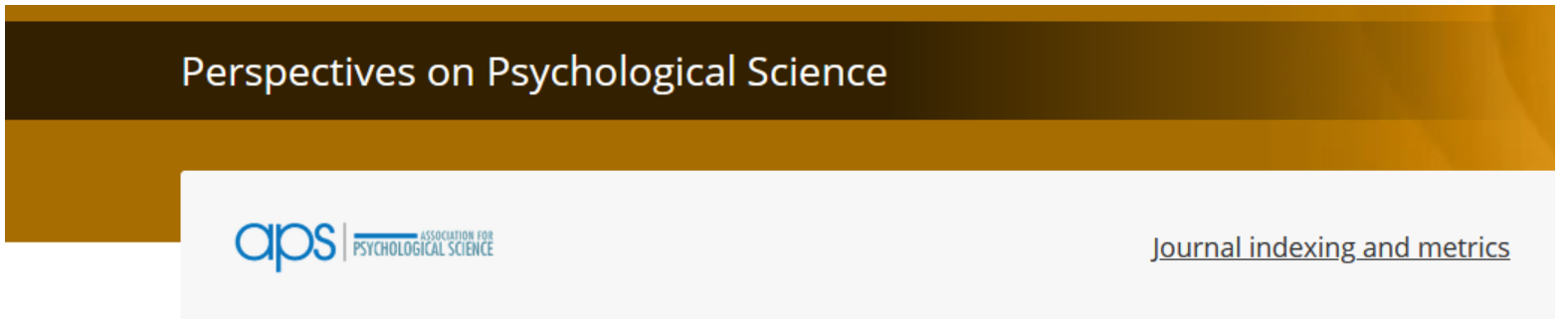
Cluster failure: Why fMRI inferences for spatial extent have inflated false-positive rates

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

Edited by Emery N. Brown, Massachusetts General Hospital, Boston, MA, and approved May 17, 2016 (received for review February 12, 2016)

June 28, 2016 | 113 (28) 7900-7905 | https://doi.org/10.1073/pnas.1602413113

Multiverse analysis



Free access | Research article | First published online September 29, 2016

Increasing Transparency Through a Multiverse Analysis

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

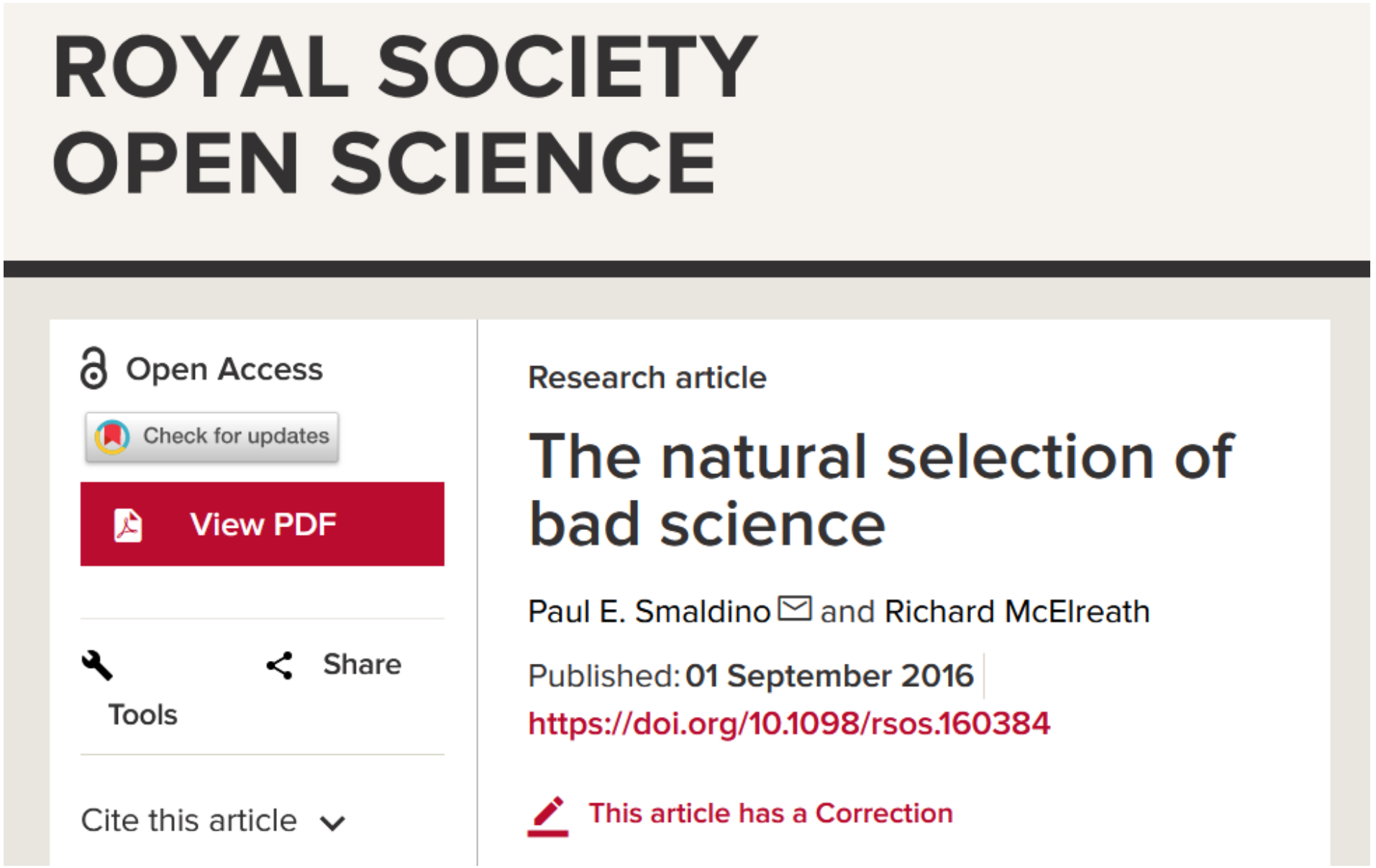
Volume 11, Issue 5 | https://doi.org/10.1177/1745691616658637

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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The natural selection of bad science

Paul E. Smaldino and Richard McElreath

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This article has a Correction

Study planning: Power analysis