

# Empowering early-career researchers to enhance research culture with ReproducibiliTea

---

***Dr William Ngiam***

*Lecturer at the University of Adelaide*

*Rigor and Reproducibility Seminar Series, University of Florida*

*31st October 2024*

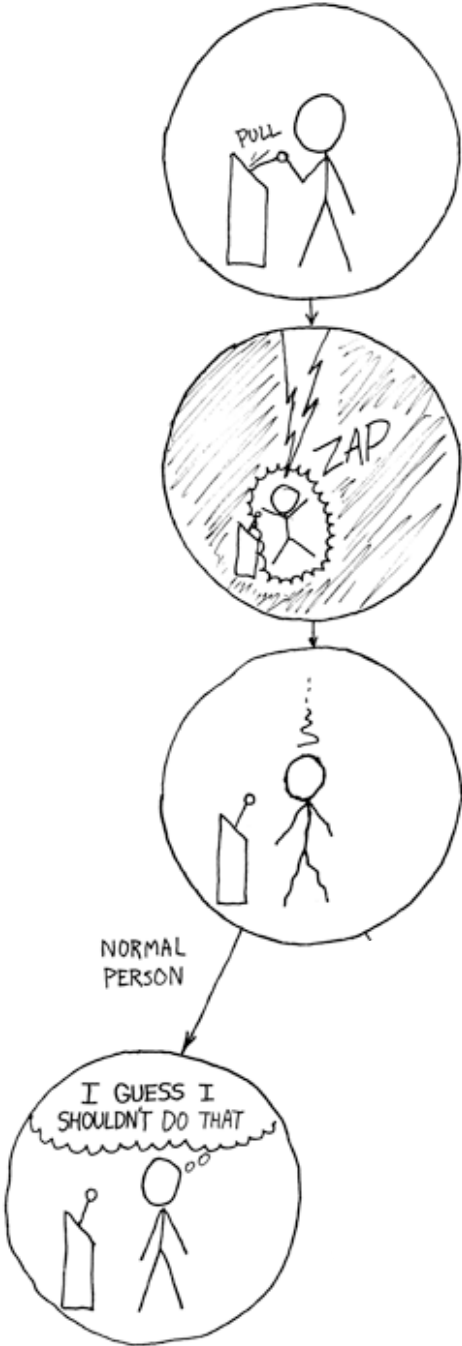
# Who am I?

- **Lecturer** in the School of Psychology at the University of Adelaide
  - I study visual attention and working memory – how we represent information in the mind and brain
  - We can focus on surprisingly little – attention is a precious resource, and so we need to be attending to the right things!
- **An active advocate** for early-career researchers and Open Science
  - A contributor, as an early-career researcher myself; throughout my postdoc until now
- I think **a lot is at stake**
  - I worry about an anti-science society – one where scientific research is no longer considered *credible*
  - I think the Open Science movement has a major role in ensuring science continues to have a positive impact on society

My goal for this talk is to inspire *you* to take **action and improve science**

- Provide an overview of the reproducibility crisis (from the lens of psychological science)
- Summarise the reforms that have to be introduced by the Open Science movement
- Share my journey and perhaps convince you to pursue open and transparent science

# How does science work?



Is this how we actually do science?



# The reproducibility crisis

- Also known as the replicability crisis
  - Sometimes the generalizability crisis, or the methodological crisis
- The **current** collective concern that many scientific studies are difficult to reproduce or do not replicate
  - The psychological sciences (and biomedical sciences) have high-profile controversies at the start of the 2010s
  - There have been concerns about the lack of replications in the past!
    - e.g. Paul Meehl, Jacob Cohen and others were sounding the alarm in the 1970s

# Notable examples of failed replications

- Priming people with elderly stereotypes leads to slower walking (Bargh, 1996) (almost 6000 citations!)
  - Multiple failures to replicate
  - Recent evidence suggesting that any walking speed effect was due to experimenters' expectations of what would happen
- Daryl Bem, a well-known and respected social psychologist and professor at the time, publishes **positive evidence for precognition and premonition**
  - 9 experiments, 1000 participants
  - Standard statistical analyses
  - Published in the *Journal of Personality and Social Psychology* (a highly prestigious journal) after peer review!
  - A pre-registered replication failed to find any of the reported effects in three attempts (Ritchie, Wiseman and French, 2012)

Bargh, J. A., Chen, M., & Burrows, L. (1996). Automaticity of social behavior: Direct effects of trait construct and stereotype activation on action. *Journal of personality and social psychology*, 71(2), 230.

Bem, D. J. (2011). Feeling the future: experimental evidence for anomalous retroactive influences on cognition and affect. *Journal of personality and social psychology*, 100(3), 407.

Ritchie, S. J., Wiseman, R., & French, C. C. (2012). Failing the future: Three unsuccessful attempts to replicate Bem's 'Retroactive Facilitation of Recall' Effect. *PloS one*, 7(3).

<https://www.theguardian.com/science/2012/mar/15/precognition-studies-curse-failed-replications>

# Notable examples of failed replications

- People with refillable soup bowls ate 73% more soup unknowingly! (Wansink, Painter and North, 2005)
  - Dubious that [this study ever happened](#) (Heathers, 2018)
  - Wansink has 18 retracted papers, 7 expressions of concern, 15 corrections
- Ego depletion – using up self-control resources on one task leads to hindered self-control on other tasks
  - A large-scale multi-lab replication attempt found [no effect](#). (Vohs et al., 2021)
- Diederik Stapel, a former professor of social psychology, is found to have faked data in numerous research findings after young researchers examine his data
  - Currently at 58 retractions – 8<sup>th</sup> most retractions on the Retraction Watch Leaderboard

Wansink, B., Painter, J. E., & North, J. (2005). Bottomless bowls: why visual cues of portion size may influence intake. *Obesity research*, 13(1), 93-100.

Heathers, J. (2018). <https://jamesheathers.medium.com/sprite-case-study-5-sunset-for-souper-man-ee898b6af9f5>

Vohs, K., Schmeichel, B., Lohmann, S., Gronau, Q. F., Finley, A. J., Wagenmakers, E. J., & Albarracín, D. (2021). A multi-site preregistered paradigmatic test of the ego depletion effect.

Retraction Watch Leaderboard: <https://retractionwatch.com/the-retraction-watch-leaderboard/>

# Failures to replicate in psychology

- 39% of studies (36 of 97 that had positive findings) published in high-ranking psychology journals replicated (*Reproducibility Project: Psychology*; Open Science Collaboration, 2015)
- 14 of 28 psychology findings replicated with massive sample sizes (*Many Labs 2*; Klein, 2018)
- 3 of 10 psychology findings replicated across many participant pools (*Many Labs 3*; Ebersole et al., 2016)
- 13 of 21 social science experiments in *Nature* and *Science* between 2010 and 2015 replicated (Camerer, et al., 2018)

Open Science Collaboration. (2015). Reproducibility Project: Psychology. OSF. doi:10.17605/OSF.IO/EZCUJ

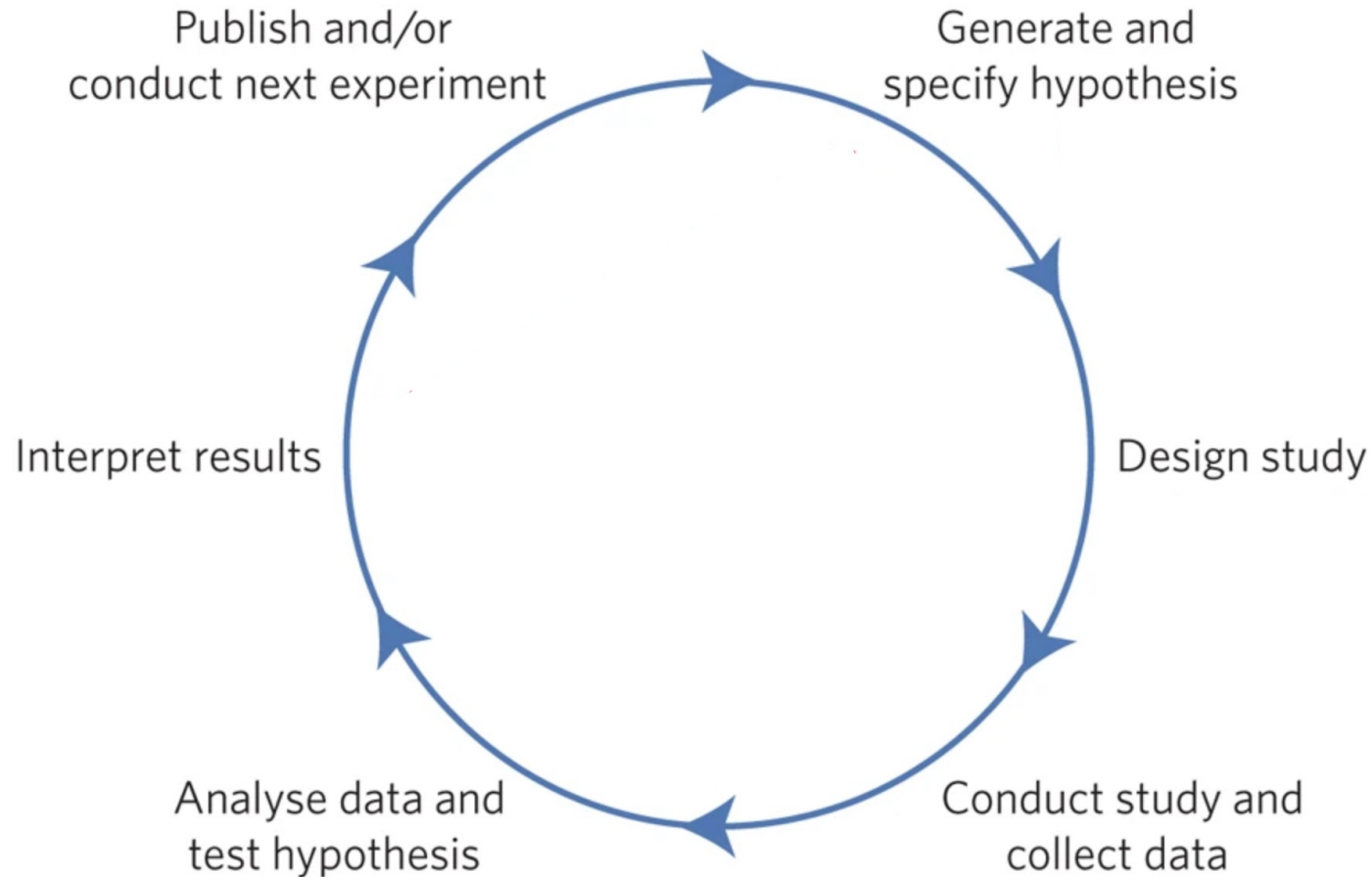
Klein, R. A., Vianello, M., Hasselman, F., Adams, B. G., Adams Jr, R. B., Alper, S., ... & Batra, R. (2018). Many Labs 2: Investigating variation in replicability across samples and settings. *Advances in Methods and Practices in Psychological Science*, 1(4), 443-490

Ebersole, C. R., Atherton, O. E., PhD, Belanger, A. L., Skulborstad, H. M., Allen, J., Banks, J. B., ... Nosek, B. A. (2016, August 17). Many Labs 3: Evaluating participant pool quality across the academic semester via replication. <https://doi.org/10.31234/osf.io/q4emc>.

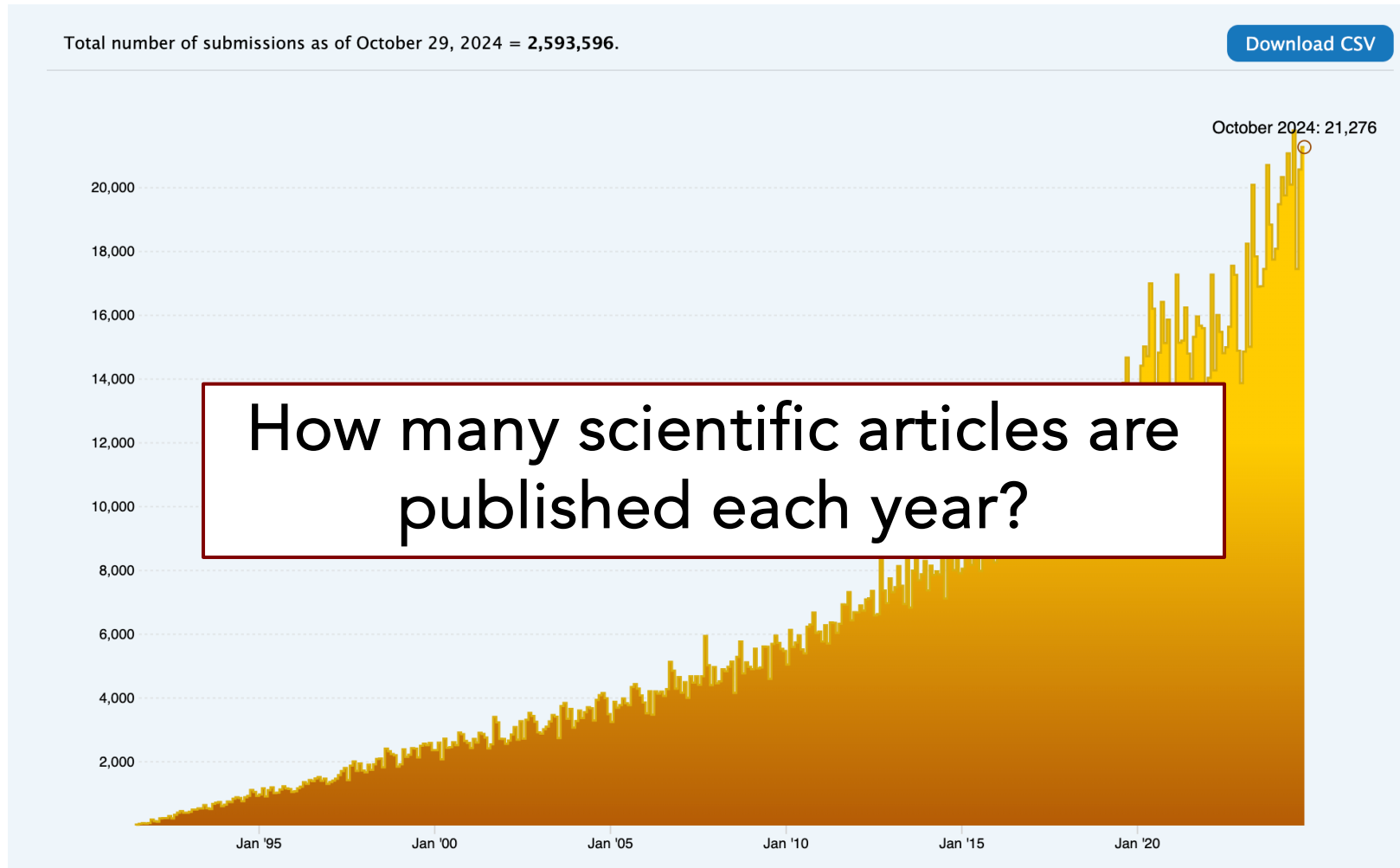
Camerer, C. F., Dreber, A., Holzmeister, F., Ho, T. H., Huber, J., Johannesson, M., ... & Wu, H. (2018). Evaluating the replicability of social science experiments in *Nature* and *Science* between 2010 and 2015. *Nature Human Behaviour*, 2(9), 637-644.



# Threats to reproducible science



# Exponential growth of scientific publications



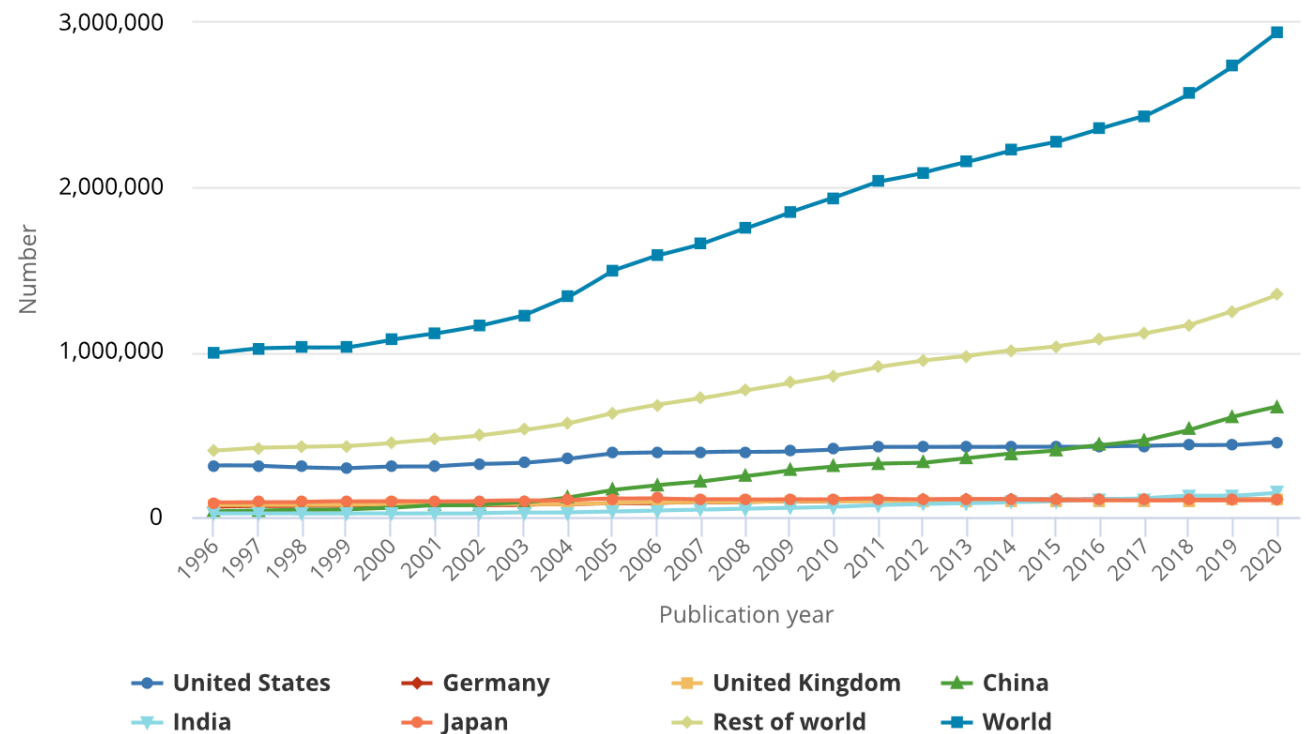
# Exponential growth of scientific publications

- Estimated to have reached **2.9 million articles** in 2020 (National Science Board, National Science Foundation)
- Increasing by approximately **4% each year** (Pan, Petersen, Pammolli and Fortunato, 2016)

National Center for Science and Engineering Statistics | NSB-2021-4

Figure PBS-2

S&E articles, by selected region, country, or economy and rest of world: 1996–2020



Review by National Center for Science and Engineering Statistics. <https://ncses.nsf.gov/pubs/nsb20214/publication-output-by-country-region-or-economy-and-scientific-field>

Pan, R. K., Petersen, A. M., Pammolli, F., & Fortunato, S. (2018). The memory of science: Inflation, myopia, and the knowledge network. *Journal of Informetrics*, 12(3), 656-678. <https://arxiv.org/abs/1607.05606>

# Is the goal of science just to publish?

2024-8-13

## The AI Scientist: Towards Fully Automated Open-Ended Scientific Discovery

Chris Lu<sup>1,2,\*</sup>, Cong Lu<sup>3,4,\*</sup>, Robert Tjarko Lange<sup>1,\*</sup>, Jakob Foerster<sup>2,†</sup>, Jeff Clune<sup>3,4,5,†</sup> and David Ha<sup>1,†</sup>

<sup>\*</sup>Equal Contribution, <sup>1</sup>Sakana AI, <sup>2</sup>FLAIR, University of Oxford, <sup>3</sup>University of British Columbia, <sup>4</sup>Vector Institute, <sup>5</sup>Canada CIFAR AI Chair, <sup>†</sup>Equal Advising

One of the grand challenges of artificial general intelligence is developing agents capable of conducting scientific research and discovering new knowledge. While frontier models have already been used as aids to human scientists, e.g. for brainstorming ideas, writing code, or prediction tasks, they still conduct only a small part of the scientific process. This paper presents the first comprehensive framework for fully *automatic scientific discovery*, enabling frontier large language models (LLMs) to perform research independently and communicate their findings. We introduce **THE AI SCIENTIST**, which generates novel research ideas, writes code, executes experiments, visualizes results, describes its findings by writing a full scientific paper, and then runs a simulated review process for evaluation. In principle, this process can be repeated to iteratively develop ideas in an open-ended fashion and add them to a growing archive of knowledge, acting like the human scientific community. We demonstrate the versatility of this approach by applying it to three distinct subfields of machine learning: diffusion modeling, transformer-based language modeling, and learning dynamics. Each idea is implemented and developed into a full paper at a meager cost of less than \$15 per paper, illustrating the potential for our framework to democratize research and significantly accelerate scientific progress. To evaluate the generated papers, we design and validate an automated reviewer, which we show achieves near-human performance in evaluating paper scores. **THE AI SCIENTIST** can produce papers that exceed the acceptance threshold at a top machine learning conference as judged by our automated reviewer. **This approach signifies the beginning of a new era in scientific discovery in machine learning: bringing the transformative benefits of AI agents to the entire research process of AI itself, and taking us closer to a world where endless affordable creativity and innovation can be unleashed on the world's most challenging problems.** Our code is open-sourced at <https://github.com/SakanaAI/AI-Scientist>.

My impression is that their attention is misplaced on the incentives, and lacks a considered philosophy of science.

Does producing more papers lead to more knowledge?  
Solutions to world's problems?  
Progress in society?

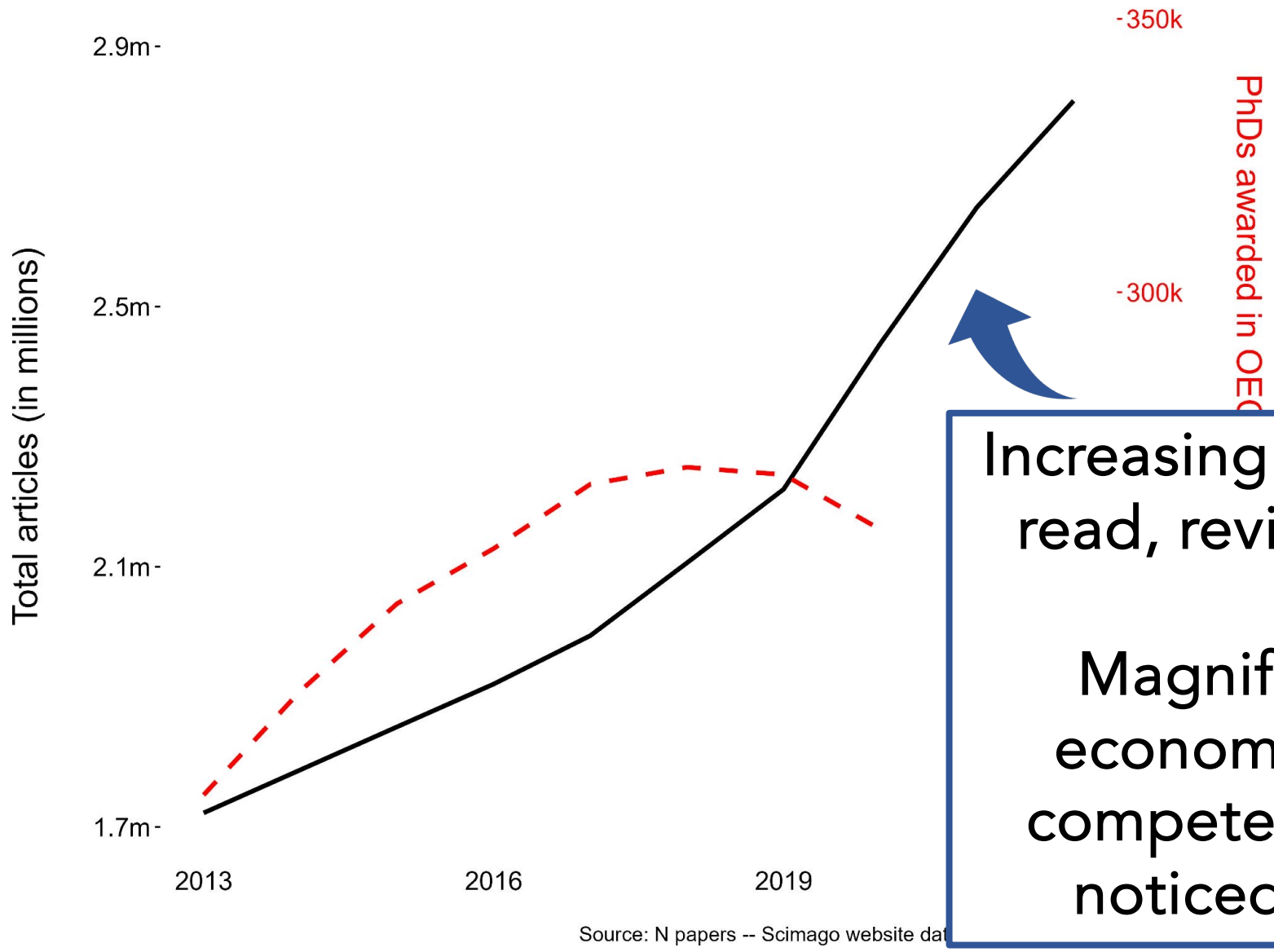


# The **decline** of negative results

- The proportion of papers reporting a positive result has been **increasing**

Does having more papers  
(mostly with positive findings)  
mean faster scientific progress?  
I say **not really.**

- In the recent psychology literature, this proportion is estimated to be **~95%** (Scheel, Schijen and Lakens, 2021)



Increasing strain on scientists to read, review and co-ordinate.

Magnifying an "attention economy" where scientists compete for their work to be noticed and have impact.

Source: N papers -- Scimago website data

Figure copied from <https://bsky.app/profile/hansonmark.bsky.social/post/3kajeqzv3nt2b>  
 Hanson, Barreiro, Crosetto and Brockington (2023). The strain on scientific publishing. *ArXiv*. <https://arxiv.org/abs/2309.15884>

# What comes at the cost of scientific rigor

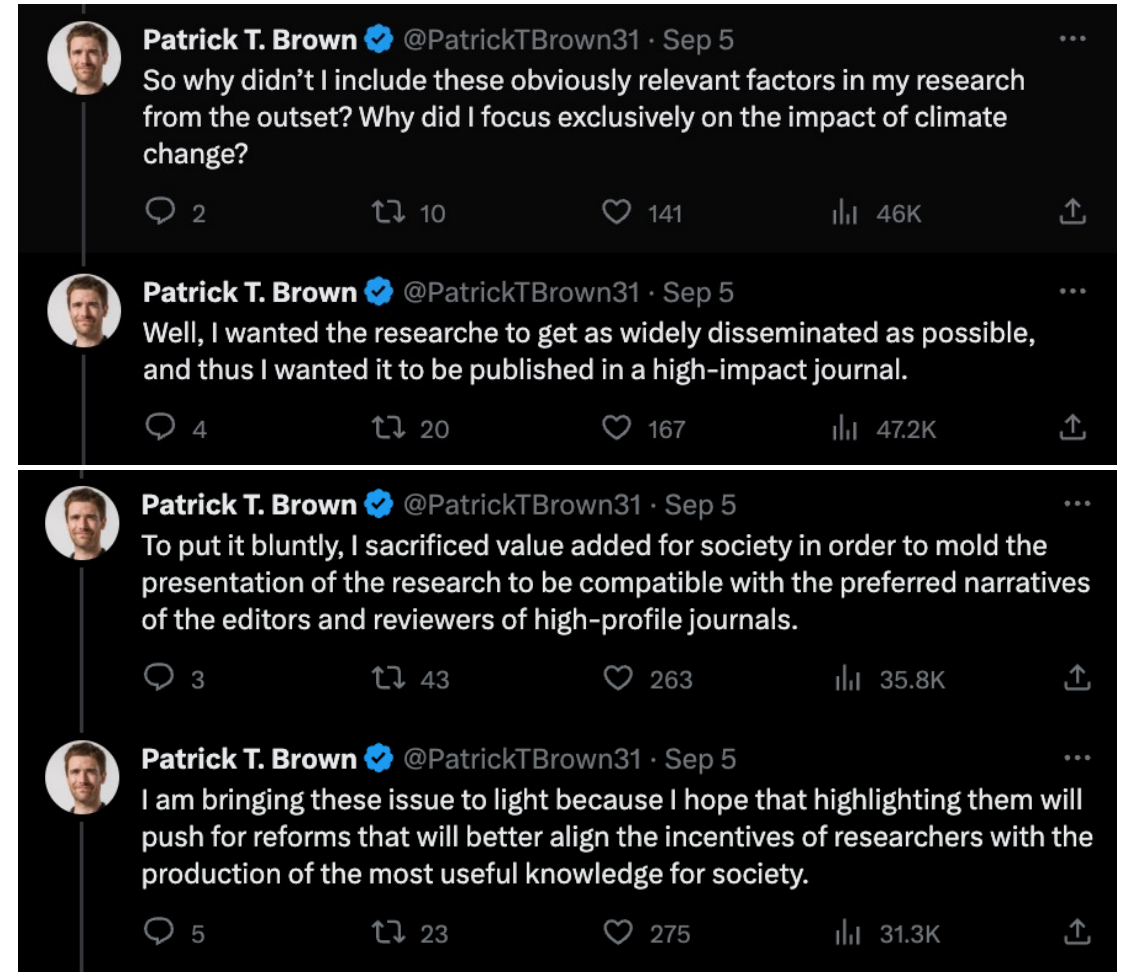
## Climate warming increases extreme daily wildfire growth risk in California

[Patrick T. Brown](#) , [Holt Hanley](#), [Ankur Mahesh](#), [Colorado Reed](#), [Scott J. Strenfel](#), [Steven J. Davis](#), [Adam K. Kochanski](#) & [Craig B. Clements](#)

[Nature](#) 621, 760–766 (2023) | [Cite this article](#)

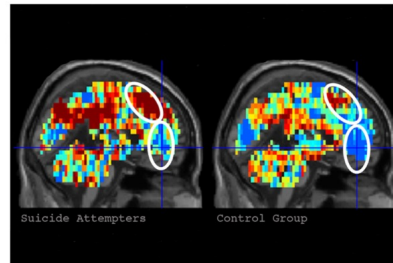
12k Accesses | 1508 Altmetric | [Metrics](#)

Is this appropriate scientific communication?



# How a now-retracted study got published in the first place, leading to a \$3.8 million NIH grant

The scientific paper inspired international headlines with its bold claim that the combination of brain scans and machine learning algorithms could identify people at risk for suicide with 91% accuracy.



August 29, 2018  
Carnegie Mellon, Pitt Receive \$3.8M NIMH Grant To Diagnose Suicidal Thinking Using Brain Imaging

The promise of the work garnered lead author Marcel Adam Just of Carnegie Mellon University in Pittsburgh and co-author David Brent of the University of Pittsburgh a five-year, \$3.8 million grant from the National Institute of Mental Health to conduct a larger follow-up study.

## Retraction Watch

Tracking retractions as a window into the scientific process

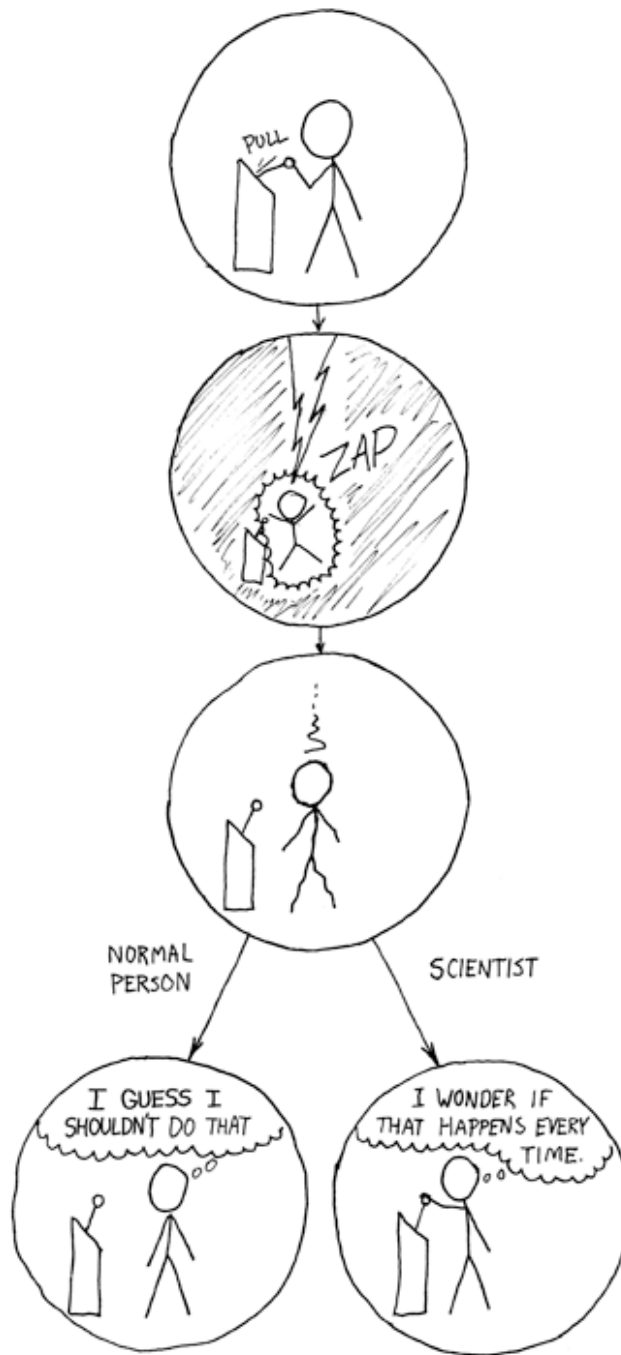
One of the reviewers was not impressed, because the main analysis still focused on 34 participants “cherry-picked” from an original pool of 79, the reviewer wrote.

The authors retracted the paper this year after Timothy Verstynen of Carnegie Mellon University and Konrad Paul Kording of the University of Pennsylvania submitted a Matters Arising, a paper detailing their unsuccessful attempts to replicate the 2017 work with the code and data the authors had made available and their concerns about bias in the model.



This was received by Nature in September 2020, and published on 6<sup>th</sup> April, 2023 with retraction of the original article 6 years later.





How often do direct replications occur in psychology?

0.2%  
(169 out of 82,775 articles)

# Replications in publications ratio

[Tweet I posted.](#)

- [Simine Vazire \(2023\)](#) (email, unofficial): **0.2%** (169 out of 84,834) Psychology
- [Kobrock & Roettger \(2022\)](#): **0.06%** Linguistics
- [Hardwicke et al \(2021\)](#) PPS: **5%** Psychology, **1%** Social Sciences
- [Kelly \(2019\)](#): Pe
- [Mueller-Langer](#)
- [Marsden et al. \(2018\)](#): **0%** Language
- [Makel et al. \(2016\)](#) RSE: **0.5%** Special Education
- [McNeeley & Warner \(2015\)](#): **2%** Criminology
- [Makel et al. \(2014\)](#) ER: **0.13%** Education
- [Makel et al. \(2012\)](#) PPS: **0.1%** Psychology
- [Kelly \(2006\)](#) QRB: **0-34%** (exact vs. conceptual vs. quasireplicaiton) **Biology**

**Not enough.**



Current academic structures have lead to more papers, but with incentives and research assessment being broken, it has not meant more rigorous science.

# Is science self-correcting?

- Psychology researchers realize that decisions made on statistical analysis can introduce bias and **increase the likelihood of false positives**
- Large-scale replication efforts **fail to replicate most** published findings
  - When an effect is replicated, the effect size is typically smaller than reported
- Scientists work within structures that incentivize producing research articles – leading to an increasing rate of article production
  - **Research quality and rigor appears to be diminished**, leading to more research issues and dampening positive impact on society



# The credibility revolution

- In the words of **Simine Vazire**, founder of the Society for Improvement of Psychological Science:
  - A “*crisis*” implies we are at a loss for solutions, when in fact we have identified many ways to improve science’s credibility.”
- Many scientists are actively working on solving the current problems!



Vazire, S. (2018). Implications of the credibility revolution for productivity, creativity, and progress. *Perspectives on Psychological Science*, 13(4), 411-417.

Comic panel from Repeat After Me by Maki Naro from The Nib – <https://www.thenib.com/repeat-after-me>

# The Open Science movement

- “An umbrella term used to refer to the concepts of **openness, transparency, rigor, reproducibility, replicability, and accumulation of knowledge**, which are considered fundamental features of science” (Crüwell et al., 2018)
- A rapidly growing and evolving movement that has had (and continues to have) a long-lasting effect on how science is being done!



# Preregistration and Registered Reports

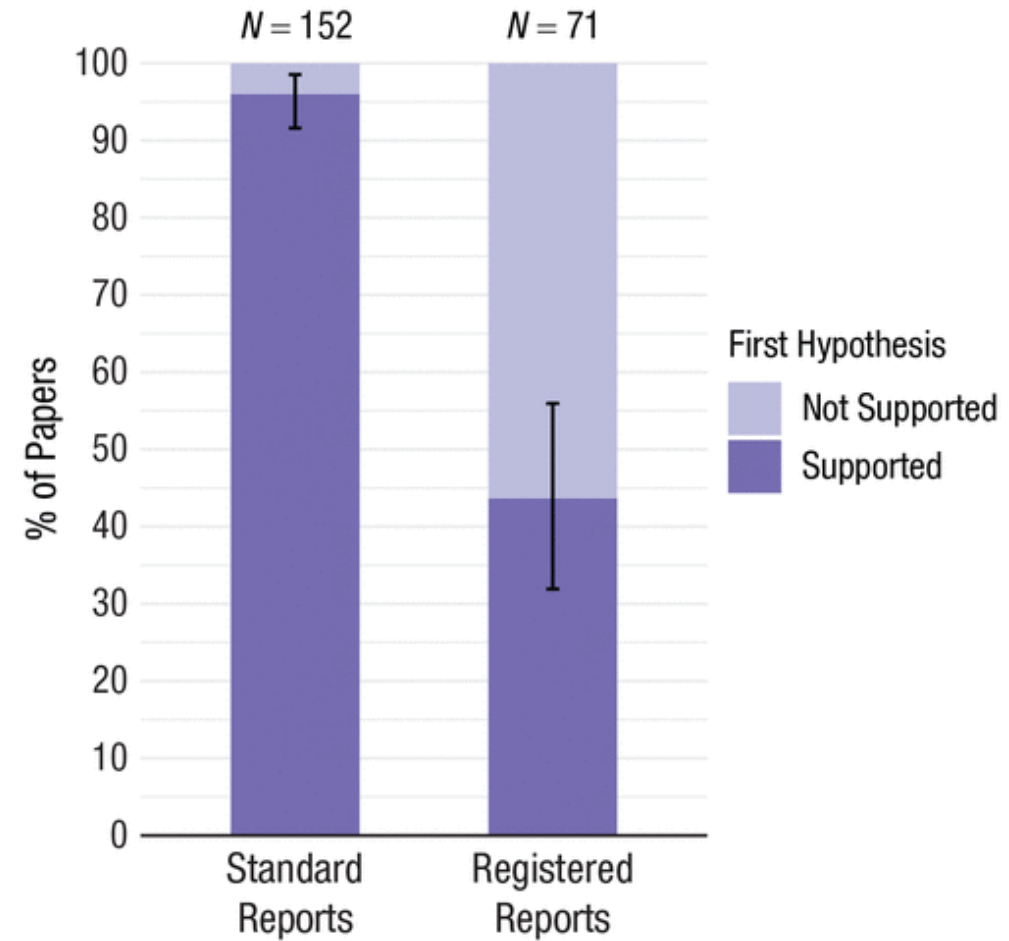
- Preregistration involves **publicly posting** the research question, hypotheses, design, planned analysis before the data is collected (or examined)
  - Hosted on AsPredicted.org or Open Science Framework and others!
  - Brings transparency to the researchers' design and analysis decisions, combating researcher bias, analytical flexibility and p-hacking
- Registered Reports are a **new publishing format** where the study design is peer-reviewed and accepted in-principle (Chambers et al., 2015)
  - This combats **publication bias** – the notion that positive results are most worth publishing – and shifts focus to rigor and methodology away from the findings

Chambers, C. D., Dienes, Z., McIntosh, R. D., Rotshtein, P., & Willmes, K. (2015). Registered reports: realigning incentives in scientific publishing. *Cortex*, 66, A1-A2.

For a glossary of Open Scholarship terms, see <https://forrt.org/glossary> by the Framework for Open and Reproducible Research Training

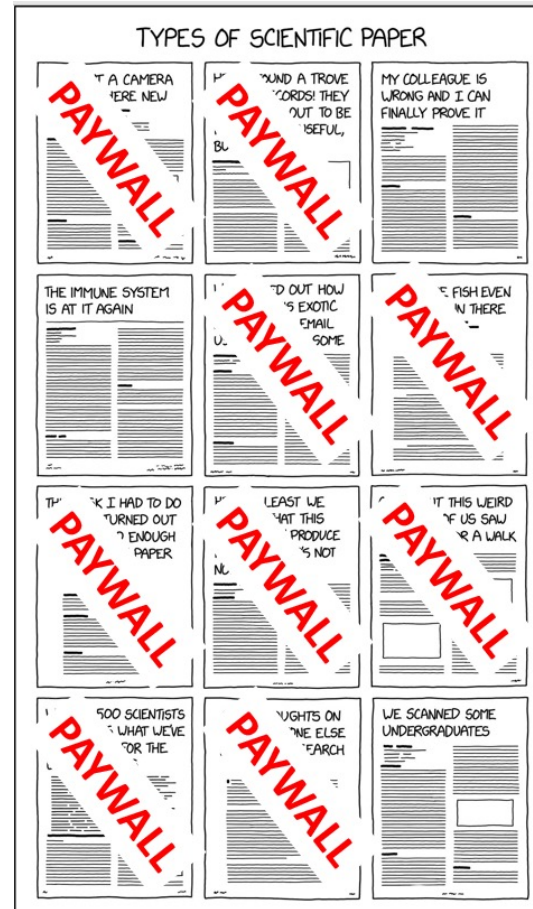
# It is working!

- Registered Reports have substantially fewer positive results than the standard literature (Scheel, Schijen and Lakens, 2021)
  - Likely due to a reduction in publication bias and error inflation!



# Open access to the knowledge

- Scientific knowledge should be **freely accessible** to the public!



Comic by <https://twitter.com/AndrewBarnas/status/1388161745684996098/photo/1>  
Original comic: <https://xkcd.com/2456/>

# Profit margins of scientific publishing companies

- Elsevier made an operating profit of £982 million in 2019, £1,021 million in 2020, £1,001 million in 2021, £1.3 billion in 2022, £1.79 billion in 2023, at an operating margin of ~31-37% according to their annual reports.

Profit	Company	Industry
10%	BMW	automobiles
23%	Rio Tinto	mining
25%	Google	search
29%	Apple	premium computing
<b>35%</b>	<b>Springer</b>	<b>scholarly publishing</b>
<b>37%</b>	<b>Elsevier</b>	<b>scholarly publishing</b>

http://wp.me/ph4jF-km CC-BY Alex Holcombe

RELX Annual Report and Financial Statements accessed via <https://www.relx.com/investors/annual-reports/2021>  
<https://markets.ft.com/data/announce/detail?dockey=1323-16333416-4LUAGTEE271HMCQHV3723NQ9NR>

Figure courtesy of Alex Holcombe's blogpost "Scholarly publisher profit update" <https://alexholcombe.wordpress.com/2015/05/21/scholarly-publisher-profit-update/>.

# Research Integrity and Peer Review

[Home](#) [About](#) [Articles](#) [Submission Guidelines](#)

Research | [Open Access](#) | [Published: 14 November 2021](#)

## A billion-dollar donation: estimating the cost of researchers' time spent on peer review

[Balazs Aczel](#) , [Barnabas Szaszi](#)  & [Alex O. Holcombe](#)

[Research Integrity and Peer Review](#) **6**, Article number: 14 (2021) | [Cite this article](#)

**38k** Accesses | **17** Citations | **3032** Altmetric | [Metrics](#)

# Open access publishing

- Making scientific publicly accessible via preprints (*PsyArXiv* or *bioRxiv*) or publishing in (diamond) open access journals



✔ **accepted:** PsyArXiv uses post-moderation. This preprint has been accepted by a moderator and is publicly available and searchable.

Page: 1 of 51 Automatic Zoom

VISUAL WORKING MEMORY THEORY MAP 1

1 **Mapping visual working memory models to a theoretical framework**

2 William Xiang Quan Ngiam

3 Department of Psychology, University of Chicago

4 Institute of Mind and Biology, University of Chicago

5

6 **Correspondence:** [wngiam@uchicago.edu](mailto:wngiam@uchicago.edu)

7

8 **Note:** This version of the article has been accepted for publication, after

9 peer review but is not the Version of Record and does not reflect post-

10 acceptance improvements, or any corrections. The Version of Record is

11 available online at: <https://doi.org/10.3758/s13423-023-02356-5>. Use of

12 this Accepted Version is subject to the publisher's Accepted Manuscript

13 terms of use [https://www.springernature.com/gp/open-](https://www.springernature.com/gp/open-research/policies/accepted-manuscript-terms)

14 [research/policies/accepted-manuscript-terms](https://www.springernature.com/gp/open-research/policies/accepted-manuscript-terms).

15

Download preprint

Views: 1382 | Downloads: 626



Be the first to endorse this work



### Abstract

The body of research on visual working memory (VWM) – the system often described as a limited memory store of visual information in service of ongoing tasks – is growing rapidly. The discovery

Show more ▾

### preprint DOI

<https://doi.org/10.31234/osf.io/g8erx>

### License

CC-BY Attribution 4.0 International >

### Disciplines

- Memory
- Cognitive Psychology
- Social and Behavioral Sciences

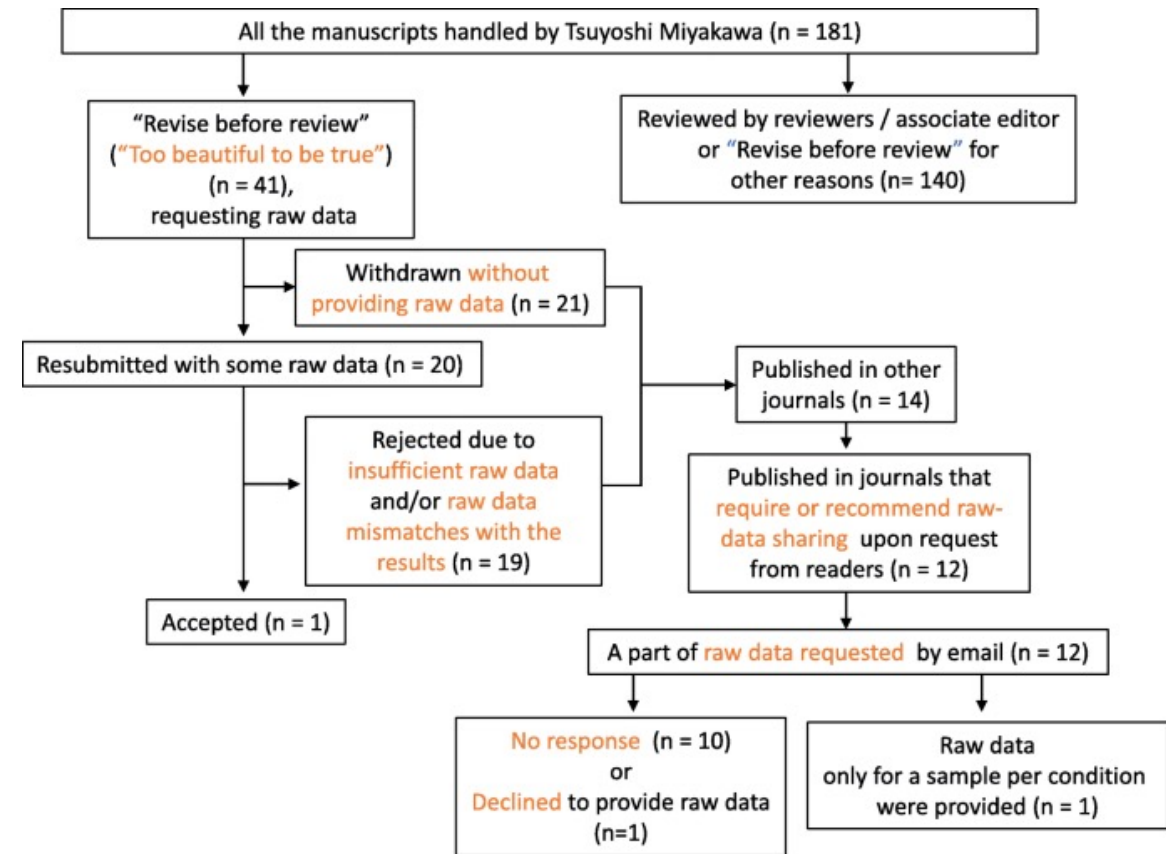
# Open access publishing

- Making scientific publicly accessible via preprints (*PsyArXiv* or *bioRxiv*) or publishing in (diamond) open access journals
  - Journals have article processing charges (APC) (charging the scientist!) to publish the paper for open access
    - USD\$3710 for *Cognitive Psychology*, USD\$3450 for *NeuroImage*
  - Receives more citations and coverage than non-OA research, likely due to increased ease of access and visibility (McKiernan et al., 2016)
- Consider other content formats for sharing research that are likely more effective science communication!
  - Open access shifts power away from publishers
  - Creating open educational resources (e.g. how-to or explainer videos)
  - Writing informal blogposts



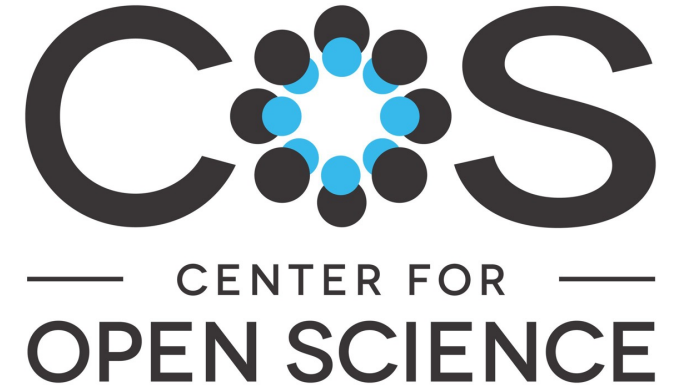
# "Data available upon request"

- Tsuyoshi Miyakawa, Editor-in-Chief at *Molecular Brain*, requested data for 41 submissions.
  - 21 withdrew their submission
  - 19 provided insufficient data or mismatches
    - 14 published elsewhere -> raw data for received on request for 1
  - 1 accepted
- Some scientists are willing to *game* the journal system for publications...



# Open access to research materials

- Sharing experimental code/data/stimuli for open access
  - Making a public repository of all research materials on the **Open Science Framework** (run by the Center for Open Science)
  - Uploading code and packages to **GitHub** and making it publicly available
- Allows for in-depth scrutiny and evaluation
  - And allows for re-analysis of the data for other purposes!
  - Promotes equity as it can reduce barriers for other researchers!



 OPEN SCIENCE FRAMEWORK



Abstract













Brady, Konkle and Alvarez (2009) argued that statistical learning boosts the number of colors that can be held online in visual working memory (WM). They showed that when specific colo...

[Read More](#)

Files 

Click on a storage provider or drag and drop to upload

 Filter 

Name ^ ▾	Modified ^ ▾
 Open Data for "Memory compression" effects in visual working mem...	
-  OSF Storage (United States)	
-  Experiment 1 Data	
-  OSF Storage (United States)	
+  Analysis Code	
+  Data	
+  UserData	
-  Experiment 2 Data	
-  OSF Storage (United States)	
+  Analysis Code	
+  Data	
+  UserData	

 Experiment 1 Data 

[Ngiam & Awh](#)

The raw data files for Experiment 1 have been uploaded here. 7/1/19: De-identified data was re-uploaded (participant information removed from files).

 Experiment 2 Data 


[Ngiam](#)


The raw data files for Experiment 2 are uploaded here. 7/1/19: The de-identified data is uploaded (participant information was removed).


Tags


Add a tag to enhance discoverability

Recent Activity

 William X. Q. Ngiam removed [Chaoxiong Ye](#) as contributor(s) from [Open Data for "Memory compression" effects in visual working memory are contingent on explicit long-term memory](#) 2019-06-20 03:56 PM

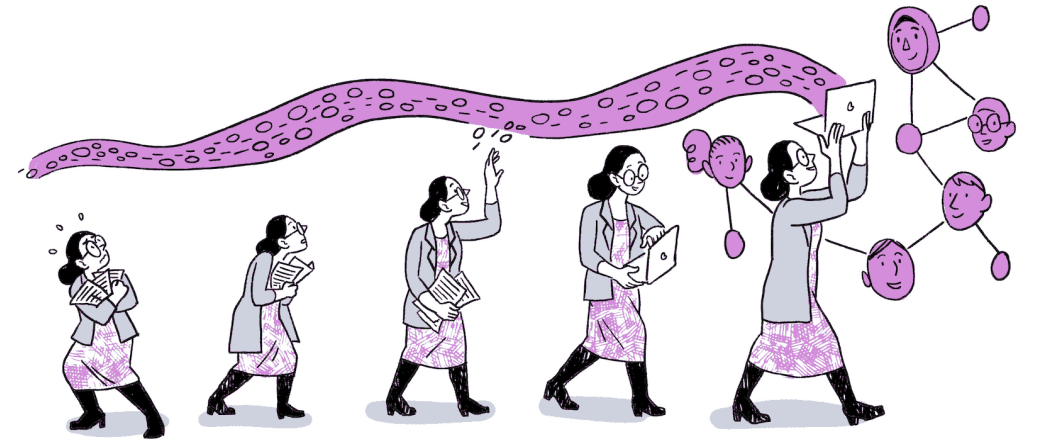
 William X. Q. Ngiam added [Chaoxiong Ye](#) as contributor(s) to [Open Data for "Memory compression" effects in visual working memory are contingent on explicit long-term memory](#) 2019-06-20 03:56 PM

 William X. Q. Ngiam made [Open Data for "Memory compression" effects in visual working memory are contingent on explicit long-term memory](#) public 2019-06-20 03:56 PM

 William X. Q. Ngiam updated wiki page [Home](#) to version 3 of [Open Data for "Memory compression" effects in visual working memory are contingent on explicit long-term memory](#) 2019-06-12 10:50 AM

Research rigor needs  
to be a priority...

and that starts with  
*you.*



EVOLVING TOWARDS AN  
ERA OF  
*OPEN RESEARCH*

Scriberia 

*The Turing Way* project illustration by Scriberia.  
Used under a CC-BY 4.0 licence.  
DOI: [10.5281/zenodo.3332807](https://doi.org/10.5281/zenodo.3332807).



**James Heathers**

@jamesheathers



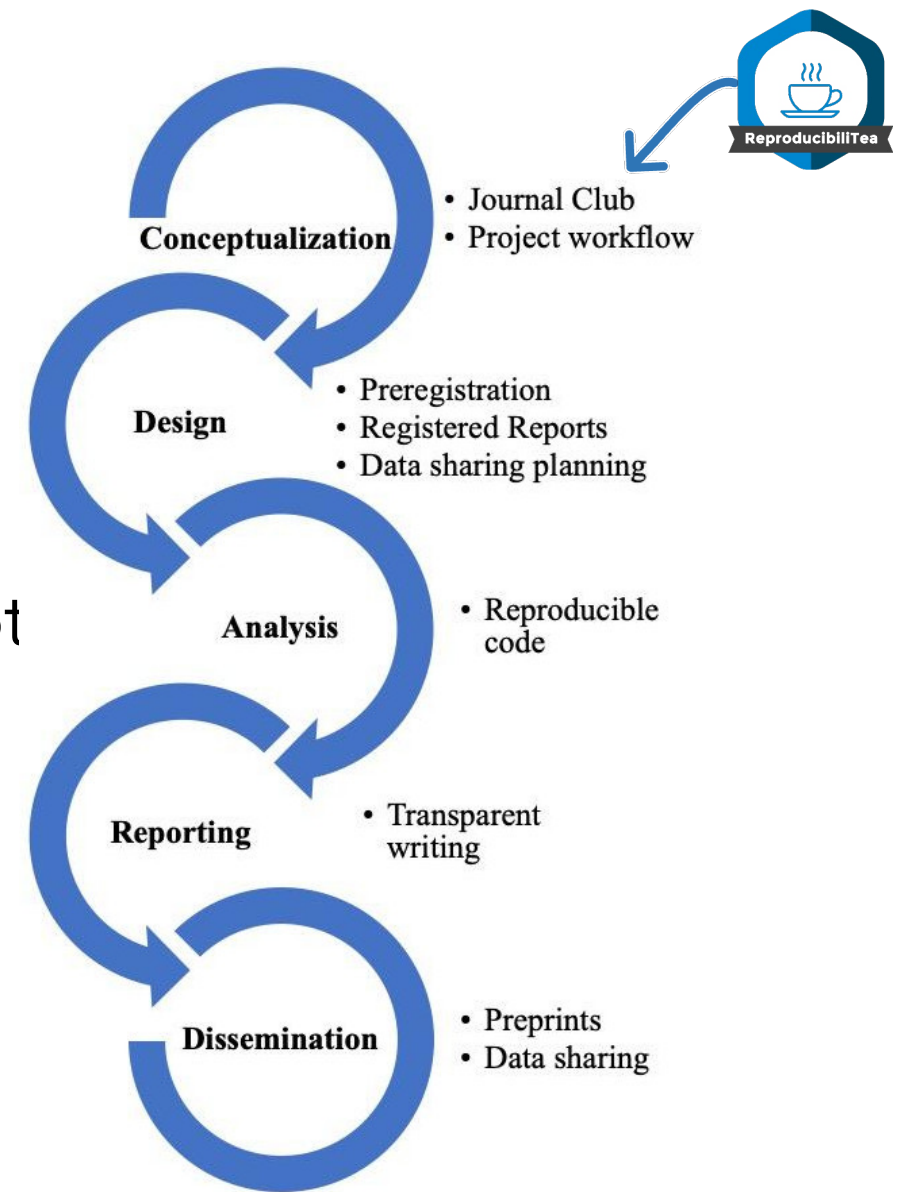
"Science is self-correcting" - sure, \*when we correct it\*, not because of Magical Progress (tm).

12:57 PM · Mar 25, 2017 · Twitter Web Client

Not doing anything **adds resistance** to changes and reforms. It calcifies existing structures.

# Where do I start?

- Open Science is not “all or nothing”
  - These are research skills that take time to develop!
- Some easy Open Science practices to adopt
  - Post free copies of published articles / deposit preprints of all manuscripts
  - Publish in open access venues
  - Publicly share data and materials
  - Preregister studies






Kathawalla, U. K., Silverstein, P., & Syed, M. (2021). Easing into open science: A guide for graduate students and their advisors. *Collabra: Psychology*, 7(1).

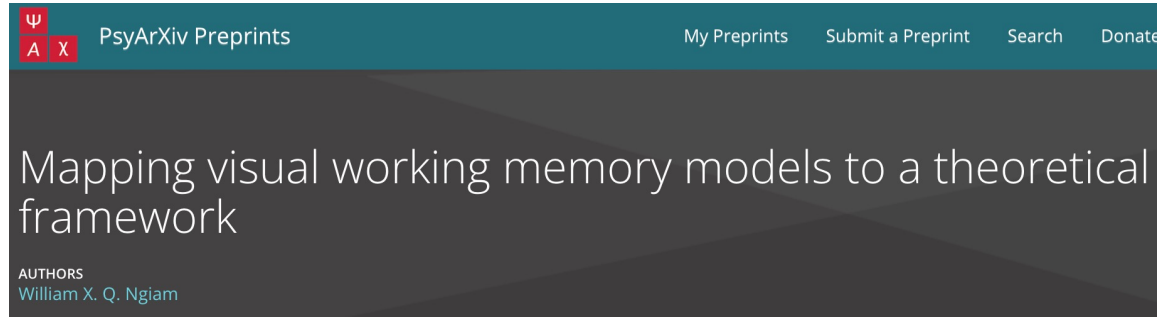
McKiernan, E. C., Bourne, P. E., Brown, C. T., Buck, S., Kenall, A., Lin, J., ... & Yarkoni, T. (2016). Point of view: How open science helps researchers succeed. *eLife*, 5, e16800.

# Personal **benefits** of Open Science

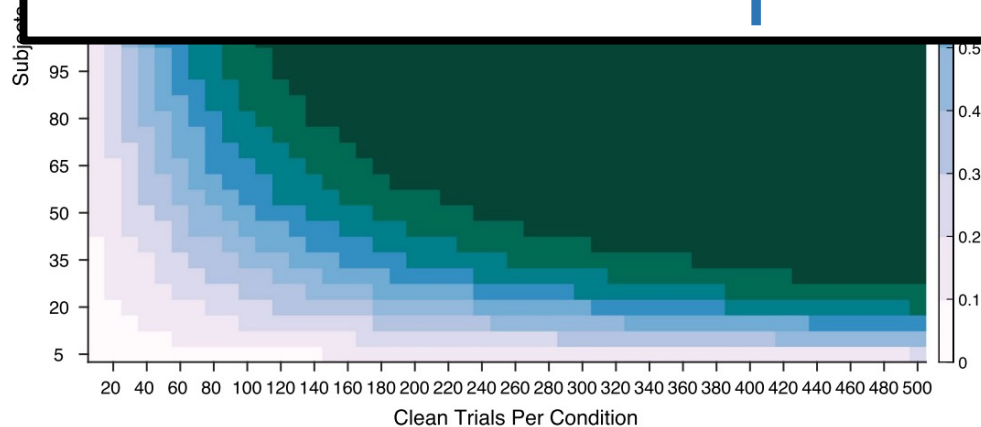
- **Improve the quality and reliability** of your scientific research
  - For example, preregistrations prompt **theory development**, justifications of sample sizes and analyses, and **statistical power considerations** to protect against researcher bias
- **Increases the impact** of your scientific research
  - Increase reviewers' quality of feedback if they reproduce your results and analyses
  - **Increase citations** from re-analysis and re-use of open datasets
- Can become part of your **academic brand**
  - Increasingly considered in grants and job applications

## Estimating the statistical power to detect set-size effects in contralateral delay activity

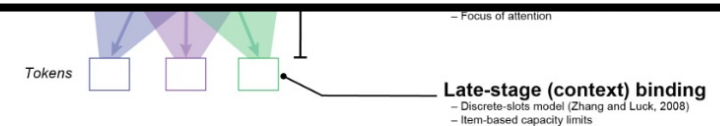
William X. Q. Ngiam<sup>1</sup>  | Kirsten C. S. Adam<sup>2</sup>  | Colin Quirk<sup>1</sup>  | Edward K. Vogel<sup>1</sup> | Edward Awh<sup>1</sup>



It's not either/or – your goals can include improving science while conducting empirical research.



**FIGURE 6** Simulated statistical power for observing a significant difference in CDA amplitude between set sizes 2 and 4 beyond the bounds of the Hakim et al. (2019) dataset



**Figure 1.** A simplified schematic of the Memory for Latent Representations (MLR) model architecture (Hedayati et al., 2022) with visual working memory phenomena and current models mapped on to its components: the variational autoencoder (VAE), the binding pool, and the tokens. This theory map aims to provide a coherent framework within which to organize visual working memory phenomena and discuss the relevant explanatory models. As such, the compatibility or inconsistencies between models can be better identified, and subsequently tested. For example, one could use a working definition for the noisy representation in VWM as the noise held in the pattern of neuron activity in the binding pool that follows a summation of information from various perceptual sources.



# The Open Science movement

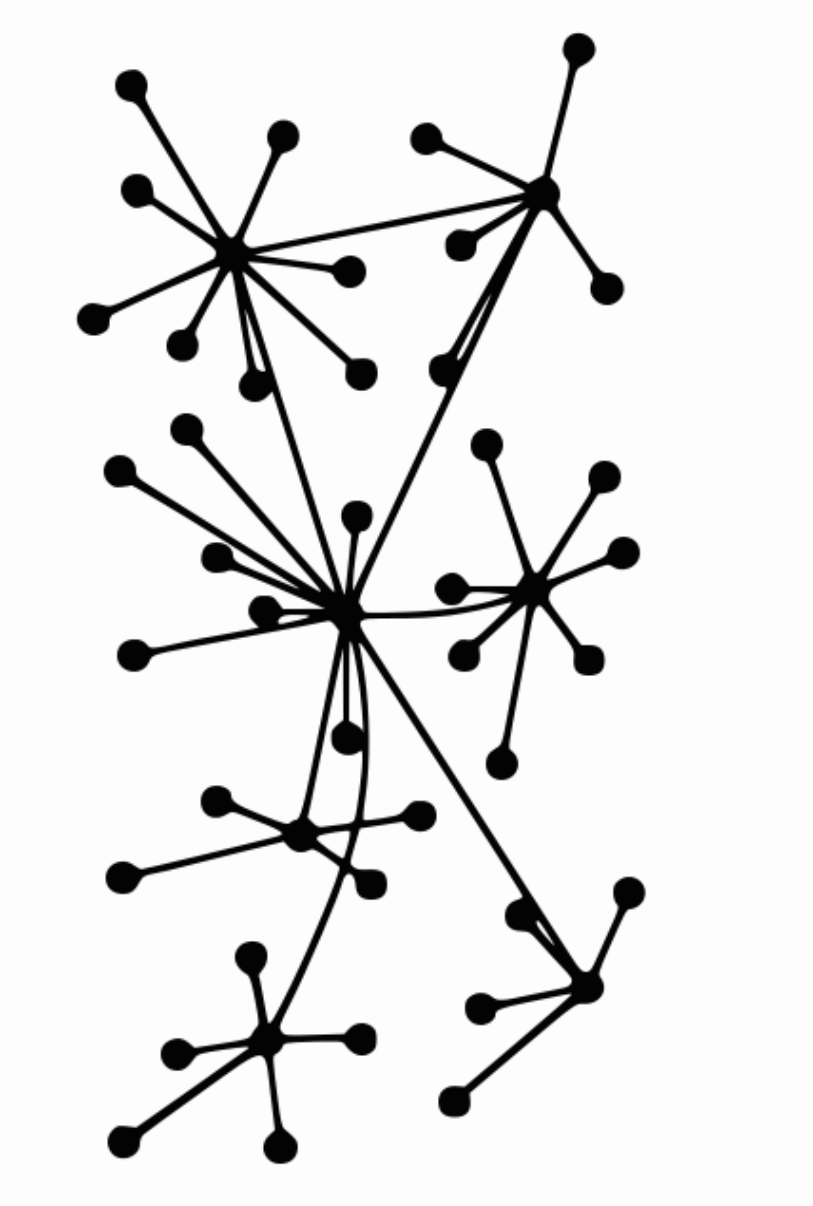
- “An umbrella term used to refer to the concepts of **openness, transparency, rigor, reproducibility, replicability, and accumulation of knowledge**, which are considered fundamental features of science” (Crüwell et al., 2018)
- A rapidly growing and evolving movement that has had (and continues to have) a long-lasting effect on how science is being done!
- Right now, it is missing the **community efforts that bolster cultural change**

# The Open Science movement

- There are a lot of ideas and initiatives in the reform movement – too many to list:
  - Experiment design/collaboration: *AsPredicted, ManyLabs, Psychological Science Accelerator...*
  - Data and Code: *Open Science Framework, OpenNeuro, BIDS...*
  - Publishing: *The Unjournal, ASAPBio, DORA, CRediT*
  - Education: *FORRT, Repro4Everyone, The Carpentries*
  - Global and National Projects: *OSIRIS, Community4Rigor, ABRIR, UKRN and other national RNs*
- Perhaps not a coherent or cohesive movement in improving science
- Not too many of these initiatives have the **next-generation of scientists** as their direct focus

# The Open Science movement

- A lot of the listed initiatives run on volunteer efforts and energy.
- The uptake of (or discussion around) open research practices is not yet *normed* across the sciences.
- These initiatives can be supercharged through **community building efforts** – only by bringing attention to the right practices and encouraging cultural change, will these reforms take hold.



# The Open Science movement

- A lot of the listed initiatives run on volunteer efforts and energy.
- Many open research practices are not yet *normed* across the sciences.
- These initiatives can be supercharged through **community building efforts** – only by bringing attention to the right practices and encouraging cultural change, will these reforms take hold.
- It is my firm belief that the focus should be on the **next-generation of scientists** – the ones who are inheriting scientific / academic structures and can be the ones that enact change!

# Early-career researchers leading the way with **ReproducibiliTea**



- An initiative founded by early-career researchers in 2018 that now spans 119 institutions across 29 countries
- Creating **open scholarship communities** at research institutions, especially empowering **early-career researchers**



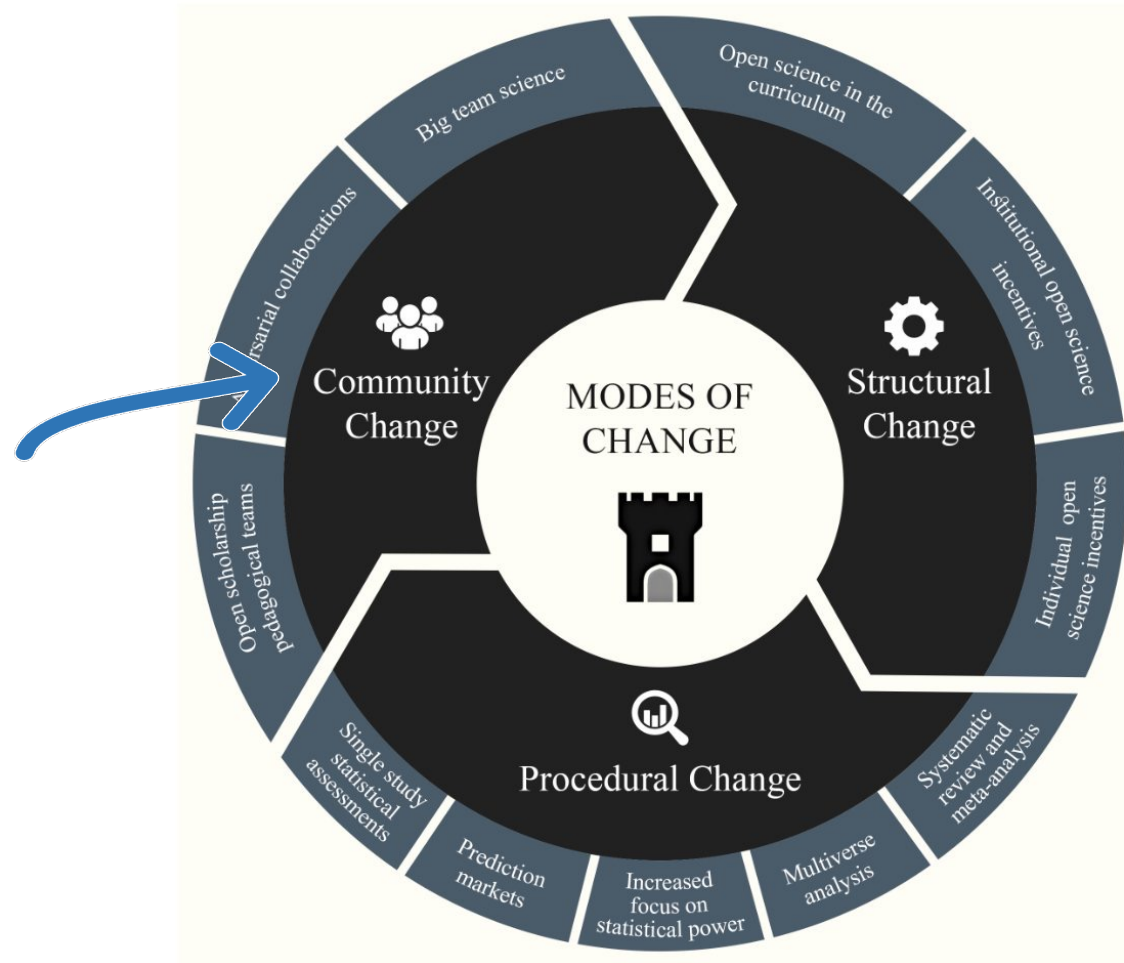
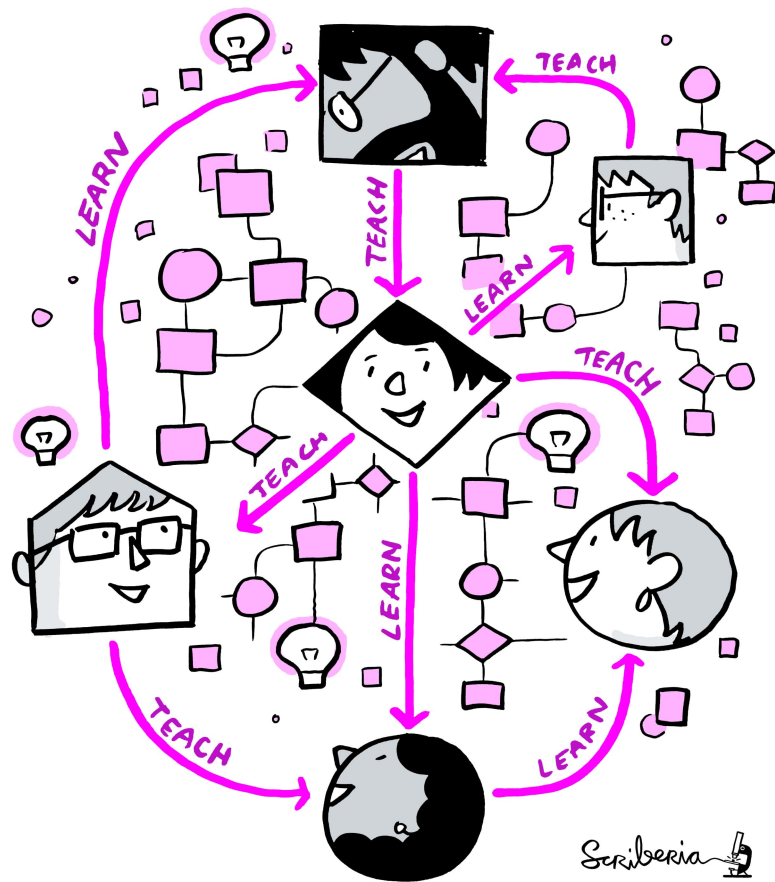


Fig. 1 Modes of change towards scientific credibility. This figure presents an overview of the three modes of change proposed in this article: structural change is often evoked at the institutional level and expressed by new norms and rules; procedural change refers to behaviours and sets of commonly used practices in the research process; community change encompasses how work and collaboration within the scientific community evolves.

Korbmacher, M., Azevedo, F., Pennington, C., Hartmann, H., Pownall, M., Schmidt, K., ... & Evans, T. (2023). The replication crisis has led to positive structural, procedural, and community changes. *Communications Psychology*. Communication network for sharing, learning and teaching. *The Turing Way* project illustration by Scriberia. Used under a CC-BY 4.0 licence. DOI: [10.5281/zenodo.3332807](https://doi.org/10.5281/zenodo.3332807).



- Started a ReproducibiliTea journal club at the University of Chicago and the University of Adelaide
- Joined the steering committee of the global organization



Podcast

**ReproducibiliTea Podcast**

ReproducibiliTea Podcast



Will Ngiam | [https://fediscience.org/@will\\_ngiam](https://fediscience.org/@will_ngiam)  
@will\_ngiam

A critical component that is often missing from psychology graduate research training is a course on \*theory in psychological science\*. I created this introductory reading list of ten relevant articles, including a brief summary and a link to a supplemental online resource!

**ReproducibiliTea Reading List on Theory in Psychological Science**

One precursor to the reproducibility crisis in psychology has been the haste to conduct empirical research, rather than rigorously develop theory and its connection to the research. These ten papers were selected to provide an introduction to theoretical psychology. They are separated by themes that your journal club may choose to explore in further detail in following meetings! We have also provided a brief summary, keywords and additional online resources to help inform your discussions.



Order	Block	Paper	Summary	Keywords	Resources
1	What is a theory?	Fried, E. I. (2020). Theories and models: What they are, what they are for, and what they are about. <i>Psychological Inquiry</i> , 31(4), 336-344. <a href="https://doi.org/10.1037/1047-7401.31.4.336">https://doi.org/10.1037/1047-7401.31.4.336</a>	<b>What is a theory?</b> An overview on the role of theories and models in science, including a brief commentary on the weakness of theories in the psychological sciences and how to make them better.	introductory, theory development	Elko Fried on 'Theory building and testing in psychological research' for the RIOT Science Club: <a href="https://youtu.be/11530c247">https://youtu.be/11530c247</a>
2		Meehl, P. E. (1978). Theoretical Risks and Tabular Asterisks: Sir Karl, Sir Ronald, and the Slow Progress of Soft Psychology. <i>Journal of Consulting and Clinical Psychology</i> , 46(3), 806-834. <a href="https://www3.nd.edu/~pam413/meehl/1978.pdf">https://www3.nd.edu/~pam413/meehl/1978.pdf</a>	<b>The lack of theory development in psychology.</b> An astute criticism of the excessive use of null hypothesis significance testing in 'soft psychology' that left psychological theories lacking 'the cumulative character of scientific knowledge because they tend to be neither refuted nor corroborated, but instead merely fade away as people lose interest.'	NHST, statistical testing, scientific inference	A video recording of the first lecture by Paul Meehl in his course on philosophical psychology from 1989, where he contrasts the role of theory in the 'hard sciences' like physics and the 'soft sciences' of psychology. <a href="https://youtu.be/11530c247">https://youtu.be/11530c247</a>
3	Does psychology have a theory problem?	Klein, S. B. (2014). What can recent replication failures tell us about the theoretical commitments of psychology?. <i>Theory &amp; Psychology</i> , 24(3), 326-334. <a href="https://doi.org/10.1177/095054531414262616">https://doi.org/10.1177/095054531414262616</a>	<b>A crisis in replication or beyond?</b> Determining success or failures of replications necessitates that theories be well-specified – clearly defining the relation between theory and prediction by linking rigorously established constructs to physical observations and detailing the essential conditions of experiments.	reproducibility crisis, replications, theory development	A personal commentary by Daniel Nelkin on the pretenses of having a theory in psychology: 'Theories and models are not the only fruit' <a href="https://www.researchgate.net/publication/318424046_Theories_and_models_are_not_the_only_fruit">https://www.researchgate.net/publication/318424046_Theories_and_models_are_not_the_only_fruit</a>
4		Scheel, A. M., Tiokein, L., Isager, P. M., & Lakens, D. (2021). Why hypothesis testers should spend less time testing hypotheses. <i>Perspectives on Psychological Science</i> , 16(4), 744-755. <a href="https://doi.org/10.1177/1745691820966765">https://doi.org/10.1177/1745691820966765</a>	<b>Are we ready to test?</b> Psychologists have been trained with a recipe: the hypothetico-deductive method – formulate a hypothesis from theory, devise a study to test the hypothesis, collect and analyze data, and finally evaluate whether there is support for or against the theory. However, without the groundwork strengthening the 'derivation chain that links theory to hypothesis test, the confirmatory testing that is prized by the recent reform movement may be premature.	exploratory versus confirmatory, derivation chain	Anne Scheel on 'Equivalence testing for psychological research' for the RIOT Science Club <a href="https://youtu.be/730R0P1XU">https://youtu.be/730R0P1XU</a>
5		Borboom, D., van der Mass, H. L., Daley, J., Kivitt, R. A., & Haig, B. D. (2021). Theory construction methodology: A practical framework for building theories in psychology. <i>Perspectives on Psychological Science</i> , 16(4), 756-766. <a href="https://doi.org/10.1177/1745691820966747">https://doi.org/10.1177/1745691820966747</a>	<b>A framework for theory construction.</b> An alternative to the hypothetico-deductive scheme, a theory construction methodology (TCM) is proposed that includes five steps: identifying a relevant phenomena, formulating a proto-theory, developing a formal model, checking the adequacy of the formal model, and evaluating the overall worth of the constructed theory.	derivation chain, theory building, formal modeling	A keynote presentation by Olivia Guest on "What makes a good theory, and how do we make a theory good?" <a href="https://youtu.be/730R0P1XU">https://youtu.be/730R0P1XU</a>
6	How to improve psychological theory	Guest, O., & Martin, A. E. (2021). How computational modeling can force theory building in psychological science. <i>Perspectives on Psychological Science</i> , 16(4), 789-802. <a href="https://doi.org/10.1177/1745691820970566">https://doi.org/10.1177/1745691820970566</a>	<b>Computational modeling can promote theory development.</b> Creating computational models can promote scientific inferences through enforcing better specification of theories as abstract constructs are formalized, and underlying intuitions and predictions are made open and transparent.	formal theory, computational modeling, scientific inference	A video recording of a talk by Olivia Guest and Andrea Martin on their paper "How computational modeling can force theory building in psychological science" <a href="https://youtu.be/730R0P1XU">https://youtu.be/730R0P1XU</a>
7		Maatman, F. O. (2021). Psychology's Theory Crisis, and Why Formal Modeling Cannot Solve It. <a href="https://osf.io/9m9p4/">https://osf.io/9m9p4/</a>	<b>Formal theories are helpful but first be determined.</b> The cause of the theory crisis stems from tests of experiments not being specific enough to support only one theory and falsify all other alternatives, and many psychological theories containing auxiliary assumptions such that the theories are not severely tested. Better methods that force precise and unlikely predictions from theories will solve the core issue, not necessarily formal modeling alone.	proto-theory, formal theory, theory building, theory specification	A Twitter thread by Freek Maatman (@psychodtheek) summarizing their paper. <a href="https://twitter.com/psychodtheek/status/141494808308206424">https://twitter.com/psychodtheek/status/141494808308206424</a>
8	Taking steps to improve psychological theory	Flake, J. K., & Fried, E. I. (2020). Measurement schmeasurement: Questionable measurement practices and how to avoid them. <i>Advances in Methods and Practices in Psychological Science</i> , 3(4), 456-465. <a href="https://doi.org/10.1177/2615245220929293">https://doi.org/10.1177/2615245220929293</a>	<b>Better measures to inform theory building.</b> Developing and testing theories requires construct measures to be scrutinized and valid. Existing questionable research practices (e.g. the arbitrary 'summing of subscales') are defined and a list of questions are provided to help the researcher promote the validity of their measures.	guide, measurement, transparency, construct validity	Jessica Flake on 'Measurement schmeasurement: Questionable measurement practices and how to avoid them' for the RIOT Science Club: <a href="https://youtu.be/730R0P1XU">https://youtu.be/730R0P1XU</a>
9		Van Rooij, J., & Blöchliger, M. (2020). Formalizing verbal theories: A tutorial by dialogue. <i>Social Psychology</i> , 51(5), 285. <a href="https://doi.org/10.1027/1864-9335/a000428">https://doi.org/10.1027/1864-9335/a000428</a>	<b>Formalizing verbal theories.</b> A guide to translating verbal theories into formal theories starting with basic mathematical definitions and notation before a toy example of building formal theories presented through multiple dialogues between fictional Dr Verbal and Dr Formal.	guide, theory building, formal modeling	Smaldino, P. E. (2020). How to translate a verbal theory into a formal model. <i>Social Psychology</i> , 51(4), 207. <a href="https://doi.org/10.1027/1864-9335/a000428">https://doi.org/10.1027/1864-9335/a000428</a>
10	Are we ready to test our theories?	Oberauer, K., & Lewandowsky, S. (2019). Addressing the theory crisis in psychology. <i>Psychonomic bulletin &amp; review</i> , 26(5), 1596-1616. <a href="https://doi.org/10.3758/s13423-019-01645-2">https://doi.org/10.3758/s13423-019-01645-2</a>	<b>Discovery-oriented research versus theory-testing research.</b> A critical and comprehensive review of the reproducibility crisis and proposed solutions, such as preregistration, formal modeling and stricter statistical standards. A distinction is made between two paths: discovery-oriented research, where it is accepted that theory cannot yet lead to strong inferences and necessitating empirical standards through direct replication, versus theory-testing research, where theories are formulated as precisely as possible to close the gap between theory and hypothesis.	reproducibility crisis, preregistration, statistical inference, formal modeling, exploratory versus confirmatory, theory specification	Elko Fried contextualizes and summarizes the field of theoretical psychology in his blogpost 'On Theory'. The inspiration for this resource, and a good place to inform where to go next to continue learning about psychological theory. <a href="https://elko.fried.com/theory/">https://elko.fried.com/theory/</a>

Created by William Xiang Quan Ngiam

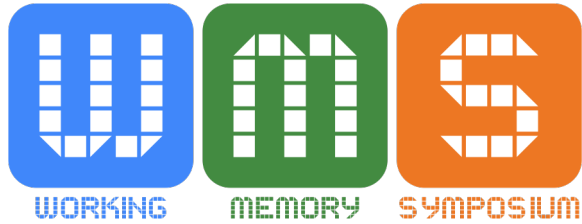
ReproducibiliTea

6:45 PM · Oct 1, 2022

View Tweet analytics

420 Retweets 29 Quotes 1,908 Likes 1,317 Bookmarks





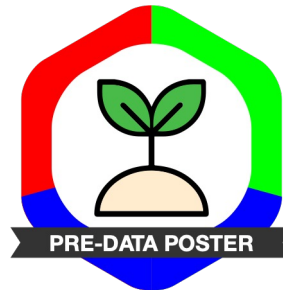
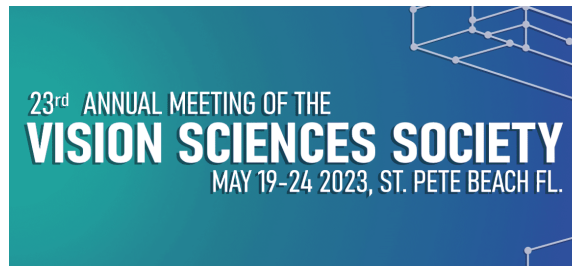
- Organized a free virtual conference for early-career researchers to present their work when in-person conferences shut down due to the pandemic



**OPEN SCIENCE: A VISION FOR A FAIR AND EQUITABLE SCIENCE**

**William X. Q. Ngiam, PH.D.**

Postdoctoral Researcher, University of Chicago



Pre-Data-Collection Poster Session

2022 Open Science Workshop on Preregistration



**Doing Our Part to Change the Culture of Science: Becoming a Champion for Rigor**

**Organizer/Moderator:** Devon Crawford  
**Speaker:** Lique Coolen, Sandra Hewett, Brielle Ferguson, Nafisa Jadavji, Michael Dougherty, Shai Silberberg, William Ngiam  
**Date & Time:** Saturday, November 11, noon-2 p.m.  
**Location:** WCC 207B  
**Track:** Research Skills

FEATURED

## Fully Credited: Making Publishing More Equitable

A new model of “contributorship” addresses the marginalization of early-career researchers in scientific publications.

William X.Q. Ngiam

December 29, 2021

TAGS: APS JOURNALS | CAREER | CAREER PATH | FEATURE | INCLUSIVITY | PUBLISHING | WRITING

## nature human behaviour

Explore content ▾ About the journal ▾ Publish with us ▾

[nature](#) > [nature human behaviour](#) > [comment](#) > article

Comment | [Published: 21 February 2022](#)

## A community-sourced glossary of open scholarship terms

Framework for  
Open and  
Reproducible  
Research  
Training



FORRT

<https://doi.org/10.1093/braincomms/fcae120>

BRAIN COMMUNICATIONS 2024: fcae120 | 1

## BRAIN COMMUNICATIONS

### FIELD POTENTIAL

## Catalyzing communities of research rigour champions

Audrey C. Brumback,<sup>1,2,3</sup> William X. Q. Ngiam,<sup>4,5</sup> Dana M. Lapato,<sup>6</sup> David B. Allison,<sup>7</sup> Christin L. Daniels,<sup>8</sup> Michael Dougherty,<sup>9</sup> Haley F. Hazlett,<sup>10</sup> Kara L. Kerr,<sup>11</sup> Susan Pusek,<sup>12</sup> Melissa L. Rethlefsen<sup>13</sup> and Naomi Schrag<sup>14</sup>; on behalf of the NINDS workshop Catalyzing Communities of Research Rigor Champions

The credibility revolution in science can only succeed if ***we take action together.***

