Issues with Scientific Evidence

Understanding Political Numbers

April 24, 2019

Science is human

...all too human

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The *way science is done* is affected by the professional context in which researchers operate

Professional context

Academic Research

- "Publish or perish"
- What gets rewarded? Inquiry vs. accomplishment
- Statistical vs. domain expertise
- Prestige and overwork

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Campaigns, advocacy, industry

- Organizations need **information** to make **decisions**
- Quest for "good enough"
- Honesty vs. advocacy
- Machine learning: performance vs interpretation

Science (ideally)

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Conducting Research

- Researchers identify interesting puzzles
- Use reliable body of *scientific literature* to develop theoretical explanations
- Devise studies to test theories
- Collect and analyze data, evaluate evidence w/r/t theories

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Disseminating Research

- Researchers write a study
- Peer review: study is evaluated by other experts
- Reliable studies are accepted into scientific literature
- Knowledge accumulates over time

Science ("reality bites" version)

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Research is high-stakes career output

- Other researchers judging your work "interesting" is major factor in career survival
- Citations to existing science is very political (peer review)
- Studies are "low power" tests of theory
- Data analysis is biased toward favorable findings

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Disseminating Research

- Non-scientific (peri-scientific?) considerations
- Peer reviewers have idiosyncratic and inconsistent opinions (low n)
- Flashy results vs. Careful methodology
- Published record is a biased

Statistical significance

p-values are useful but abused

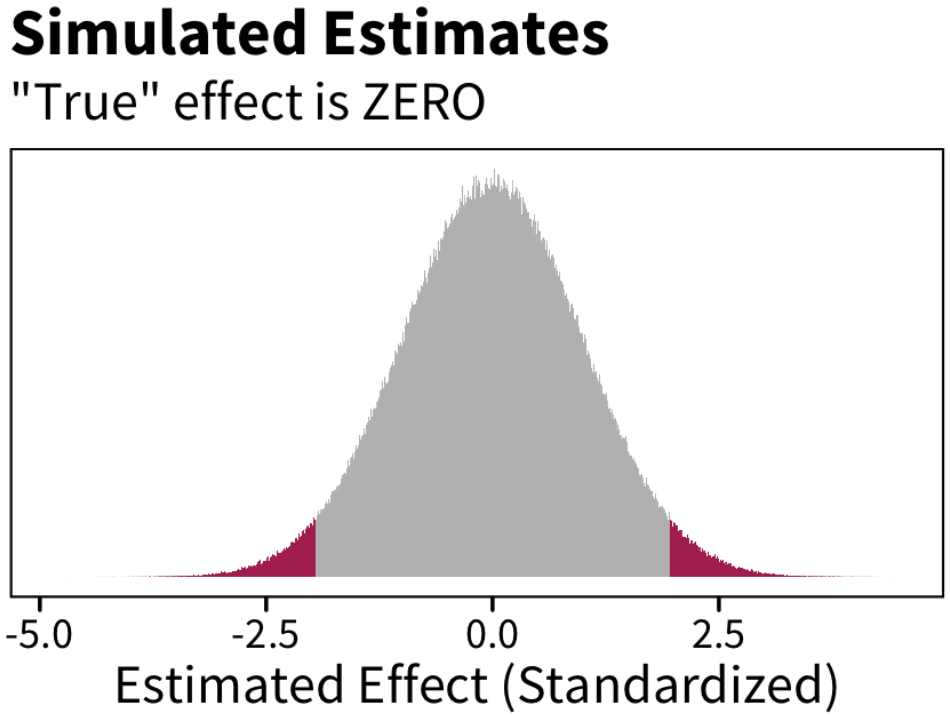
p-value: probability of a "more extreme" effect (if no true relationship)

Dichotomania: splits the world into "zero" and "non-zero" effects

p-hacking

Data analysis is a "garden of forking paths"

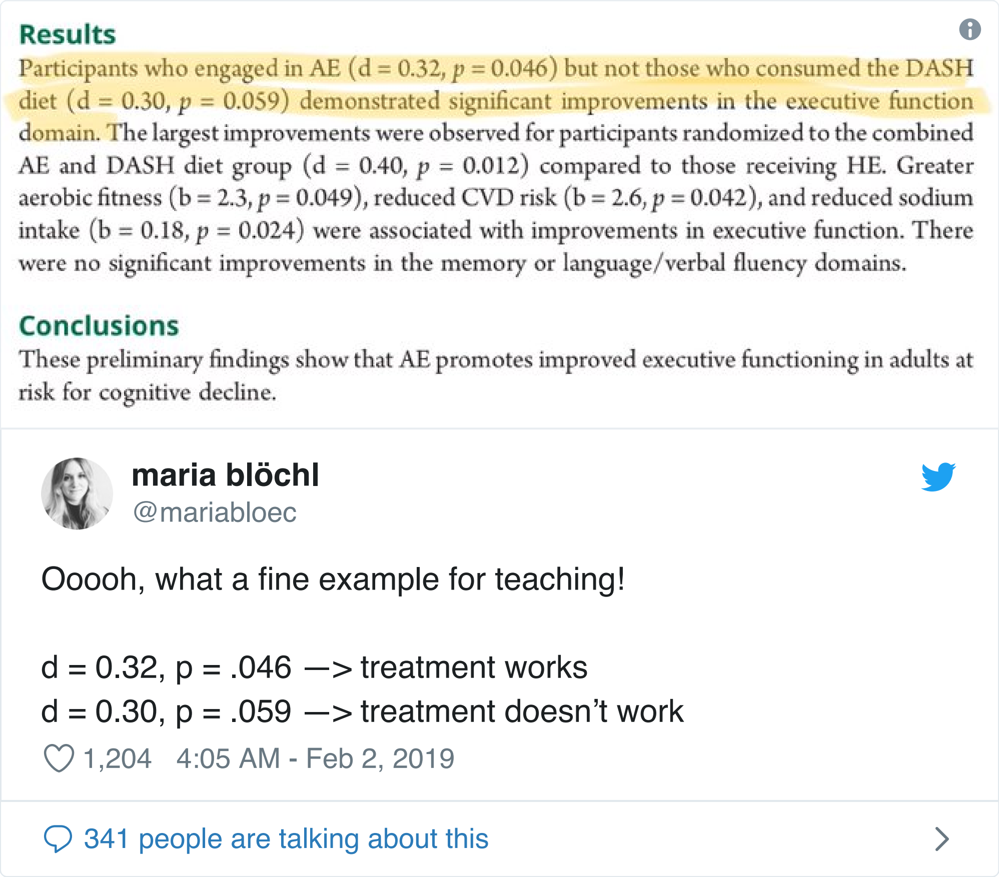
The difference between "significant" and "not significant" is not itself statistically significant



The "statistical significance filter"

> Got reviewer comments back.
>
> We report a P-values of 0.051 and 0.062. Reviewer: "If it’s not significant, it’s not significant. Delete."
>
> Here's a response I've used in the past, sharing for anyone who might find it useful pic.twitter.com/dQIxBCdsV8
>
> — Kevin Kohl (@KevinDKohl) January 29, 2019

Dichotomania



Results

Participants who engaged in AE (d = 0.32, *p* = 0.046) but not those who consumed the DASH diet (d = 0.30, *p* = 0.059) demonstrated significant improvements in the executive function domain. The largest improvements were observed for participants randomized to the combined AE and DASH diet group (d = 0.40, *p* = 0.012) compared to those receiving HE. Greater aerobic fitness (b = 2.3, *p* = 0.049), reduced CVD risk (b = 2.6, *p* = 0.042), and reduced sodium intake (b = 0.18, *p* = 0.024) were associated with improvements in executive function. There were no significant improvements in the memory or language/verbal fluency domains.

Conclusions

These preliminary findings show that AE promotes improved executive functioning in adults at risk for cognitive decline.

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Ooooh, what a fine example for teaching!

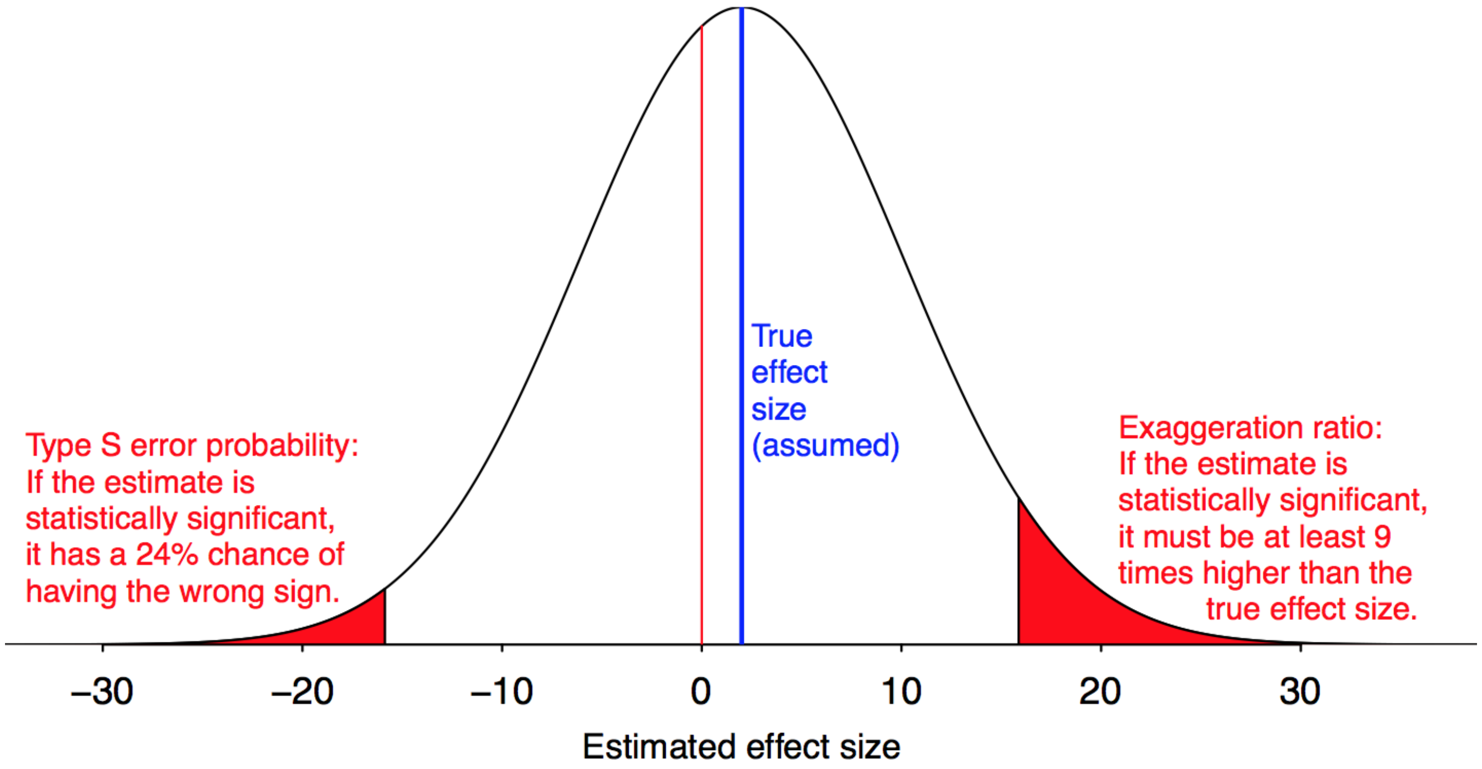
d = 0.32, p = .046 —> treatment works
d = 0.30, p = .059 —> treatment doesn’t work

♡ 1,204 4:05 AM - Feb 2, 2019

341 people are talking about this

Statistical "power"

True effects rarely zero, but need lots of data to estimate small effects



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Publication Bias

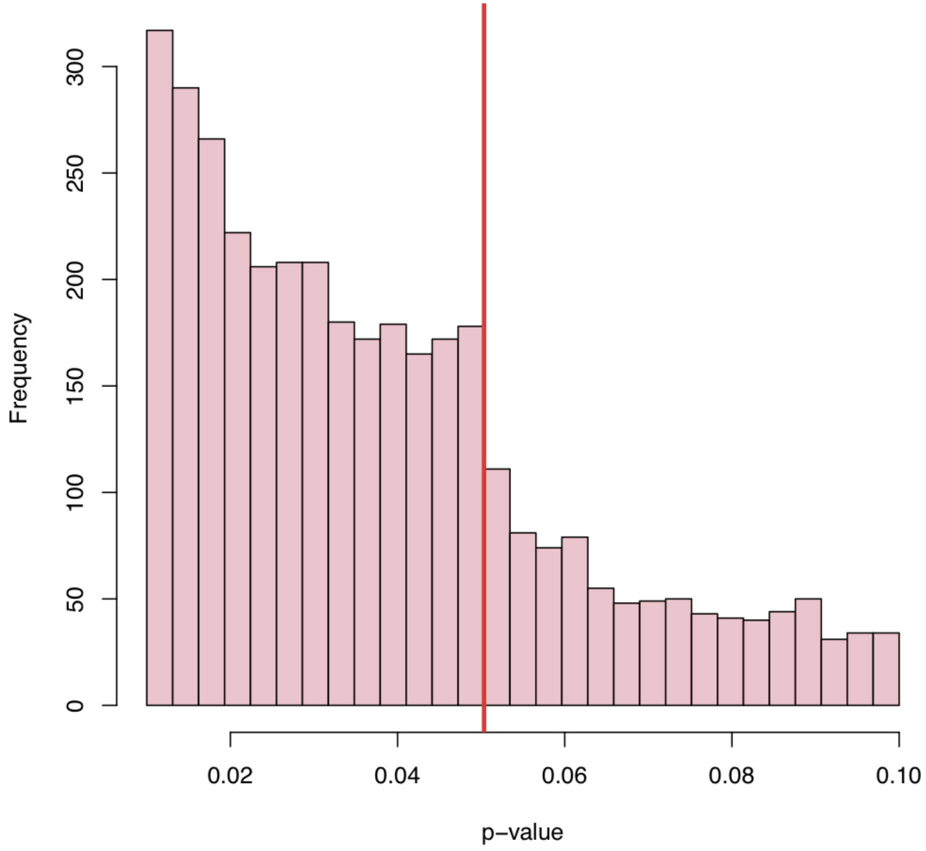
Publication bias

Most published findings are over-estimates or false (video)

File drawer problem

Replication (and failure to replicate)

Do journals care? (or hiring committees, tenure committees...?)



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Very little reward for *improving the conduct* of science

Falsifying hypotheses

Are we learning from science?

Verification vs. Falsification

Falsification and the *null hypothesis*

Reject serious, competitive hypotheses!

McElreath "Evolution of Statistical Methods" talk

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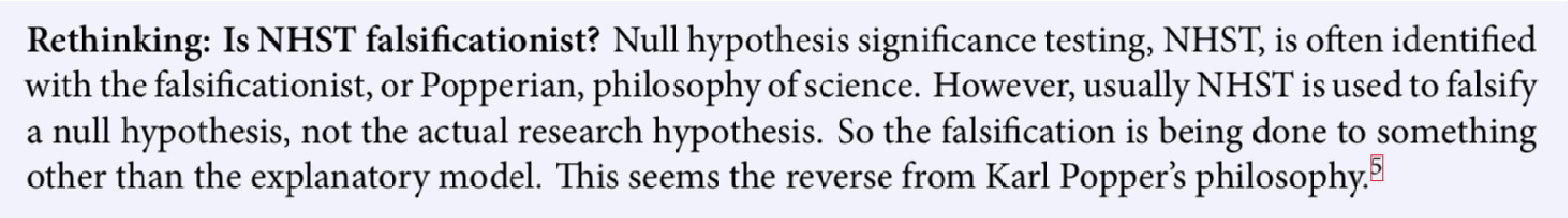

Rethinking: Is NHST falsificationist? Null hypothesis significance testing, NHST, is often identified with the falsificationist, or Popperian, philosophy of science. However, usually NHST is used to falsify a null hypothesis, not the actual research hypothesis. So the falsification is being done to something other than the explanatory model. This seems the reverse from Karl Popper's philosophy.[5]

Teaching Evaluations

`aefis.wisc.edu`

Specifics are better!

Constructive is better!