

# How Current Incentives for Scientists Lead to Poor Science for Everyone

*Everything is F\*cked*

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University of British Columbia

Oct 12th, 2023

# Overview

- 1 Toot
- 2 Incentives
- 3 Publishing World
- 4 Grants
- 5 Grad Students
- 6 Philosophy of Science
- 7 Metascience
- 8 Solutions

# A Toot

Posts and replies

◀ Back ⌂



Dan Goodman

@neuralreckoning@neuromatch.social

This week I read about a Nobel winner whose groundbreaking work didn't get funded and got her demoted, and about data fraud by two of the highest profile scientists who were lauded and mega funded. We have to stop rewarding short term flashy work and overproductive scientists.

It's fine and correct to talk about both incentives and individual responsibility. But if we scientists collectively decided to heavily downplay work without open, raw data and reproducible methods, and ignored journal title when evaluating scientists, this couldn't happen.

The system is absolutely broken and needs structural reform, yes. Journals need to go. Competitive grants are the wrong way to fund science. Scientific prizes are very problematic. But we also need to get better at reading and doing science and valuing what works in the long term.

That's the key point. If we let these things happen it means we are doing science badly.

Oct 03, 2023, 10:30 · 🌐 · Web · 61 · ★ 54



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Essay

## Why Most Published Research Findings Are False

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The long read

# Is the staggeringly profitable business of scientific publishing bad for science?

It is an industry like no other, with profit margins to rival Google - and it was created by one of Britain's most notorious tycoons: Robert Maxwell.

by Stephen Buranyi

POLICY

## **Science Funding Is Broken**

The way we pay for science does not encourage the best results

By John P.A. Ioannidis on October 1, 2018

# Incentives

PERSPECTIVE

## Current Incentives for Scientists Lead to Underpowered Studies with Erroneous Conclusions

Andrew D. Higginson<sup>1</sup>\*, Marcus R. Munafò<sup>2,3</sup>\*

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“researchers acting to maximise their fitness should spend most of their effort seeking novel results and conduct small studies that have only **10% – 40% statistical power**”

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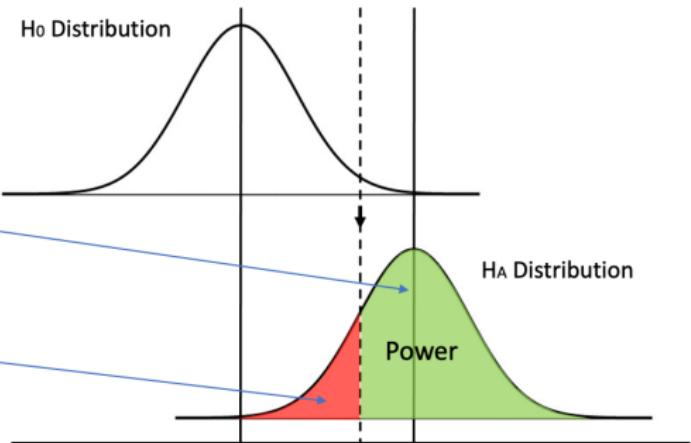
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“researchers acting to maximise their fitness should spend most of their effort seeking novel results and conduct small studies that have only **10% – 40% statistical power**”

“**half** of the studies they publish will report erroneous conclusions. Current incentive structures are in conflict with maximising the scientific value of research”

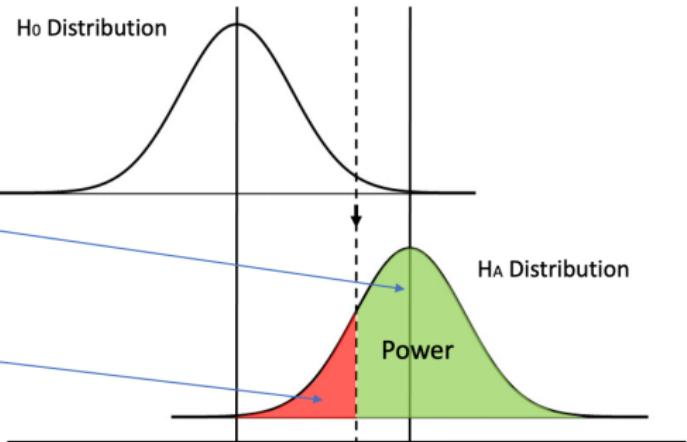
## Aside: What is Power?

	$H_0$ is True	$H_A$ is True
$H_0$	Type I Error False Positive $\alpha$ (alpha)	Correct True Positive $1-\beta$ (power)
Fail to reject $H_0$	Correct True Negative $1-\alpha$	Type II Error False Negative $\beta$ (beta)



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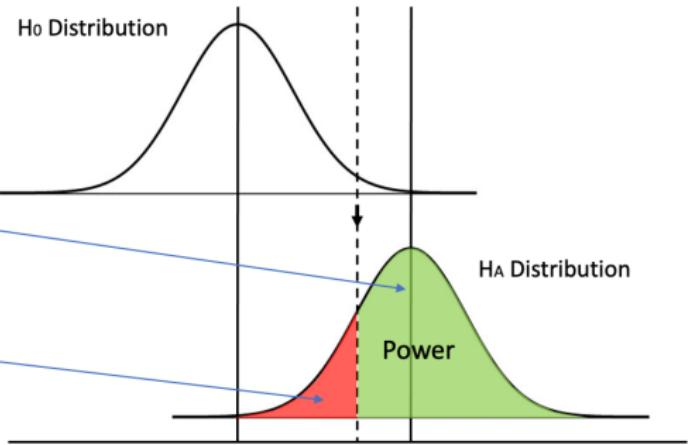
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"But wait, shouldn't underpowered studies just lead to false negatives?"  
"Underpowered studies are a major contributing factor to the reporting of both false positives and false negatives (Button et al., 2013)."  
i.e. "winner's curse" and "file drawer problem"

## Aside: Winner's Curse

### Winner's Curse

In an auction bid, the winner is the bidder making the highest estimate. If we assume that the average bid (before auction) is accurate, then the highest bidder overestimates the item's value. Thus, the auction's winner is likely to overpay.



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## Winner's Curse in Science

The term winner's curse is also used in statistics to refer to the regression toward the mean phenomenon, where the first person to report a significant test (the winner) will also report an effect size much larger than is likely to be seen in subsequent replication studies

## Aside: File-Drawer Problem

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### Publication-Bias

Why? Because journals are biased to published **positive results** (3x more likely)

This motivates researchers to manipulate their findings to ensure statistically significant results (either consciously or unconsciously)



## Back to the Incentives Paper

“Exploratory studies (i.e., those with low R) are much less likely to be true than confirmatory studies (i.e., those with high R) **even if the p-value generated is the same**, but arguably, current incentive studies reward novel (i.e., exploratory) findings over replication (i.e., confirmatory) studies.”

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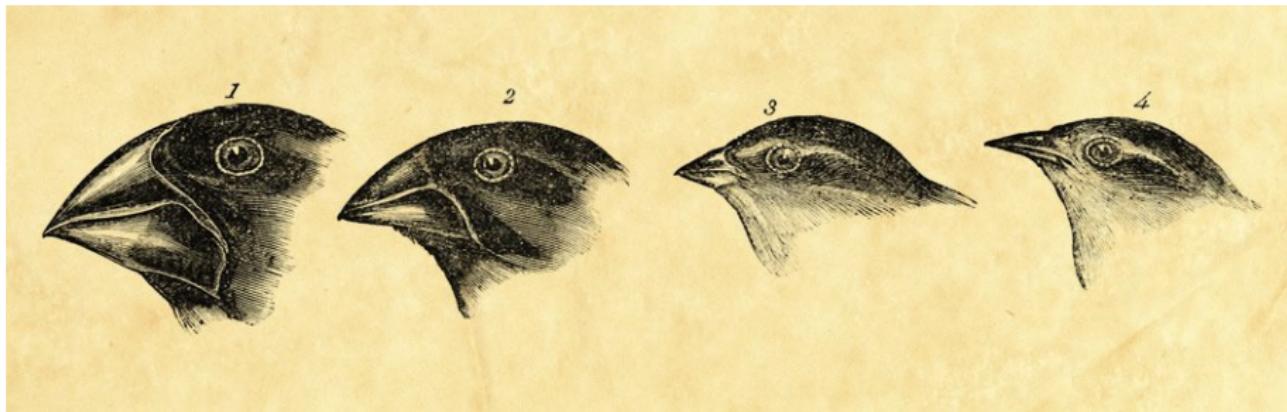
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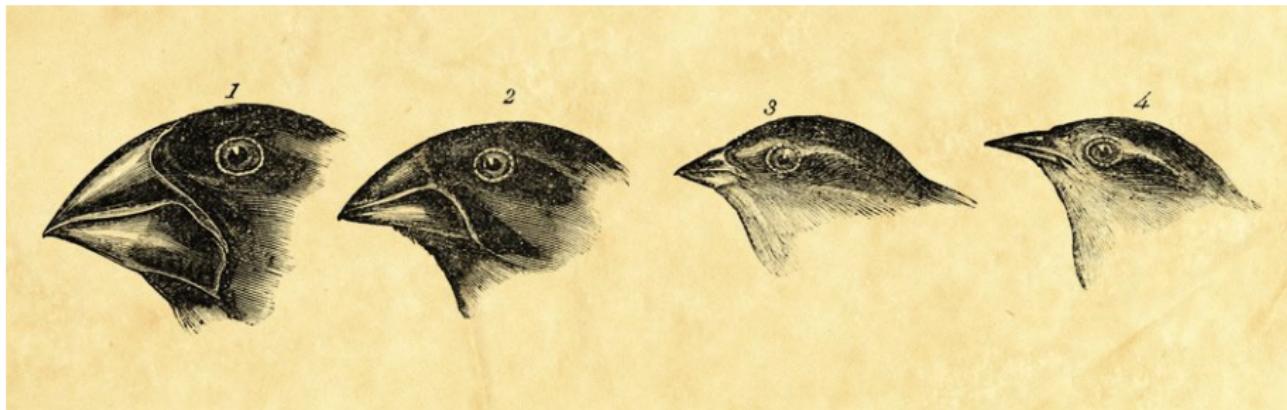
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- publish often (easier to publish if findings are positive)

# Incentives: Maximising Fitness



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# Incentives: Maximising Fitness



- “We used optimality theory to predict the rational strategy of a scientist possessing finite resources who seeks to maximise the career value of his or her publications.”
- “We considered that researchers must choose how to divide their resources between exploratory studies that seek to identify new phenomena and confirmatory studies that attempt to verify previous findings and that they must decide the amount of resources to invest per study.”

## Incentives: Results

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Life

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By Peter Aldhous

2 November 2011



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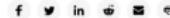


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The screenshot shows a news article from NBC News. At the top left is a small thumbnail image of a building with a tower. To its right is a logo for "NPR SHORT WAVE SCIENCE". Below the logo is the main headline: "Did an honesty researcher fabricate data?". Underneath the headline is a sub-headline: "Duke professor and behavioral scientist Dan Ariely has been accused of using falsified data in research into ways to make people more honest. New info makes the case against him look stronger." At the bottom of the screenshot are several small icons for social media sharing.

Life

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### Did an honesty researcher fabricate data?

July 28, 2023 · 4:49 AM ET

Heard on Morning Edition

 Nick Fountain

 3-Minute Listen

+ PLAYLIST



Duke professor and behavioral scientist Dan Ariely has been accused of using falsified data in research into ways to make people more honest. New info makes the case against him look stronger.



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Life

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EDUCATION

## Stanford president resigns after fallout from falsified data in his research

Updated July 20, 2023 · 6:36 PM ET

By Ayana Archie

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## Did an honesty researcher fabricate data?

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# HOW MANY CLINICAL TRIALS CAN'T BE TRUSTED?

Investigations suggest that, in some fields, at least one-quarter of clinical trials might be problematic or fake, warn researchers. They urge stronger scrutiny. **By Richard Van Noorden**

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Essay

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# Incentives: Results

nature > articles > article

Article | Open access | Published: 16 March 2022

## Essay Why Are John R.J. **Reproducible brain-wide association studies require thousands of individuals**

Scott Marek , Brenden Tervo-Clemmens , Finnegan J. Calabro, David F. Montez, Benjamin P. Kay, Alexander S. Hatoum, Meghan Rose Donohue, William Foran, Ryland L. Miller, Timothy J. Hendrickson, Stephen M. Malone, Sridhar Kandala, Eric Feczkó, Oscar Miranda-Dominguez, Alice M. Graham, Eric A. Earl, Anders J. Perrone, Michaela Cordova, Olivia Doyle, Lucille A. Moore, Gregory M. Conan, Johnny Uriarte, Kathy Snider, Benjamin J. Lynch, ... Nico U. F. Dosenbach  + Show authors

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- Current incentives that encourage scientists to build momentum around a single research focus may also be problematic [24]
- A survey of early career researchers indicated that “survival mentoring” (i.e., guidance on how to survive in the profession) is associated with increased odds of questionable behaviour in methods

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- Journals should be more stringent with statistics ( $\alpha < 0.01$ ) and sample size (power)

# Incentives: Suggestions

- Reduce incentives for novel findings (HOW?);
- Emphasis should not be placed on a select number of publications for promotion
- Journals should be more stringent with statistics ( $\alpha < 0.01$ ) and sample size (power)

## Note

I don't actually think these suggestions are all that great...

# Everything is F\*cked

## The Hardest Science

### Everything is fucked: The syllabus

PUBLISHED ON *August 11, 2016*

Sanjay Srivastava



**PSY 607: Everything is Fucked**

Prof. Sanjay Srivastava

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PSY 607: Everything is Fucked

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- Week 2: Significance testing is f\*cked
- Week 3: Causal inference from experiments is f\*cked
- Week 5: Covariates are f\*cked
- Week 6: Replicability is f\*cked
- Week 8: Scientific publishing is f\*cked
- Week 9: Meta-analysis is f\*cked
- Week 10: The scientific profession is f\*cked

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- Universities then have to pay to gain access.
- Finally: journal makes money... “bigger profit margins than Google, Amazon and Apple”

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# Publishing World

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“The government finances the research, pays salaries to those who carry out the quality control, and finally ends up buying the published product”

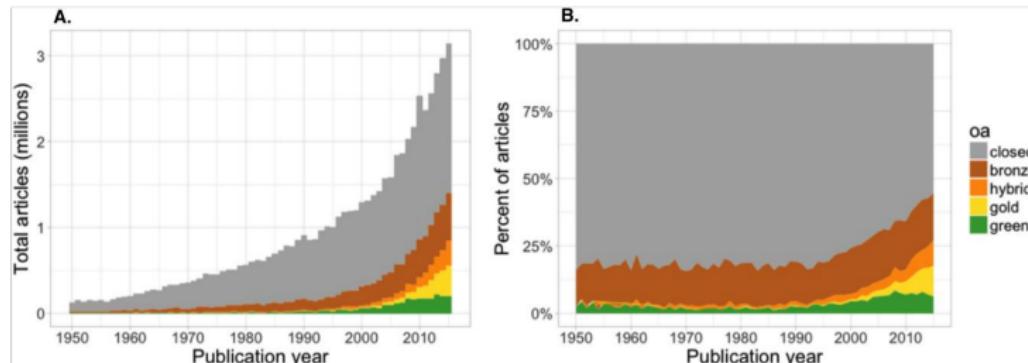
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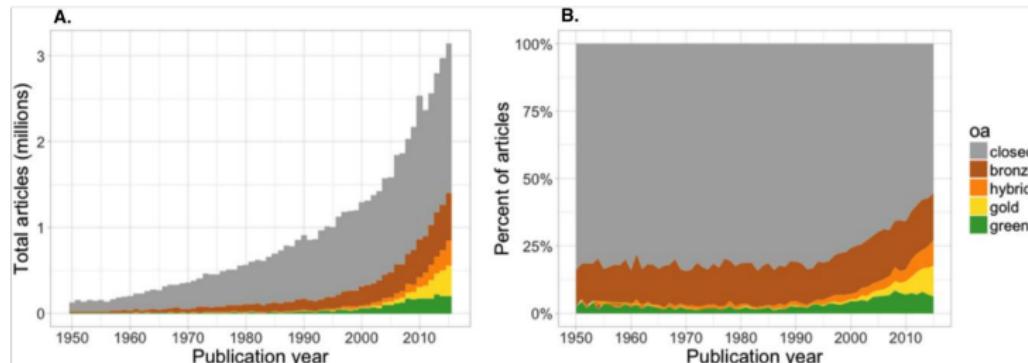
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In terms of open-access, things are getting better...



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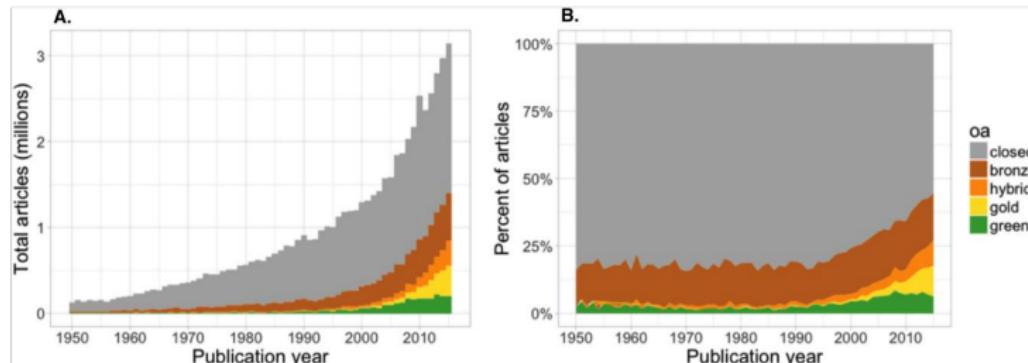
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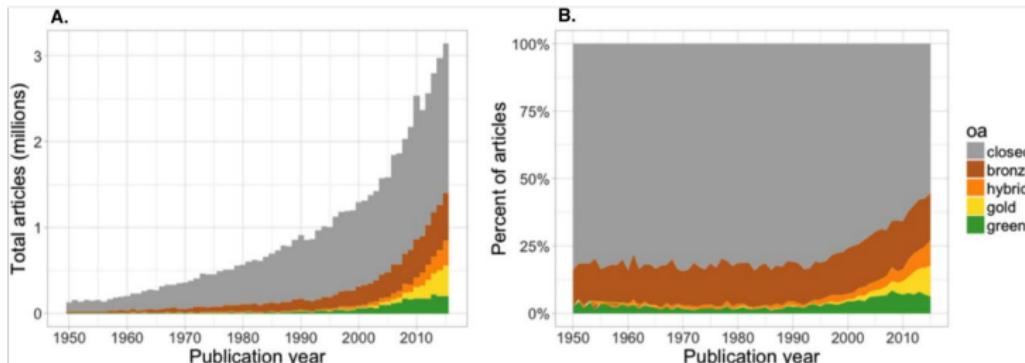
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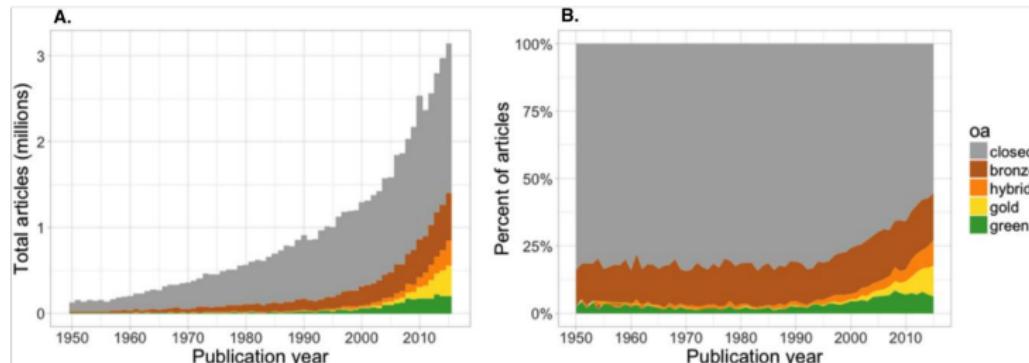
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- Green: Green articles are published in a toll-access journal, but self-archived in an OA archive (such as ArXiv preprint)

# Publishing World

And people are taking things into their own hands...

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NEWS | 21 April 2023

## Editors quit top neuroscience journal to protest against open-access charges

Members of the departing editorial teams say that the fees to publish articles are unsustainable.

[Katharine Sanderson](#)



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The image shows the Sci-Hub website homepage. At the top, there is a large red logo with the word "sci-hub" in lowercase. To the left of the logo is a black cartoon character wearing a mask and a red bow tie. Below the logo is a search bar with the placeholder text "enter your reference". To the right of the search bar is a red button with a white key icon and the word "open". Below the search bar, the text "knowledge as a human right" is displayed. At the bottom of the page, there is a navigation menu with links for "database", "about", "Elbakyan", "stats", and "donate". The background of the page features a faint watermark of scientific sketches and diagrams, including a DNA helix on the right side.

## Grants

85% of investments in biomedical research is wasted (due to cumulative effects of bad production and reporting of research)<sup>1</sup>

1: [thelancet.com/journals/laneur/article/PIIS1474-4422\(19\)30481-8/fulltext](https://www.thelancet.com/journals/laneur/article/PIIS1474-4422(19)30481-8/fulltext)

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- We fund the wrong fields: well-funded fields attract more scientists to work for them, which increases their lobbying reach, fueling a vicious cycle. Allocation of bio-medical resources can be more strongly correlated to previous allocations and research than to BoD.

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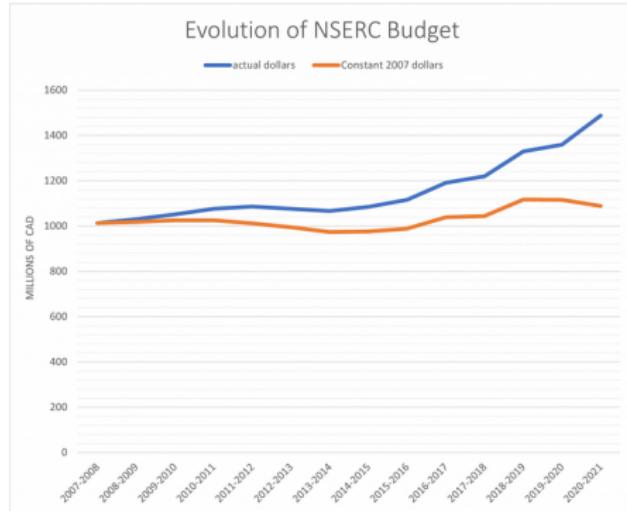
# Grants

- We do not spend enough: in many countries, public funding has stagnated and is under increasing threat from contesting budget items

CIHR budget 2000-2021



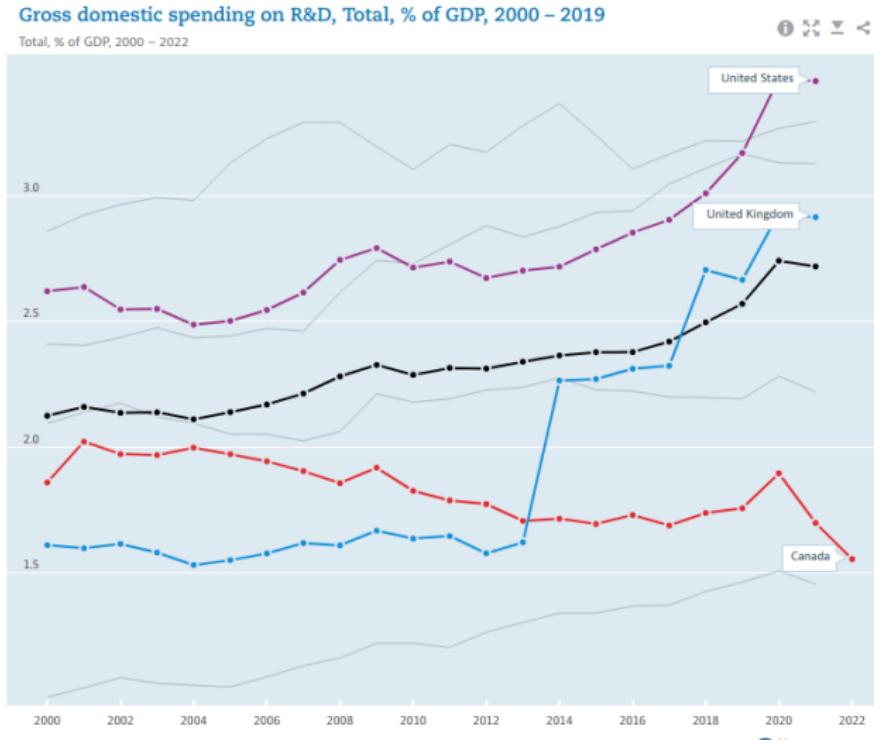
NSERC budget 2007-2021



<https://can-acn.org/science-funding-in-canada-statistics/>

# Grants

This problem is especially bad in Canada:



<https://can-acn.org/science-funding-in-canada-statistics/>

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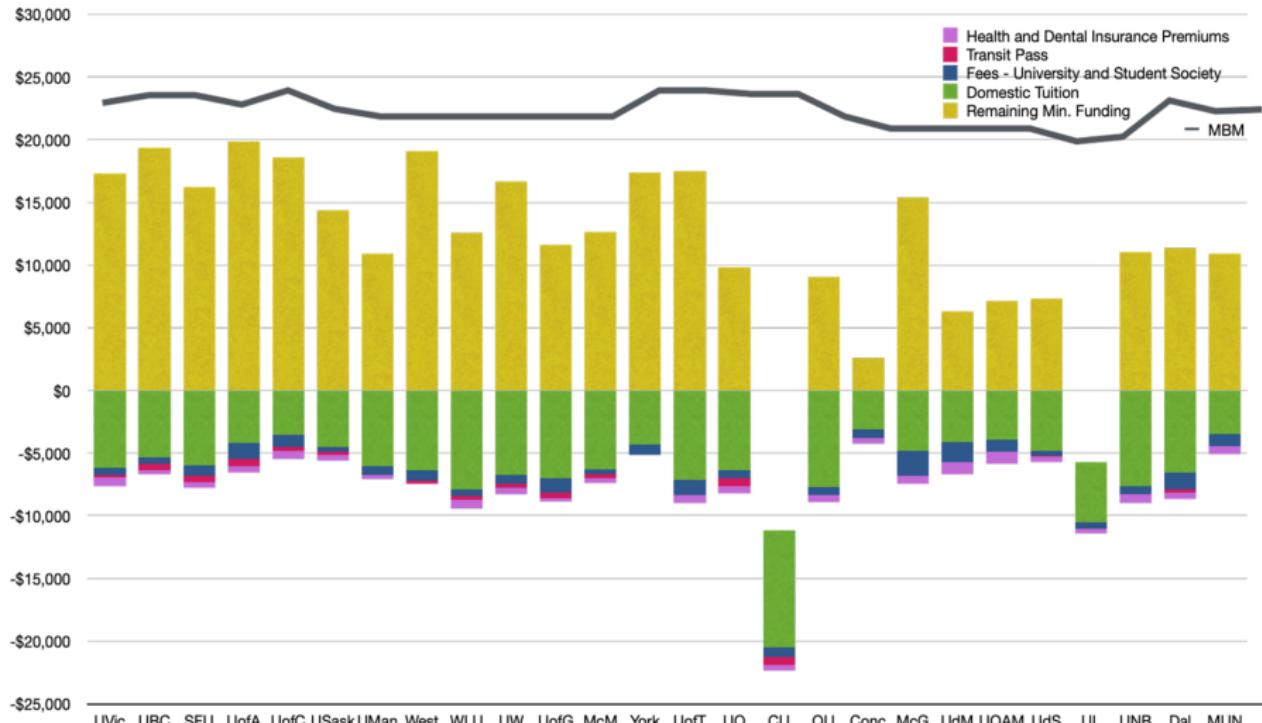
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More on these ideas when we get to metascience...

# Grad Students

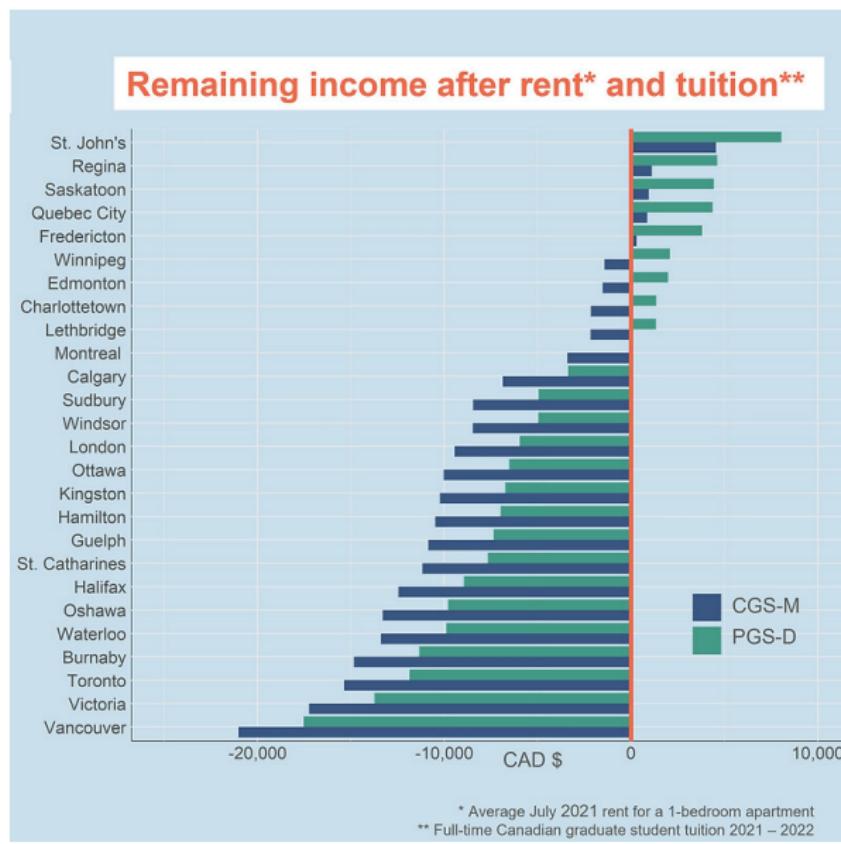
Funding for grad students is well below the poverty line



<https://www.universityaffairs.ca/career-advice/career-advice-article/the-high-cost-of-inadequate-funding-for-grad-students/>

# Grad Students

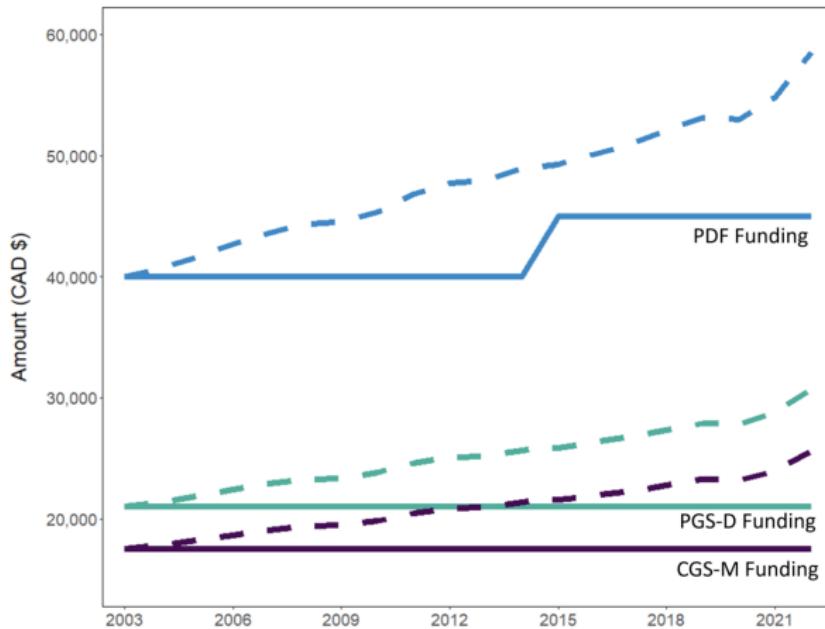
This situation is even worse when you take into account the cost of living in those cities



<https://www.supportourscience.ca/learn-more>



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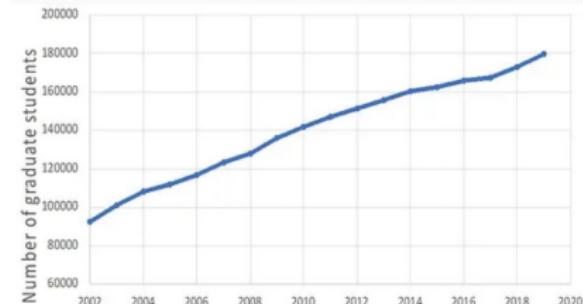
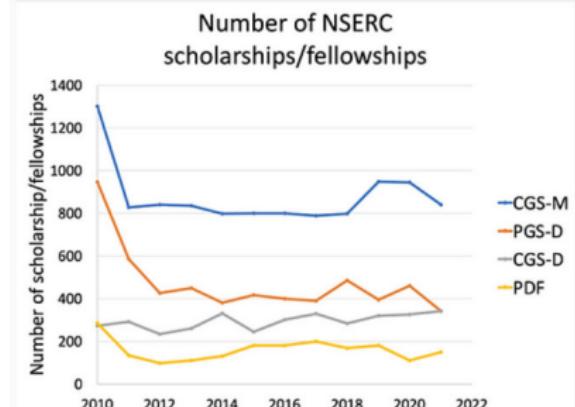


Graduate student scholarship (CGS-M & PGS-D) and postdoctoral scholar fellowship (PDF) award amounts have not kept pace with inflation (dashed lines) in Canada. Data available in the Support Our Science Data Repository.

<https://www.supportourscience.ca/learn-more>

# Grad Students

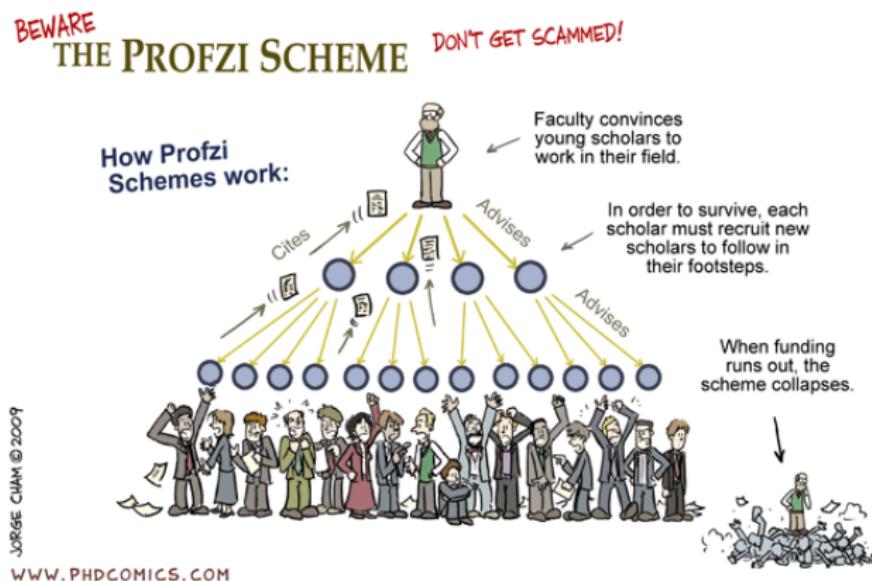
It gets worse. The number of graduate scholarships (CGS-M, PGS-D, CGS-D) decreased in 2010, and has remained relatively steady since. However, in that same time period graduate student enrollment in Canada has doubled.



Data from Statistics Canada

# Grad students

Is academia a pyramid scheme? “The number of PhD graduates in Canada is growing while the number of open tenure-track positions is stagnant or declining”



Counter: these students gain skills that serve them well in other careers

# Grad Students

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- On the other hand: “For men with PhDs working full-time, the economic return of a PhD over a master's degree has been declining; furthermore, the return is lower and dropping more quickly for those under 40 years of age. In contrast, for women with PhDs working full-time, the economic return has been rising for the overall population and for those under 40. Having said this, the earnings of men are still considerably higher than those of women overall. ”

# Grad Students

What about mental health?

1: <https://www.nature.com/articles/s41587-019-0179-y>

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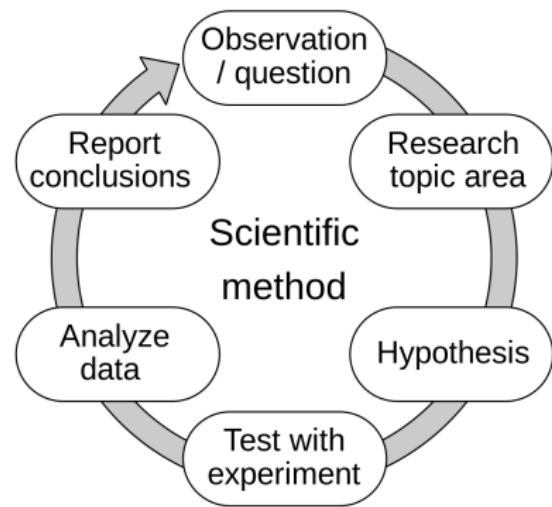
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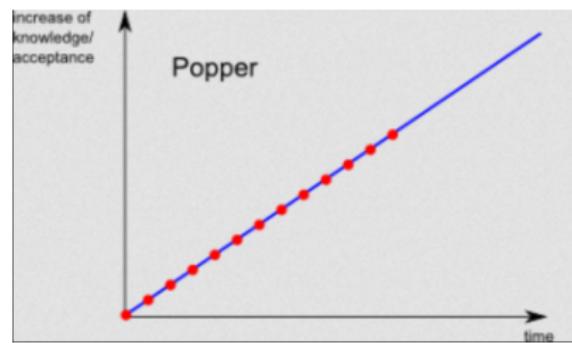
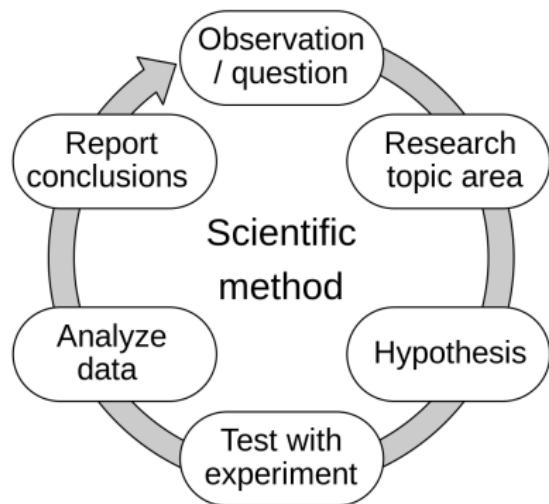
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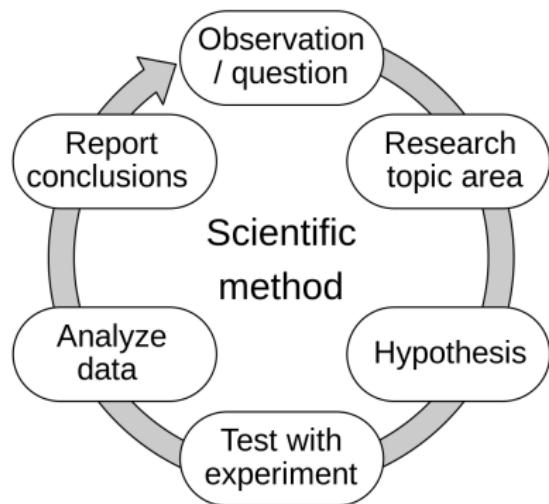
# Philosophy of Science



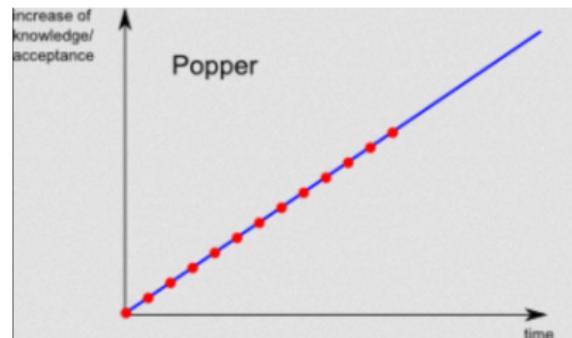
# Philosophy of Science



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Scientific  
method



But does science work this way?

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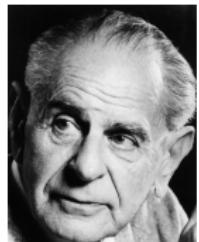
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- However, critics say that logical positivism is self-refuting (itself can't be verified)

# Philosophy of Science

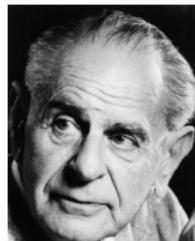
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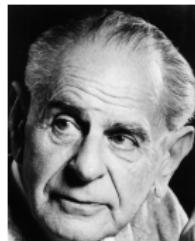
- Another problem with logical positivism can be seen with the statement “all swans are white”



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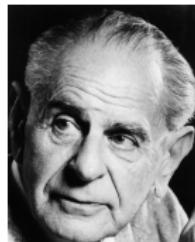
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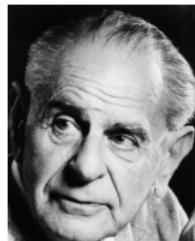
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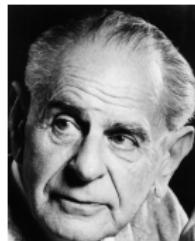


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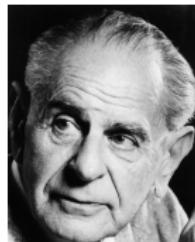
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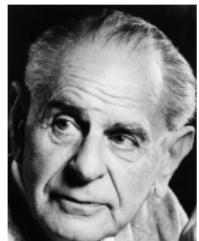
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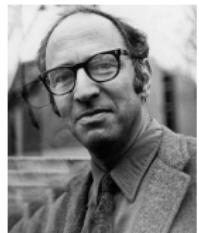


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- Dark matter can be seen as a reluctance to reject our current model of the universe

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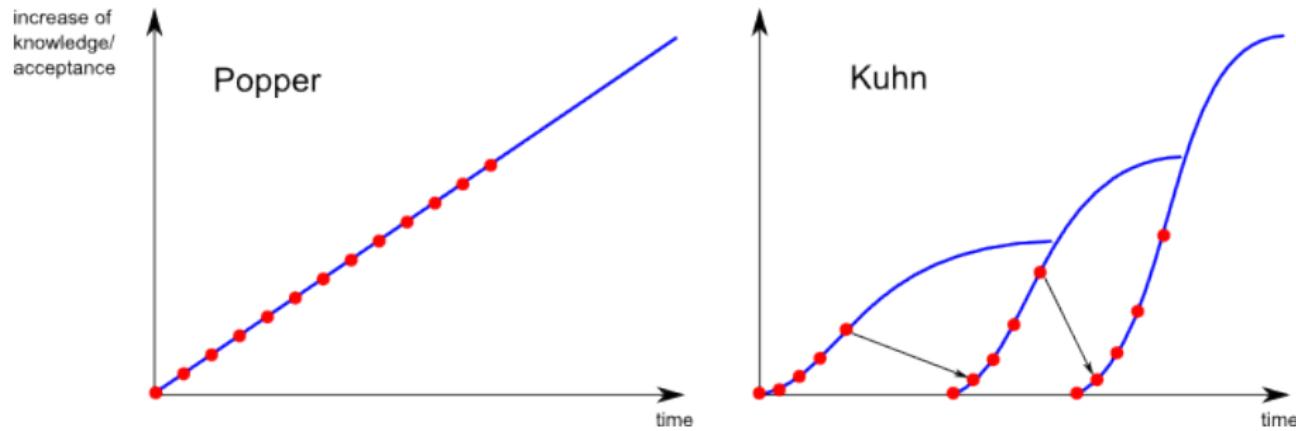
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- In response to a crisis, a revolutionary phase ensues, marked by the abandonment of the old paradigm and the emergence of a new one. This shift is often accompanied by a change in fundamental assumptions and a reevaluation of previously accepted scientific beliefs

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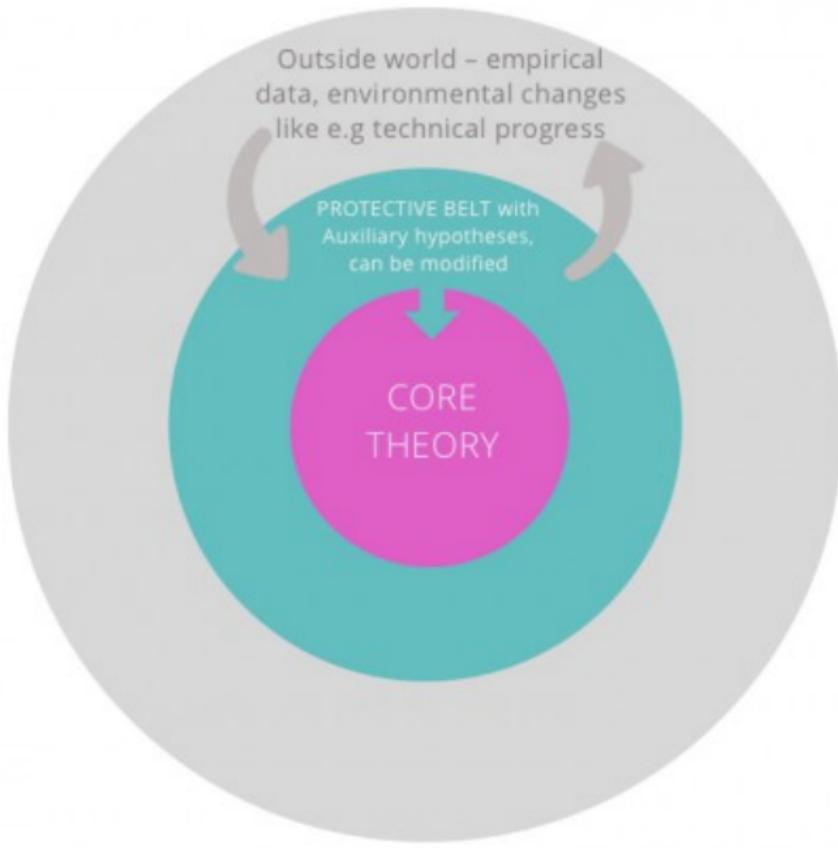
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- Essentially, Lakatos is a more *nuanced* take on Kuhn



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- These episodes violated all common prescriptive rules of science. Feyerabend argues that applying such rules in these historical situations would actually have prevented scientific revolution.



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- Phosphorus (1669): Hennig Brand was attempting to create the philosopher's stone by boiling his own urine. Brand noticed that a white substance glowed in the dark and emitted a faint light. This discovery was unintentional and occurred as a byproduct of his alchemical experiments.

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"Science is the best thing that has happened to human beings . . . but we can do it better."  
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Essay

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- Later meta-research identified widespread difficulty in replicating results in many scientific fields, including psychology and medicine. This problem was termed “the replication crisis”

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- solutions include the implementation of reporting standards, and greater transparency in scientific studies (conflict of interest)

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- Way more than I can fit in this slide . . .

## Incentives:

- Critics argue that perverse incentives have created a publish-or-perish environment in academia which promotes the production of junk science, low quality research, and false positives.
- “the number of publications has ceased to be a good metric as a result of longer author lists, shorter papers, and surging publication numbers”
- using number of publications, citation number, or impact factor can lead to: “overproduction, unnecessary fragmentations, overselling, predatory journals (pay and publish), clever plagiarism, and deliberate obfuscation of scientific results so as to sell and oversell”

Article | [Published: 04 January 2023](#)

## Papers and patents are becoming less disruptive over time

Is science stagnating?

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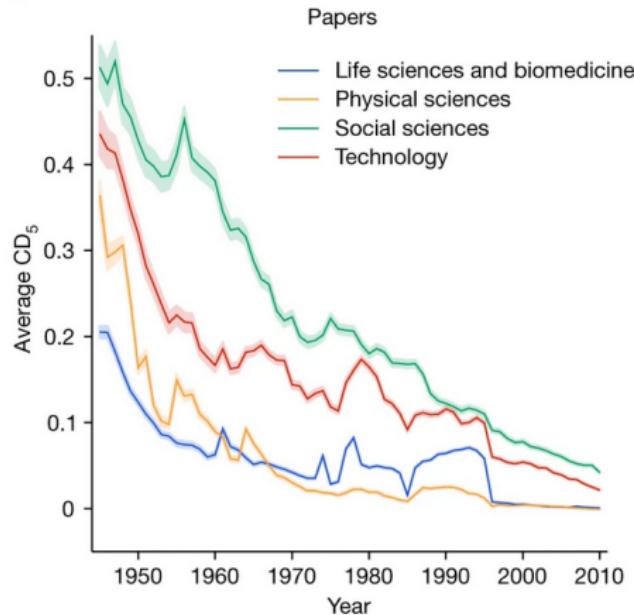
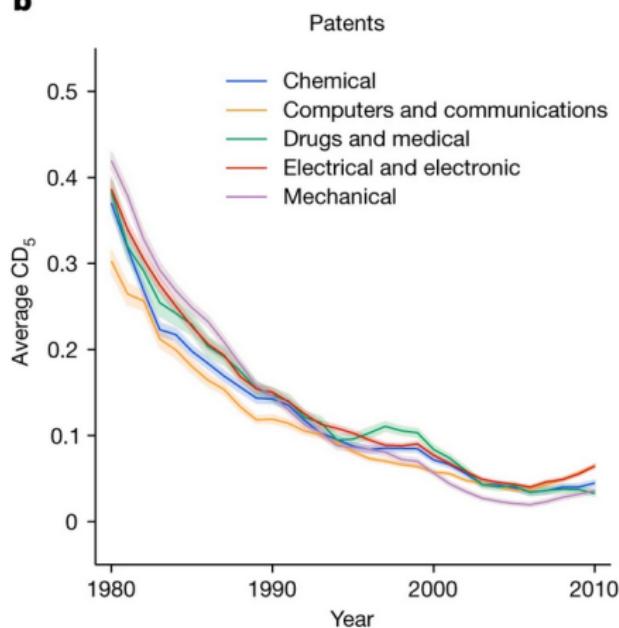
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### CD index

If a paper or patent is disruptive, the subsequent work that cites it is less likely to also cite its predecessors; for future researchers, the ideas that went into its production are less relevant (for example, Pauling's triple helix)

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**a****b**

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- Shift funding from senior people to younger researchers (even in the same lab; the average age of biomedical scientists receiving their first substantial grant is 46 and is increasing over time)

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- Researchers should be encouraged to switch fields, whereas currently they are incentivized to focus in one area
- We should invest in studying how to get the best science and how to choose and reward the best scientists. We should not trust opinion (including my own) without evidence. This will improve public opinion and hopefully funding!

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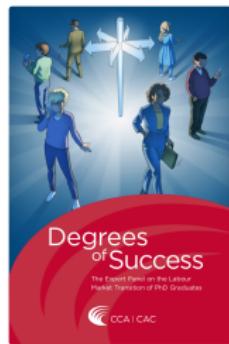
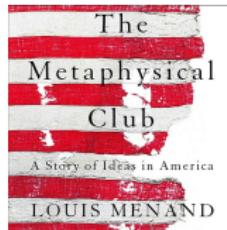
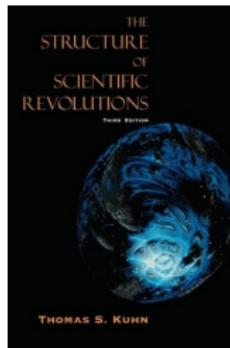
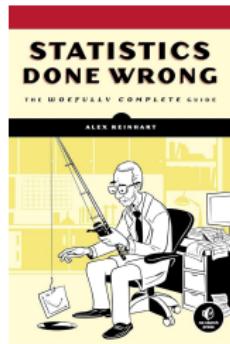
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- Metascience - the science of science - can help us improve how we do good science

# Further Reading



Essay

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## HOW MANY CLINICAL TRIALS CAN'T BE TRUSTED?

Investigations suggest that, in some fields, at least one-quarter of clinical trials might be problematic or fake, warn researchers. They urge stronger scrutiny. By Richard Van Noorden

## Science Funding Is Broken

The way we pay for science does not encourage the best results

By John P. A. Ioannidis on October 1, 2018

This talk can be downloaded from:  
<https://github.com/WeberLab/MetascienceTalk>  
You can find me on Mastodon:  
[@weberam2@qoto.org](mailto:@weberam2@qoto.org)

