

Are scientists *attending* to the right things?

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Postdoctoral Researcher in the Awh Vogel Lab

for the University of Texas Austin – thanks to Jarrod Lewis-Peacock!



THE UNIVERSITY OF
CHICAGO

I'm a visual attention researcher!



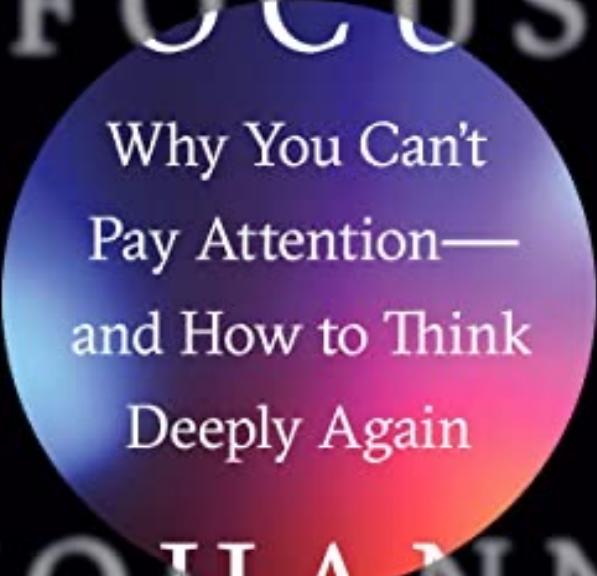
A demo – look for the change!

Our attention is very limited

Our attention is precious

We want the right things to take up our attention!

STOLEN FOCUS

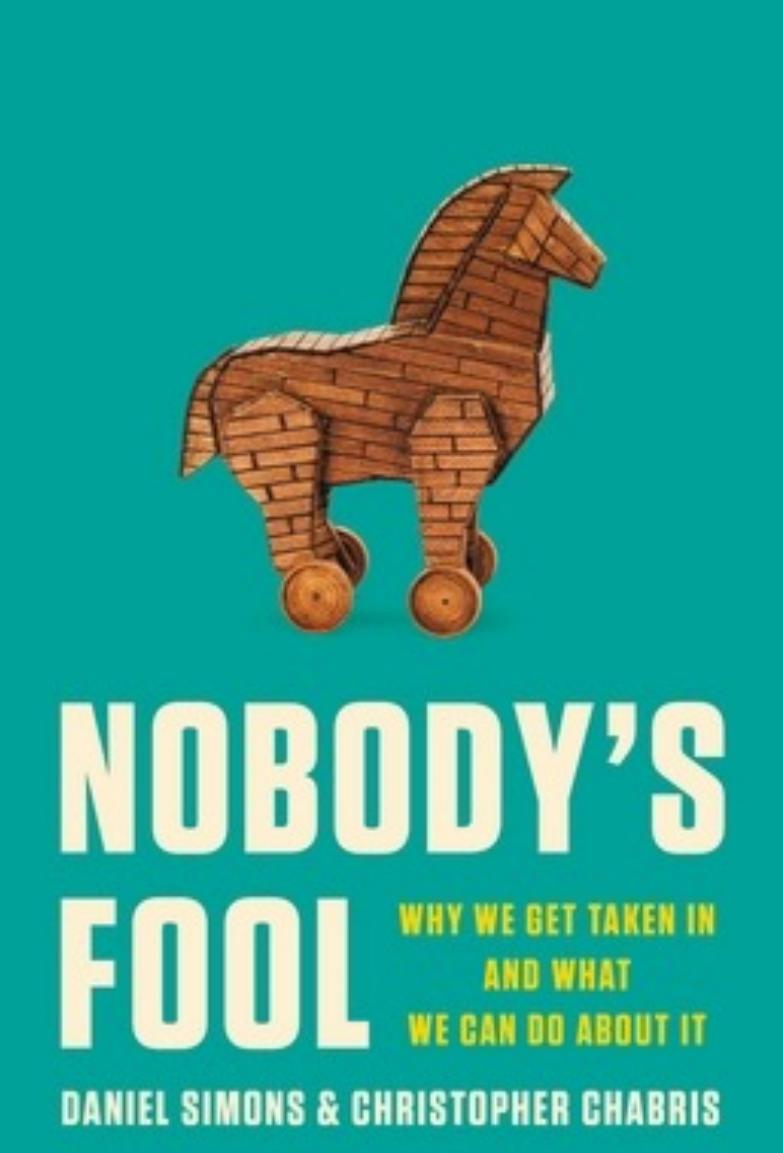


Why You Can't
Pay Attention—
and How to Think
Deeply Again

JOHANN HARI

NEW YORK TIMES BESTSELLING AUTHOR OF
CHASING THE SCREAM AND *LOST CONNECTIONS*

It feels like we are losing our
ability to *focus*



The authors of the “invisible gorilla” study!

We can be deceived by being made to attend to the wrong things.

Do these slide transitions feel a bit too familiar?

#1 New York Times Bestseller

The Power of Knowing What You Don't Know

THINK AGAIN

A D A M G R A N T

"Brilliant...guaranteed to make you
rethink your opinions and your most important decisions."
—Nobel Prize winner Daniel Kahneman

"We need to think (again) like
scientists"

1. What has got scientists' attention?
2. Are attention researchers getting it right?
3. How do we rethink attention?

What has got scientists' attention?

Exponential growth of scientific publications

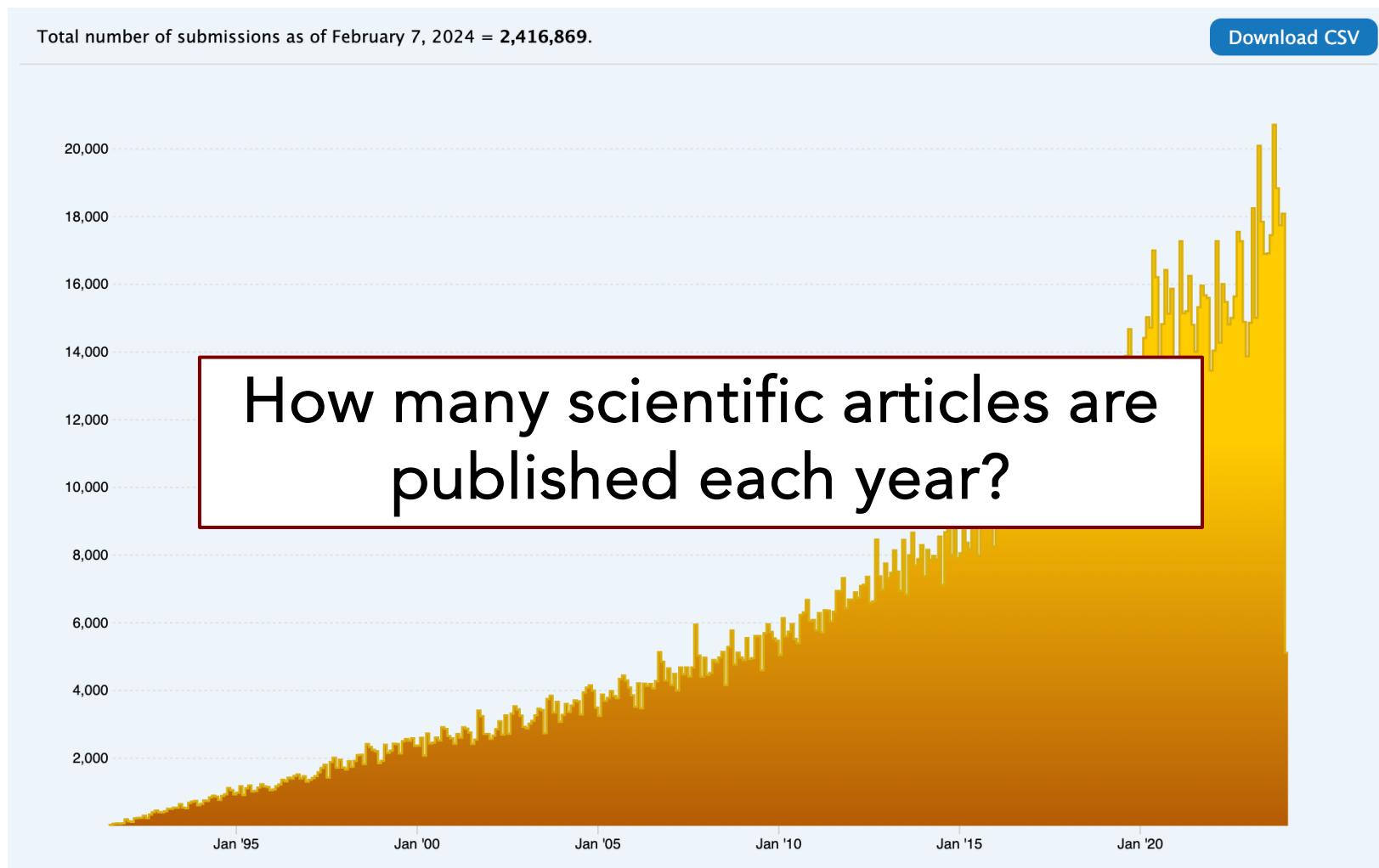


Figure taken from arxiv.org on the number of submissions over time. https://arxiv.org/stats/monthly_submissions

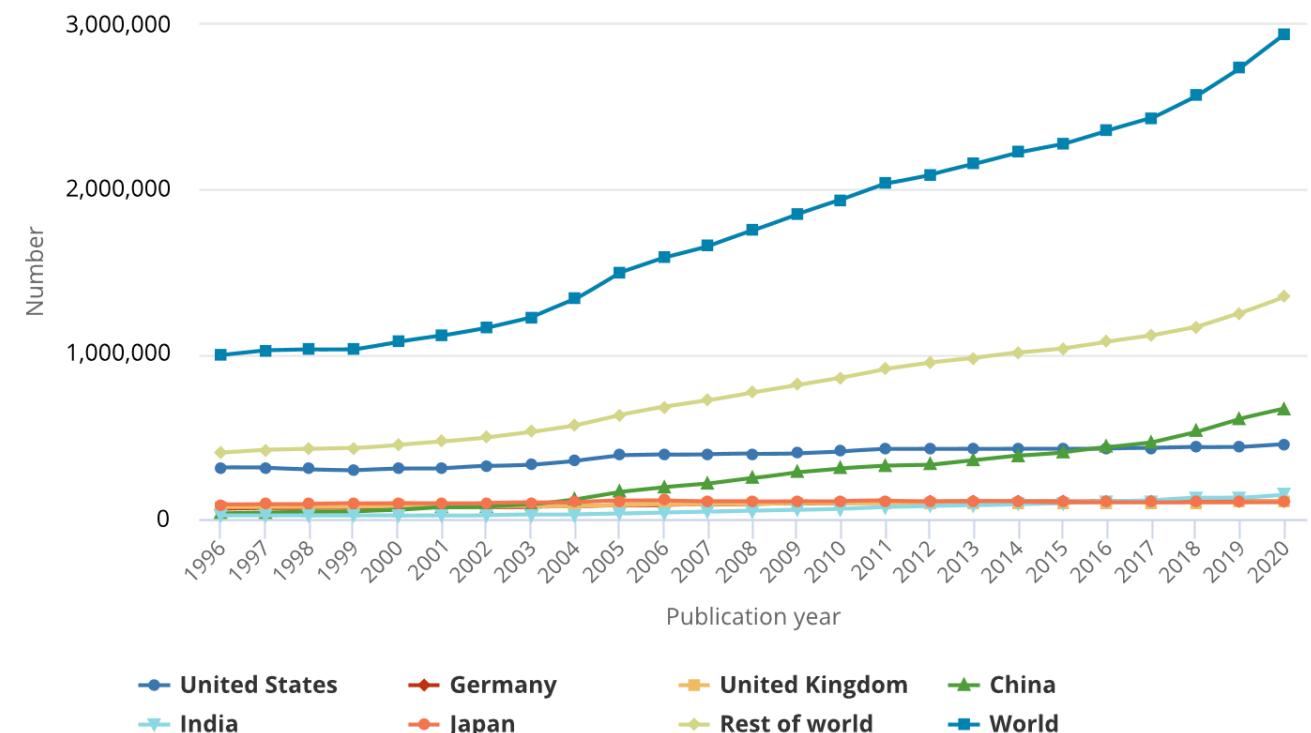
Exponential growth of scientific publications

- 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>

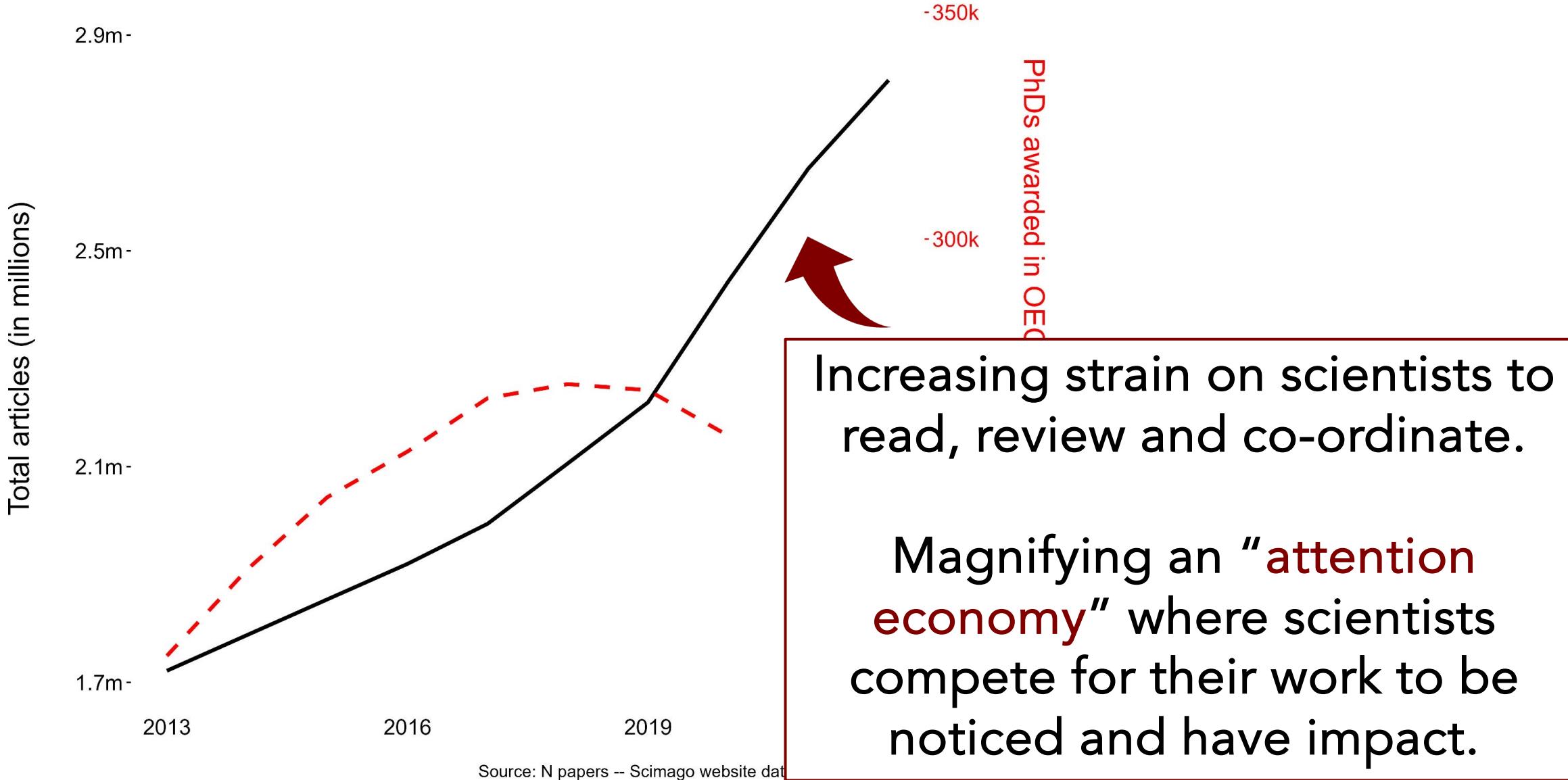


Figure copied from <https://bsky.app/profile/hansonmark.bsky.social/post/3kajeqv3nt2b>

Hanson, Barreiro, Crosetto and Brockington (2023). The strain on scientific publishing. ArXiv. <https://arxiv.org/abs/2309.15884>

The decline of negative results

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

Does 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)

Figure from Fanelli, D. (2012). Negative results are disappearing from most disciplines and countries. *Scientometrics*, 90(3), 891-904.

Scheel, A. M., Schijen, M. R., & Lakens, D. (2021). An excess of positive results: Comparing the standard Psychology literature with Registered Reports. *Advances in Methods and Practices in Psychological Science*, 4(2), 25152459211007467.

A *theory crisis* in psychological science

- An understated precursor to the *reproducibility crisis* may be the [lack of coordinated theoretical development](#)
 - An over-reliance on the hypothetico-deductive method (e.g. null hypothesis significance testing) for inferences
 - Questionable research practices (QRPs): p-hacking, HARKing, data manipulation, etc.

Borsboom D. (2013, November 20). Theoretical amnesia. *Center for Open Science*

Borsboom, D., van der Maas, H. L., Dalege, J., Kievit, R. A., & Haig, B. D. (2021). Theory construction methodology: A practical framework for building theories in psychology. *Perspectives on Psychological Science*, 16(4), 756-766.

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Meehl P. E. (1978). Theoretical risks and tabular asterisks: Sir Karl, Sir Ronald, and the slow progress of soft psychology. *Journal of Consulting and Clinical Psychology*, 46, 806–834.

Playing *20 questions* with nature

- It is often assumed that...



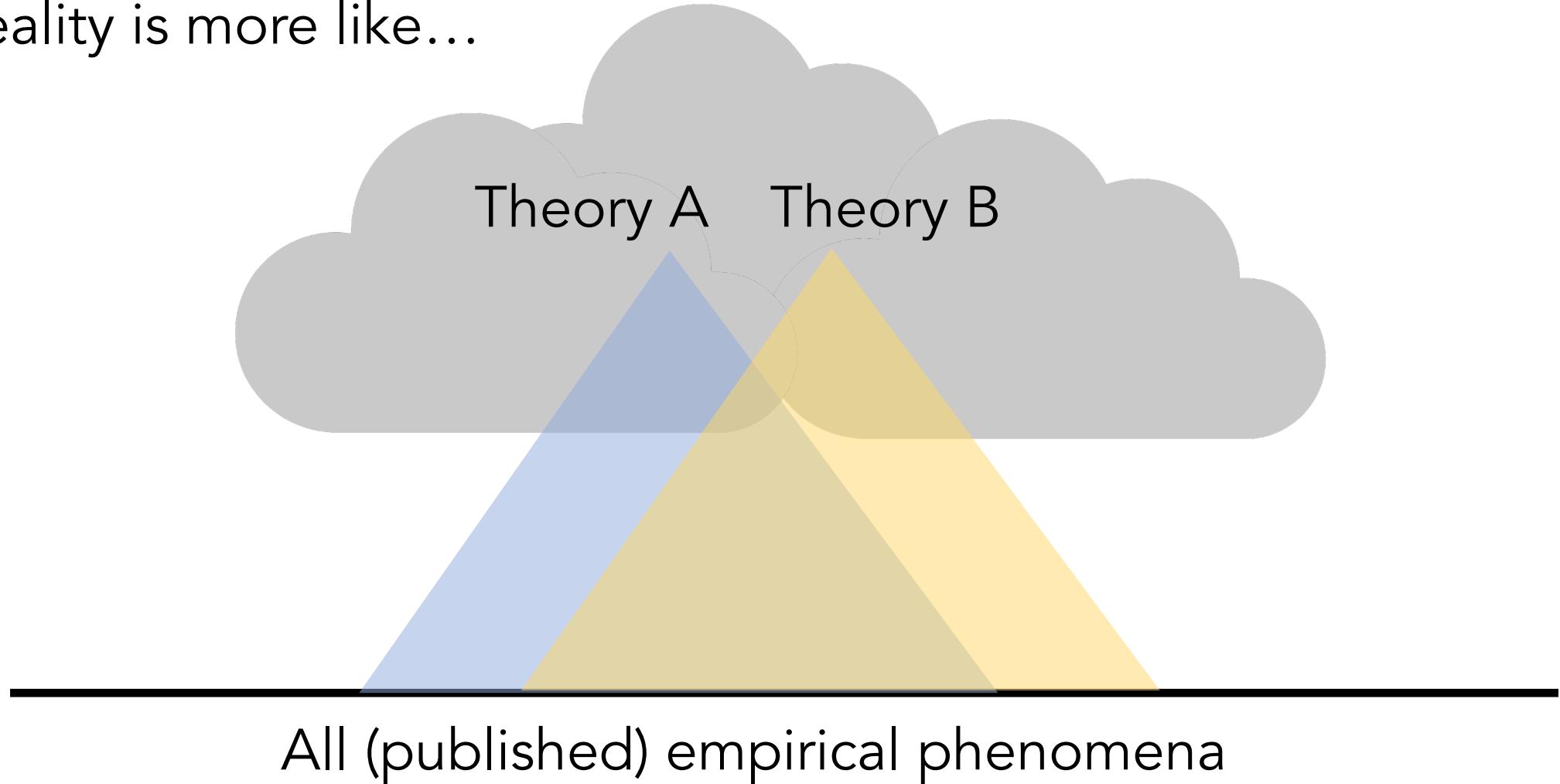
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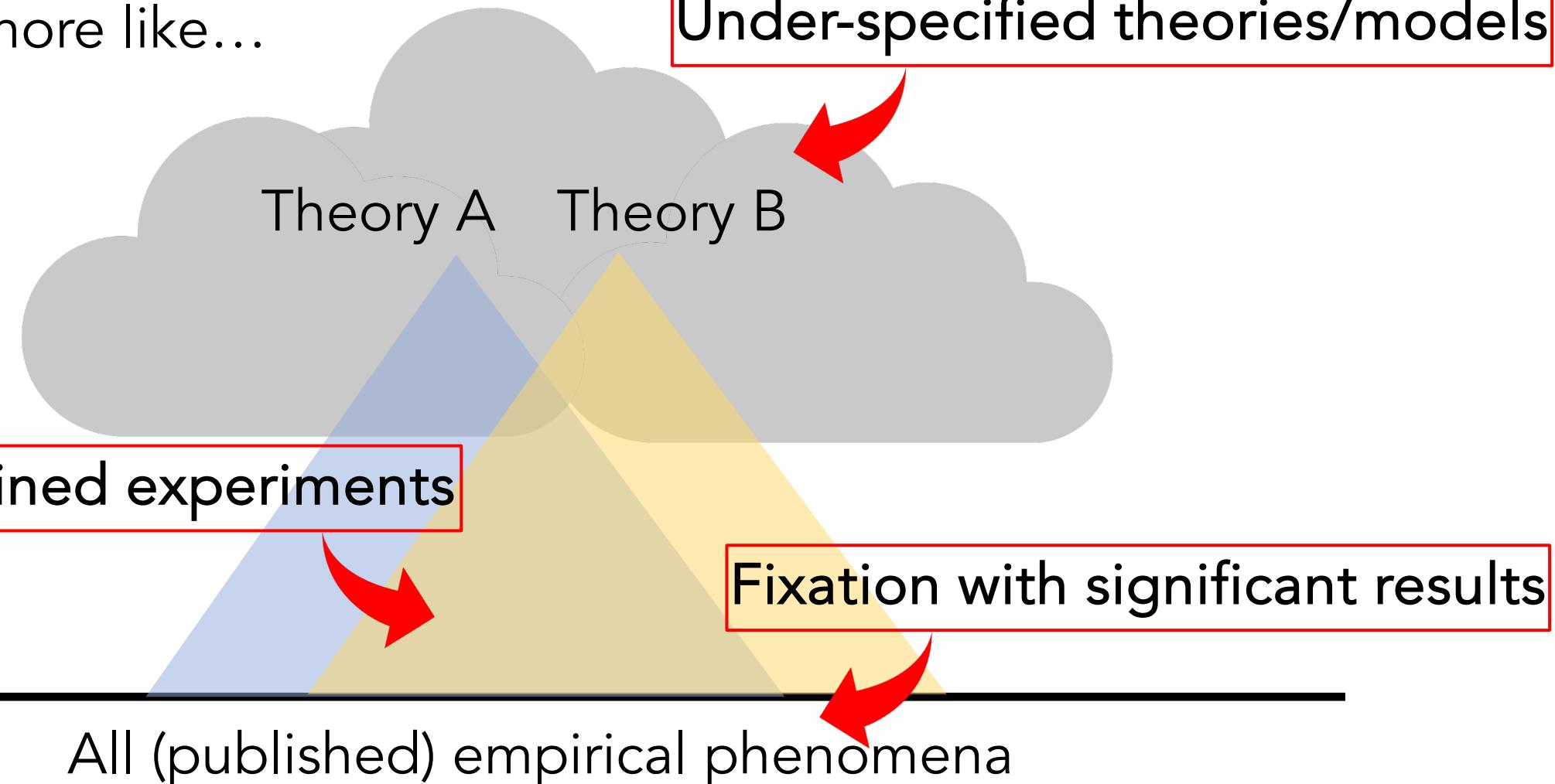
Playing *20 questions* with nature

- The reality is more like...



Playing 20 *questions* with nature

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 - An over-reliance on the hypothetico-deductive method (e.g. null hypothesis significance testing) for inferences
 - Questionable research practices (QRPs): p-hacking, HARKing, data manipulation, etc.
 - Under-specified theories with under-determined experimental designs
 - Ad hoc changes in models, straw-man of competing models, blunt instruments of measurement
 - Overgeneralization of a theory or model to all related phenomena or empirical conditions
 - A lack of intellectual humility...

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Are attention researchers getting it right?

What is visual working memory?

- “The system responsible for maintaining visual information in a state of heightened accessibility for ongoing perception and cognition.”

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• Let's say working memory is basically attention for now.

- What details a state of heightened accessibility?

What is visual working memory?

- Many subtly different definitions:

The many faces of working memory and short-term storage

Nelson Cowan 

Psychonomic Bulletin & Review 24, 1158–1170 (2017) | [Cite this article](#)

28k Accesses | 231 Citations | 39 Altmetric | [Metrics](#)

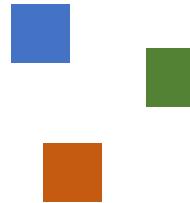
It has become clearer to me that a major source of confusion is that researchers use different definitions of the malleable and useful concept of WM. We do not seem to be converging on a common definition of the term. Others also have

What is visual working memory?

Object-based theory

"slot models"

(Luck and Vogel, 1997;
Zhang and Luck, 2008)



Feature-based theory

"resource models"

(Alvarez and Cavanagh, 2004;
Wilken and Ma, 2004)



Luck, S. J., & Vogel, E. K. (1997). <https://doi.org/10.1038/36846>

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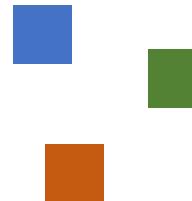
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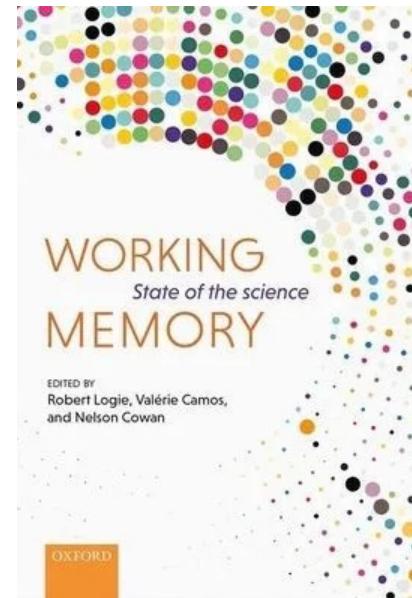
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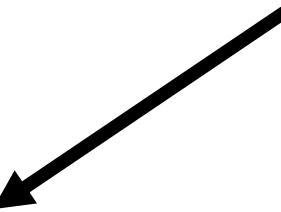
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Integrating Theories of Working Memory

Robert H. Logie, Clément Belletier, and Jason M. Doherty



First published
in late 2020



- “We argue that many of these differences reflect different research questions, different levels of explanation, differences in how participants perform their assigned tasks in different laboratories, **rather than fundamental theoretical adversity**”

How do we make progress if:

- There exist **subtly different definitions**
 - Due to different research questions, different methods, different measures, different contexts, etc.
- Theories (or models) attempt to explain all empirical phenomena related to ill-defined construct (**overgeneralization**)
- Models are **underspecified** such that empirical tests cannot be definitive
 - And these models may not reflect **fundamental theoretical adversity**

A case study: conjunction whole-report

Ngiam, Loetscher and Awh (2023) JEP:G



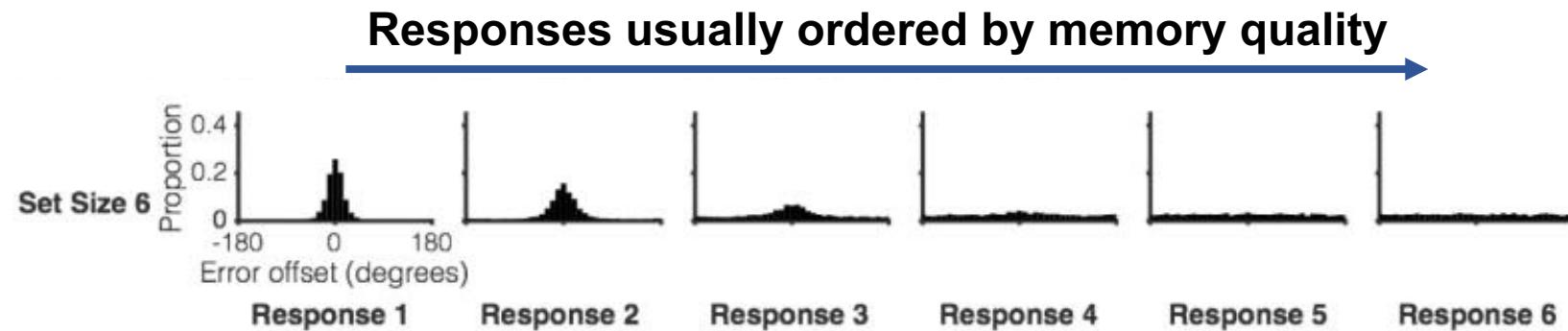
Krystian Loetscher



Edward Awh

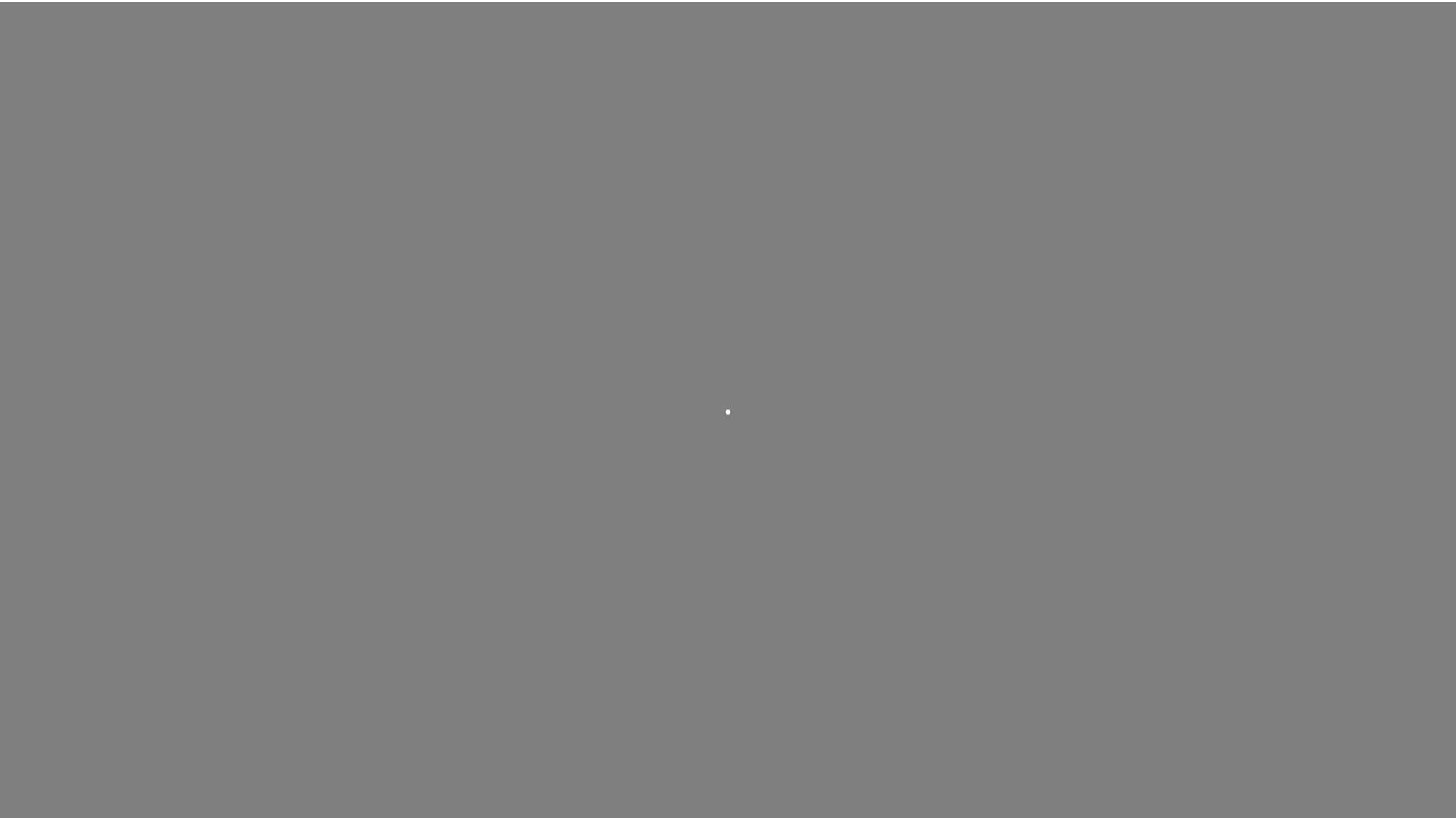
Introducing the conjunction whole-report paradigm

- Test recall for all items rather than just the one item (Adam et al., 2017)

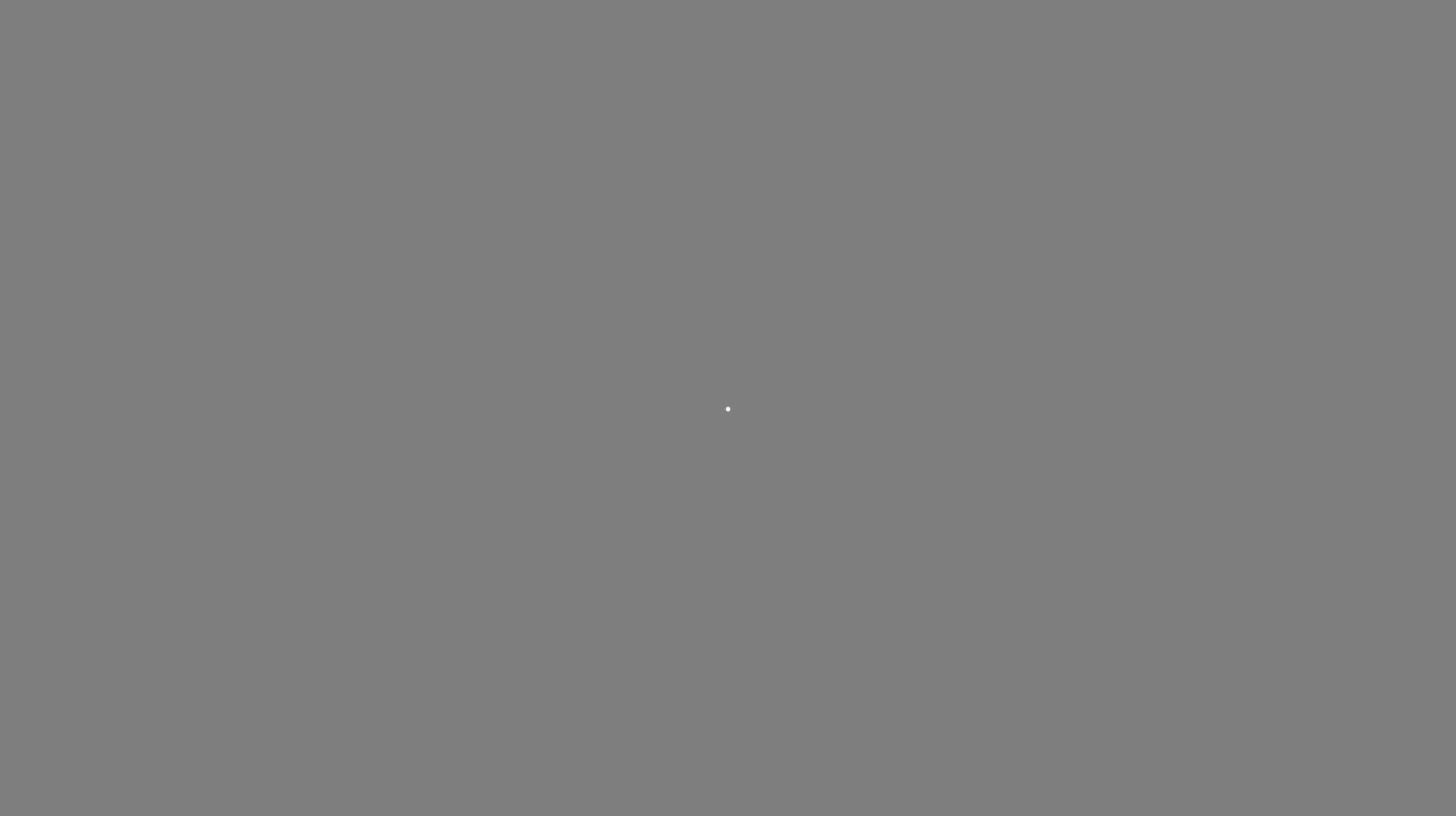


- The first whole-report experiments with conjunction stimuli
- Response interface that collects both features with one click
(Sone et al., 2021)

Orientation whole-report



Color whole-report



Conjunction whole-report



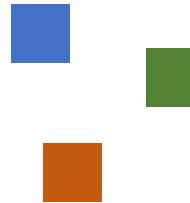
Sone, H., Kang, M. S., Li, A. Y., Tsubomi, H., & Fukuda, K. (2021). Simultaneous estimation procedure reveals the object-based, but not space-based, dependence of visual working memory representations. *Cognition*, 209, 104579.

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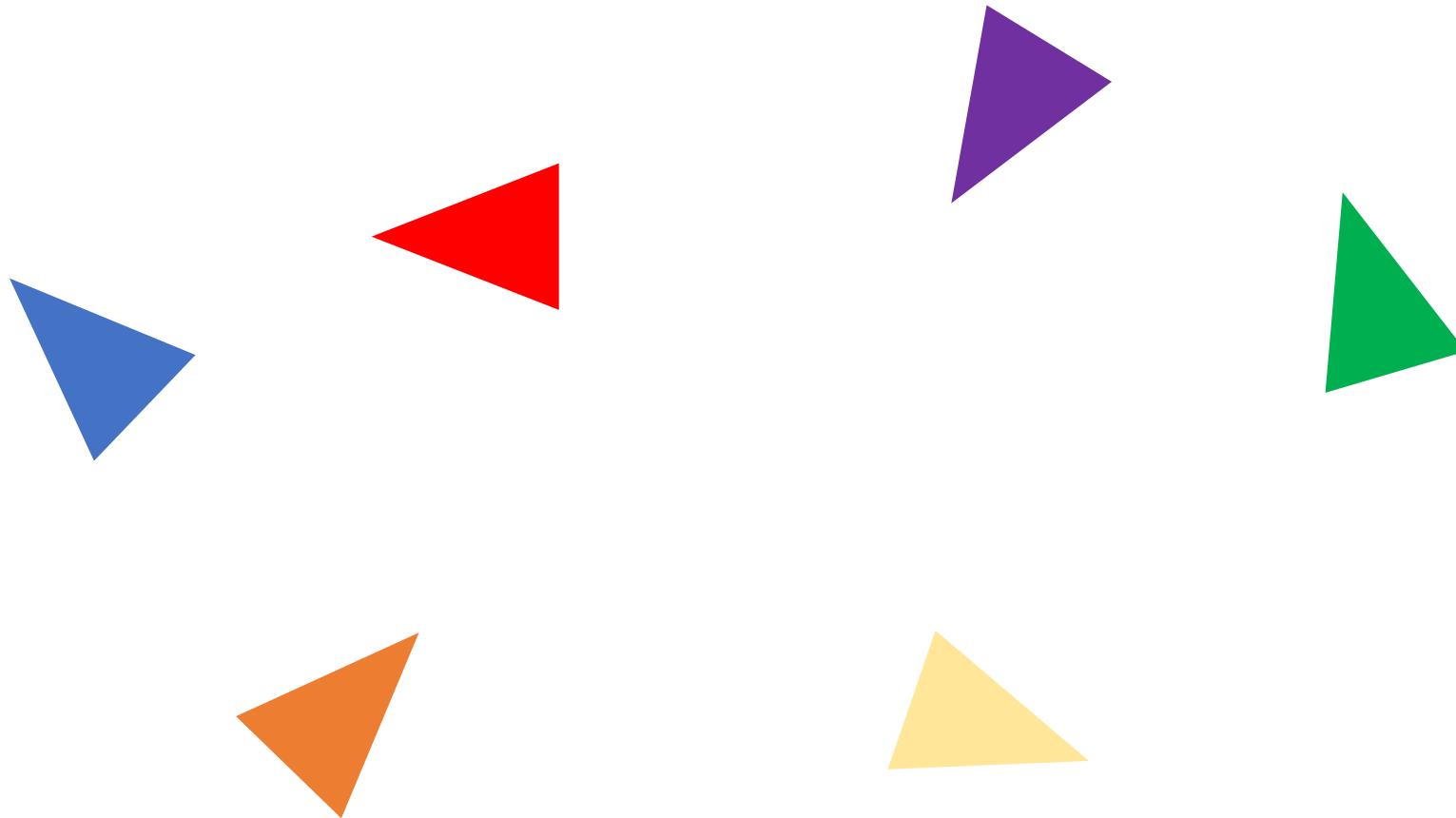
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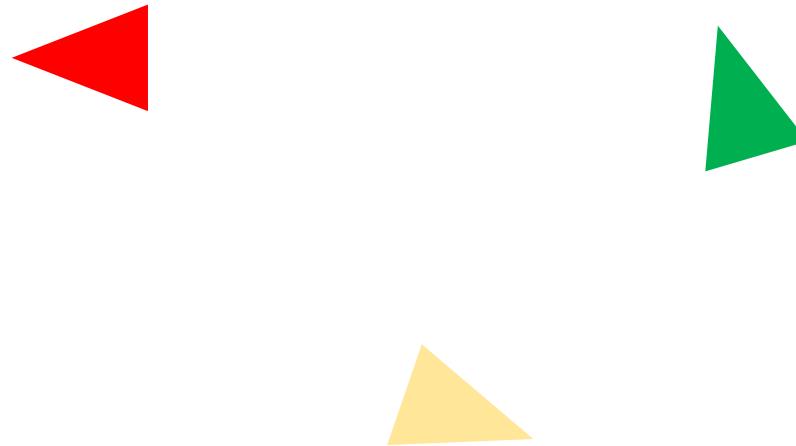
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What is the unit of working memory?

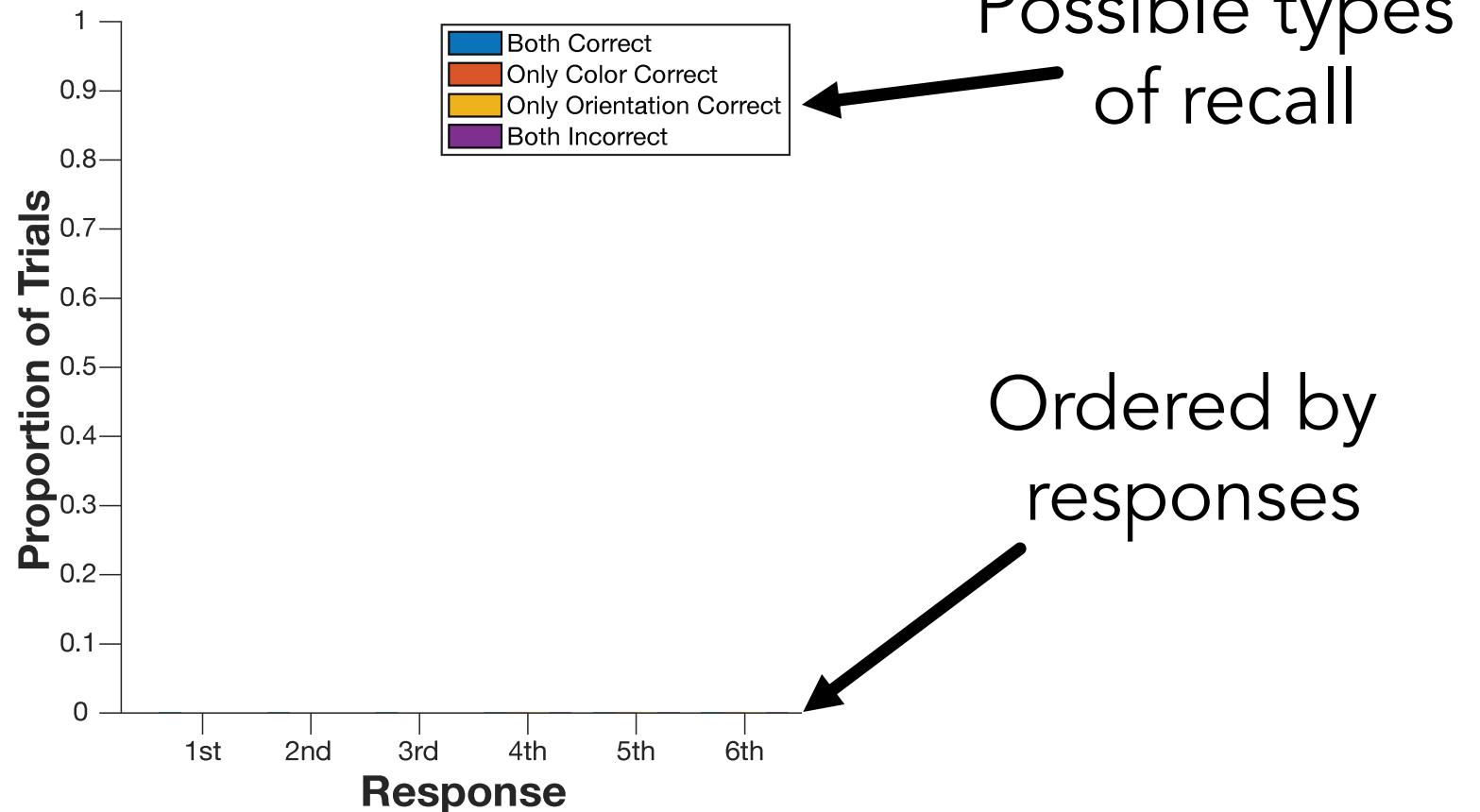


A specific object-based model – strong objects

- Fixed object capacity limit
- Lossless representations (“all-or-none”)
- No impact of complexity (additional features)

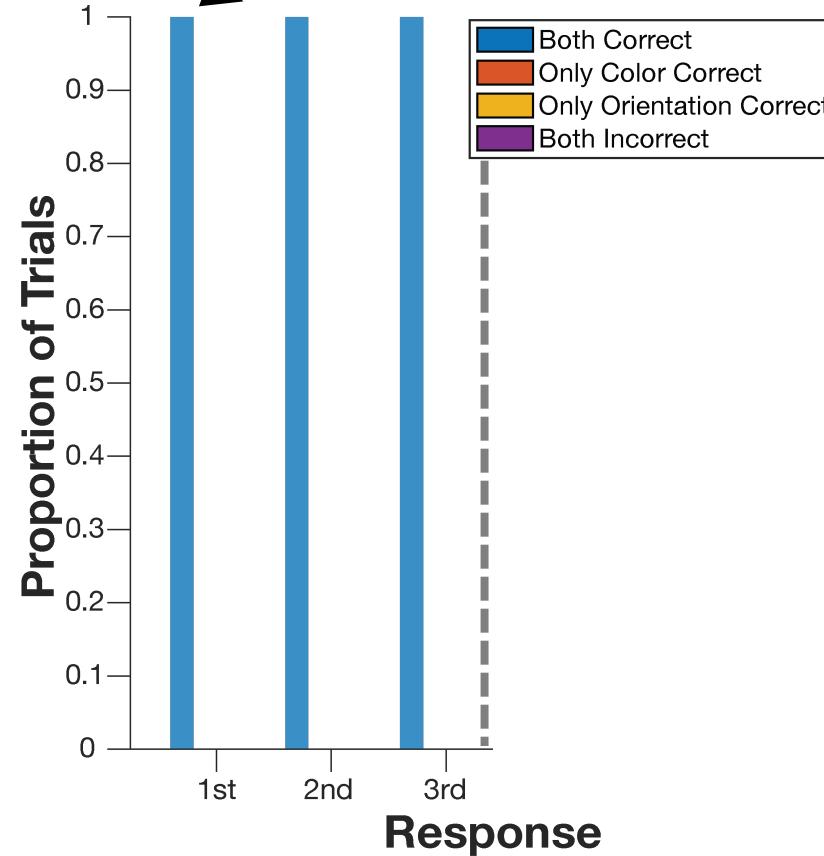


Conjunction whole-report

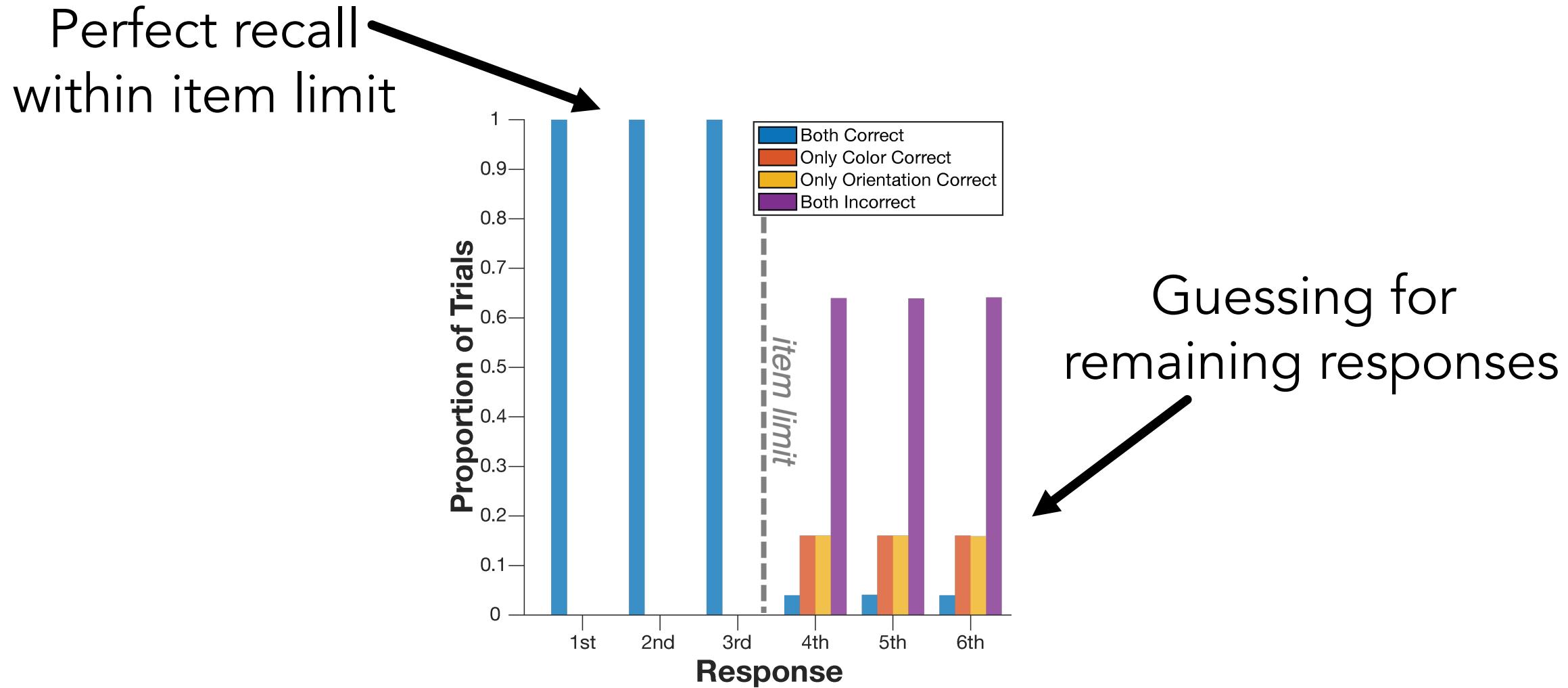


A specific slot model – strong objects

Perfect recall
within item limit

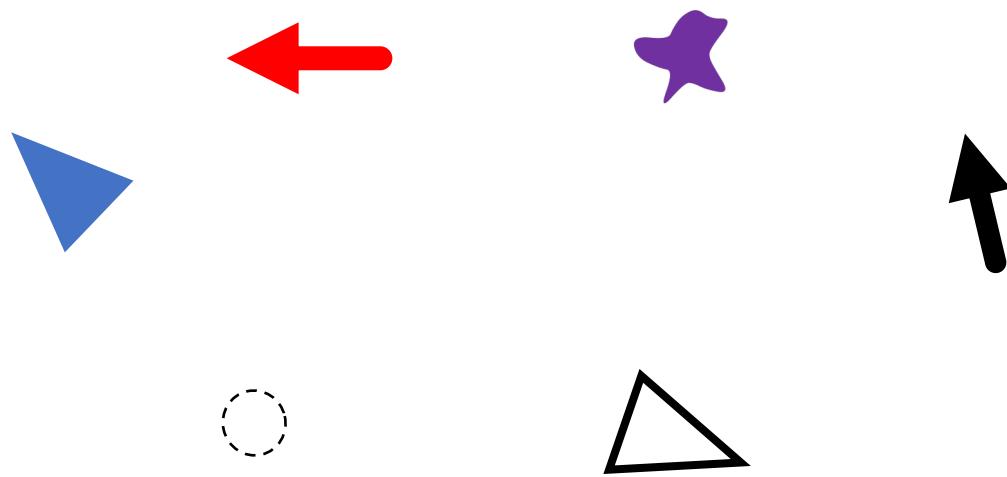


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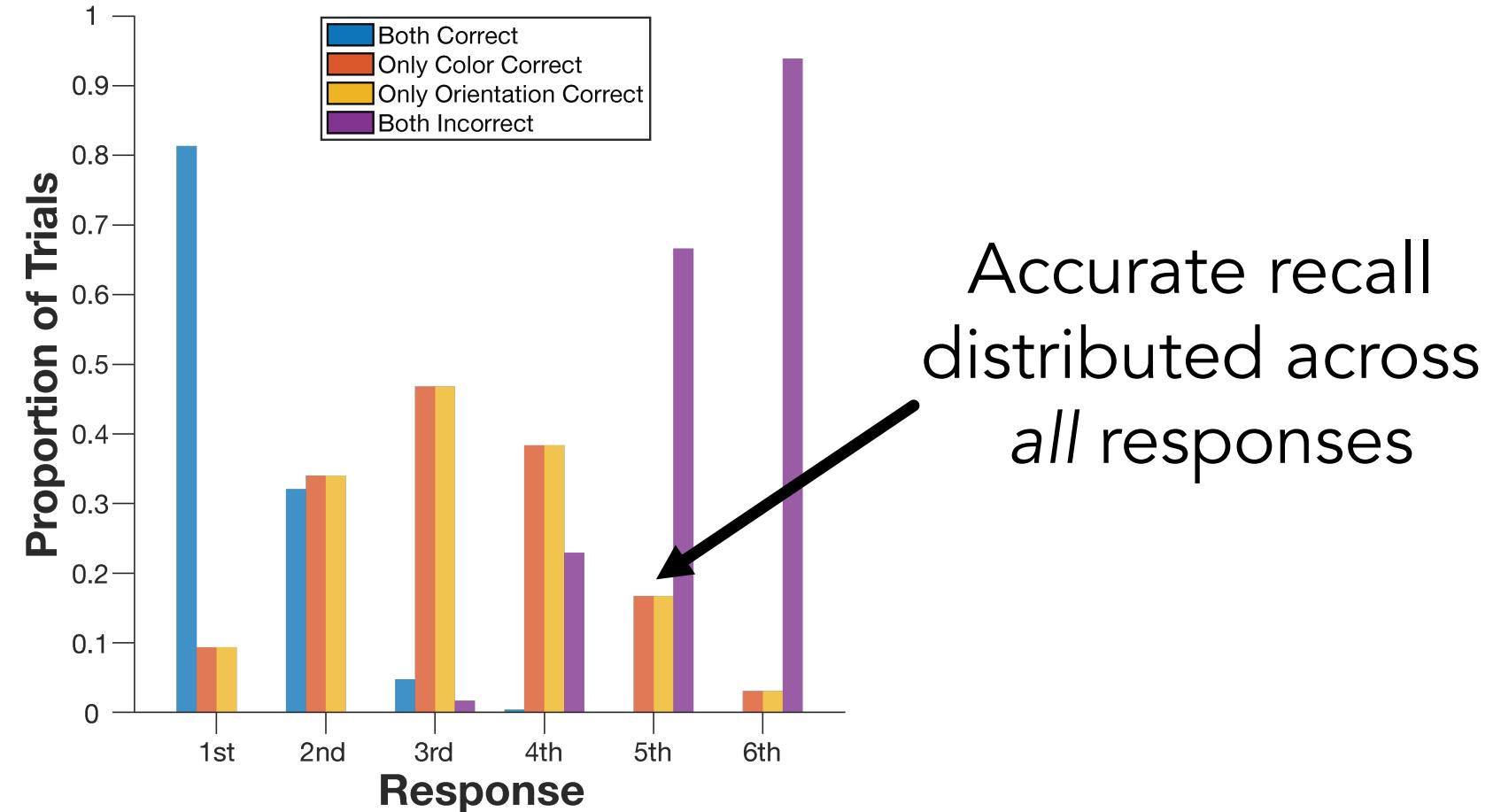
A specific resource model – independent features

- Working memory resources are distributed to all items in the array
- Feature storage is not constrained by which objects contain the features
 - Probability of successful feature storage is independent of objecthood



A specific resource model – independent features

Feature storage
independent
of objecthood



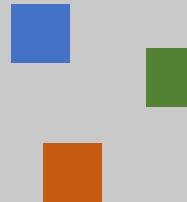
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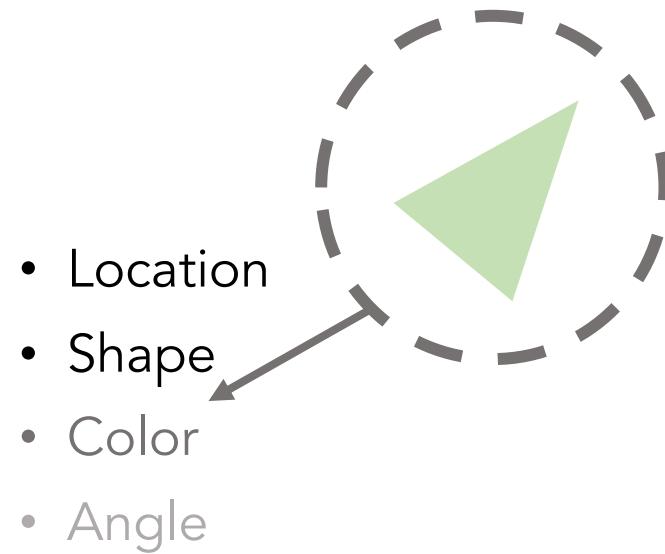
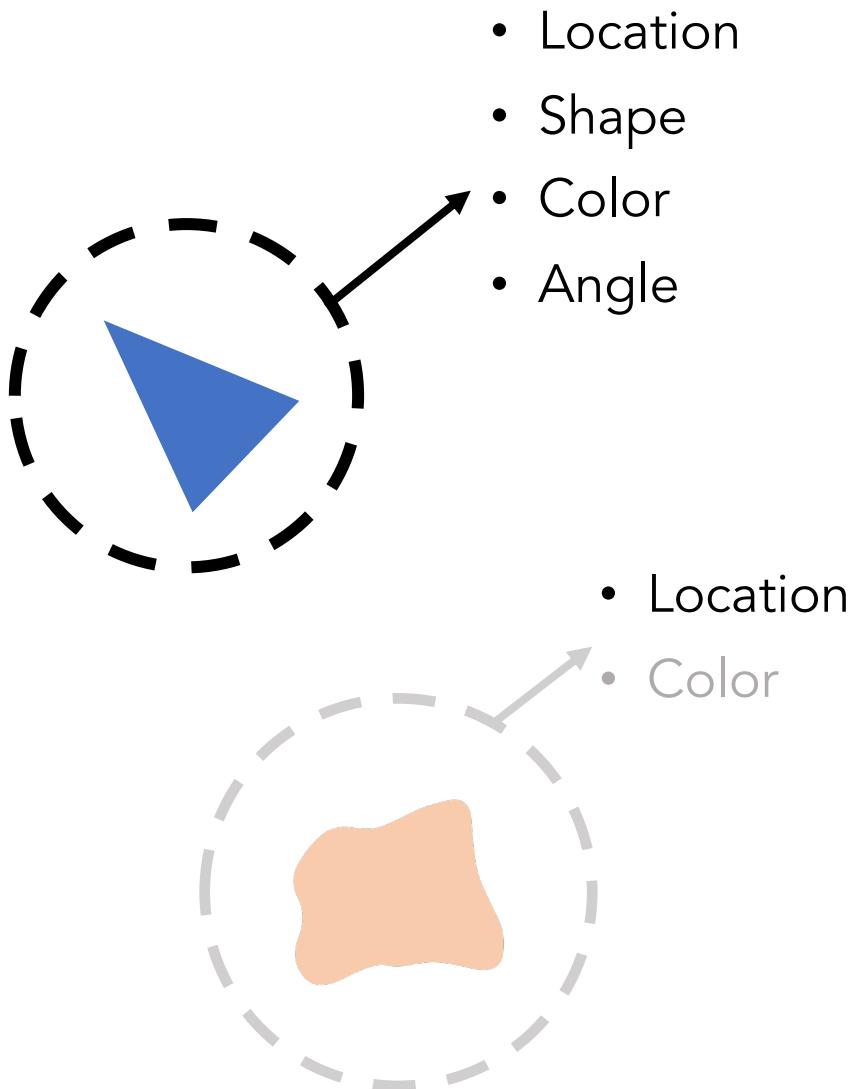
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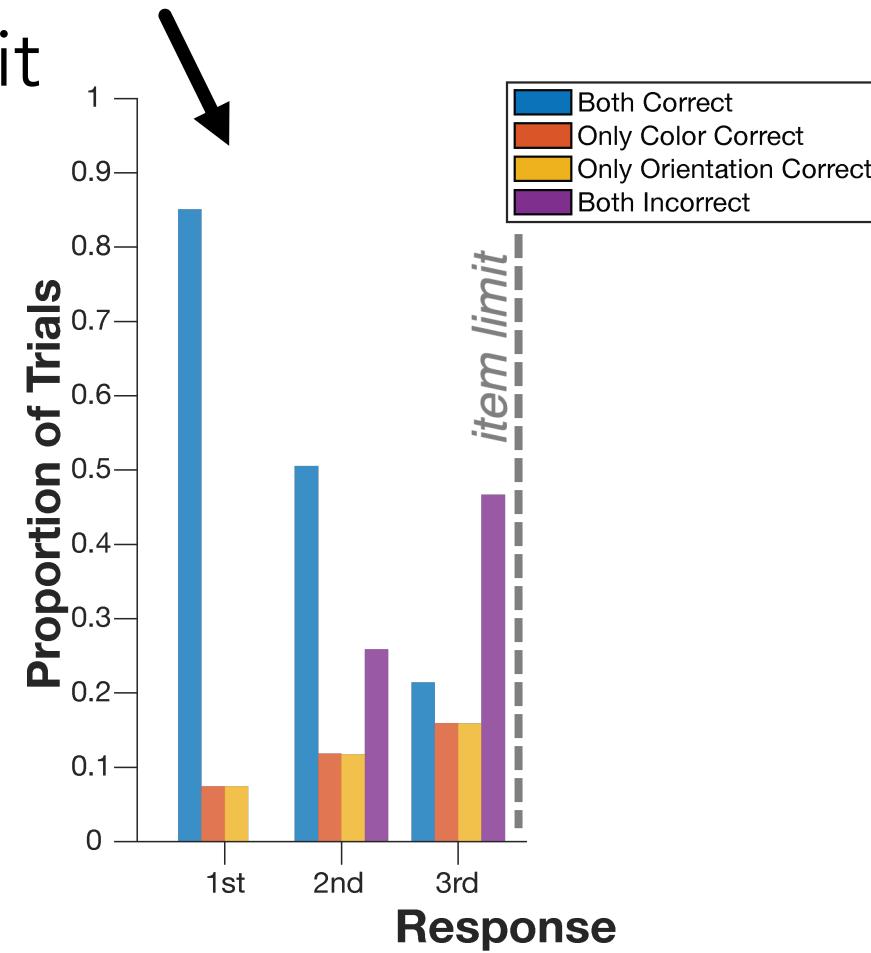
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A new model characterization – pointers



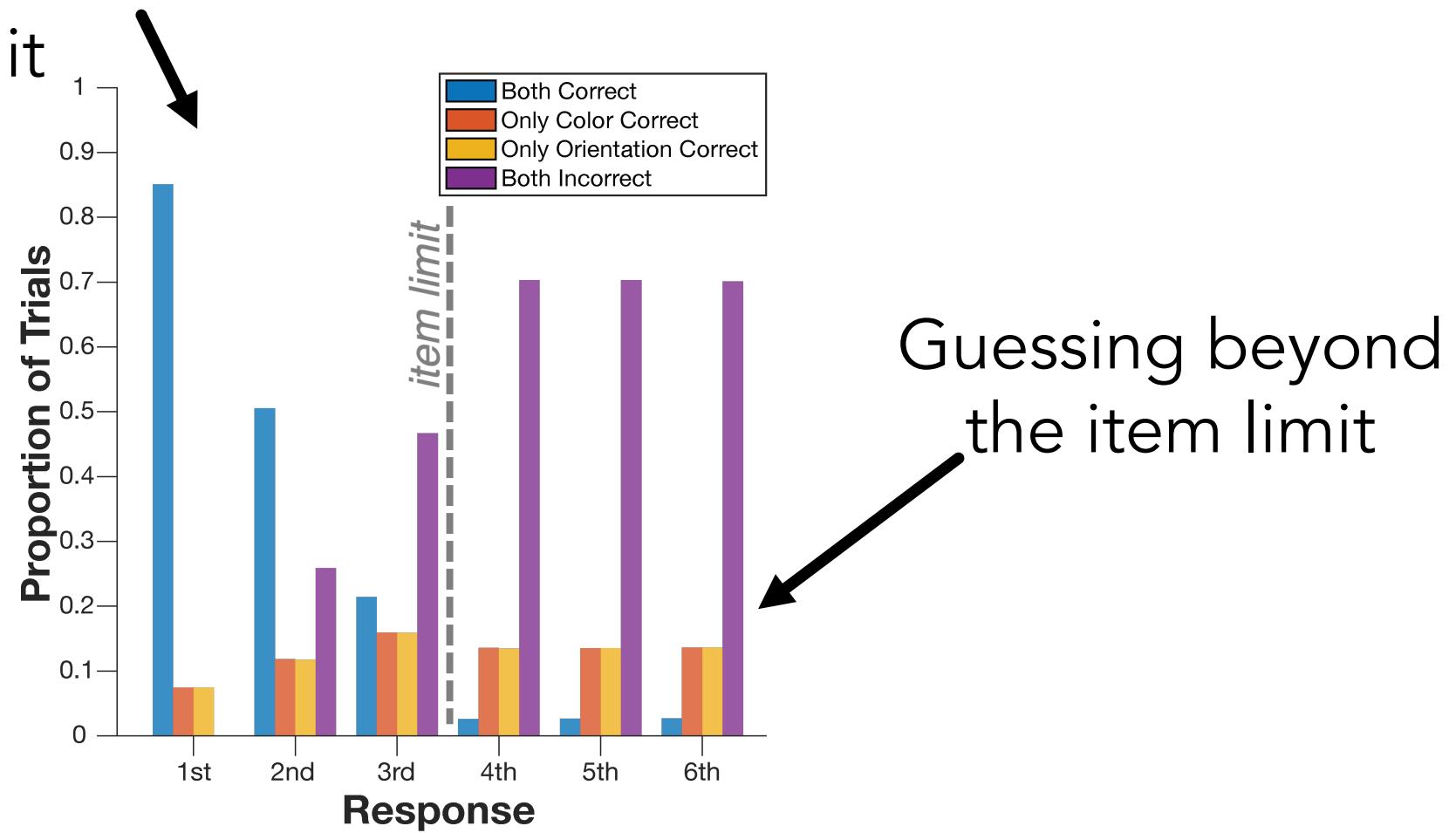
A new model characterization – pointers

Accurate recall constrained
within an item limit



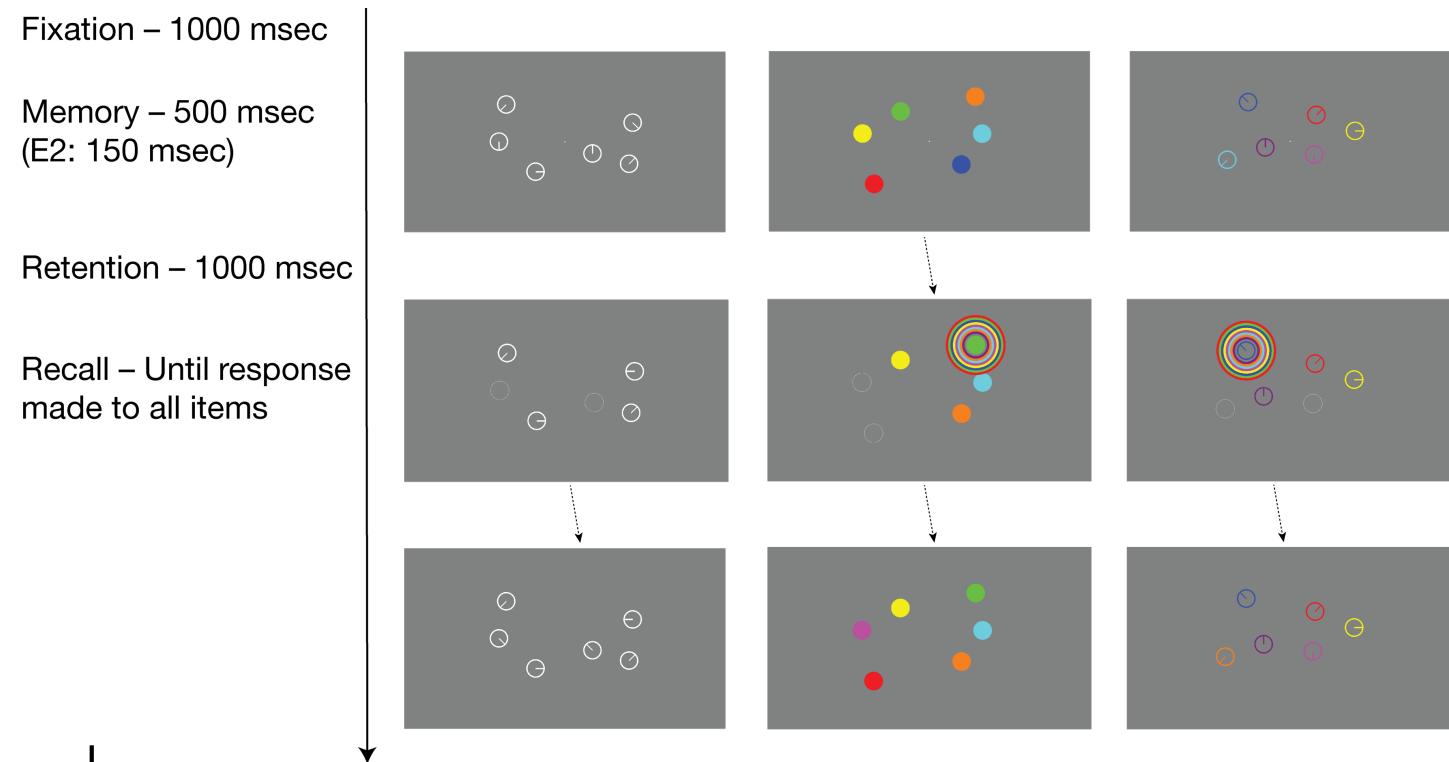
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Our conjunction whole-report experiments

- Four experiments (30 subjects each)
 - E1: Colored clock faces
 - E2: Colored clock faces but rapid
 - E3: Colored triangles
 - E4: Colored shapes
- Three conditions (300 trials each)
 - Color only
 - Orientation only or Shape only
 - Conjunction
- Eight **discrete** colors, orientations, and shapes.



Recall accuracy

Mean Recall	Experiment 1	Experiment 2	Experiment 3	Experiment 4
Colors	3.21 ± 0.74	2.94 ± 0.64		3.61 ± 0.75
Orientations/Shapes	2.79 ± 0.44	2.45 ± 0.45		3.39 ± 0.64
Conjunctions	1.62 ± 0.38	1.38 ± 0.42	1.47 ± 0.44	1.92 ± 0.43

- Memory for conjunction stimuli is **not lossless**
 - Fewer conjunctions are fully recalled overall



"It's not objects, it's features!"

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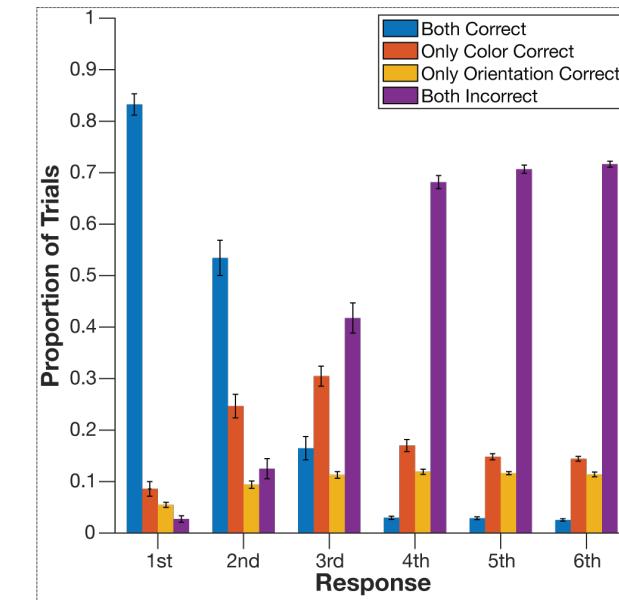
Features	4.94 ± 0.68	4.52 ± 0.83	5.11 ± 0.65	5.34 ± 0.85
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- Memory for conjunction stimuli is **not lossless**
 - Less conjunctions are fully recalled overall
- But we observe an **object-based benefit**
 - More features are recalled overall in the conjunction condition compared to the single-feature conditions (~5 features versus ~3 features)

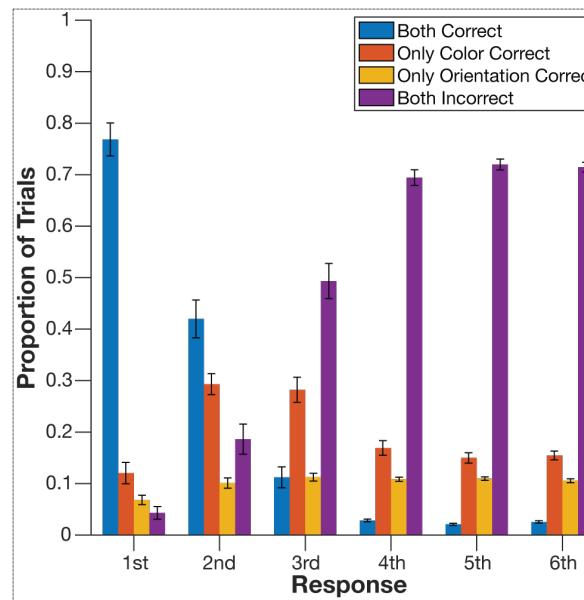
"It's objects, not features!"

Accuracy across responses

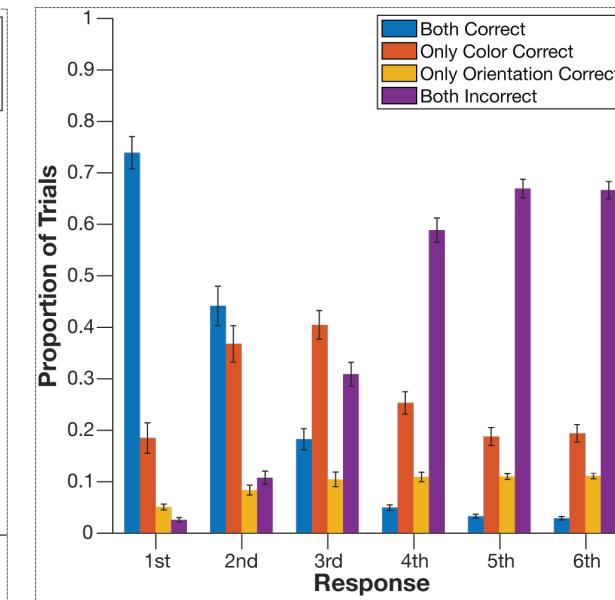
Experiment 1



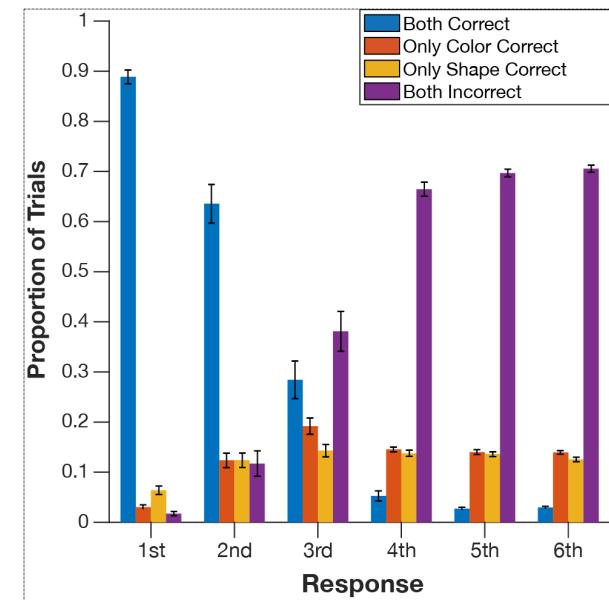
Experiment 2



Experiment 3



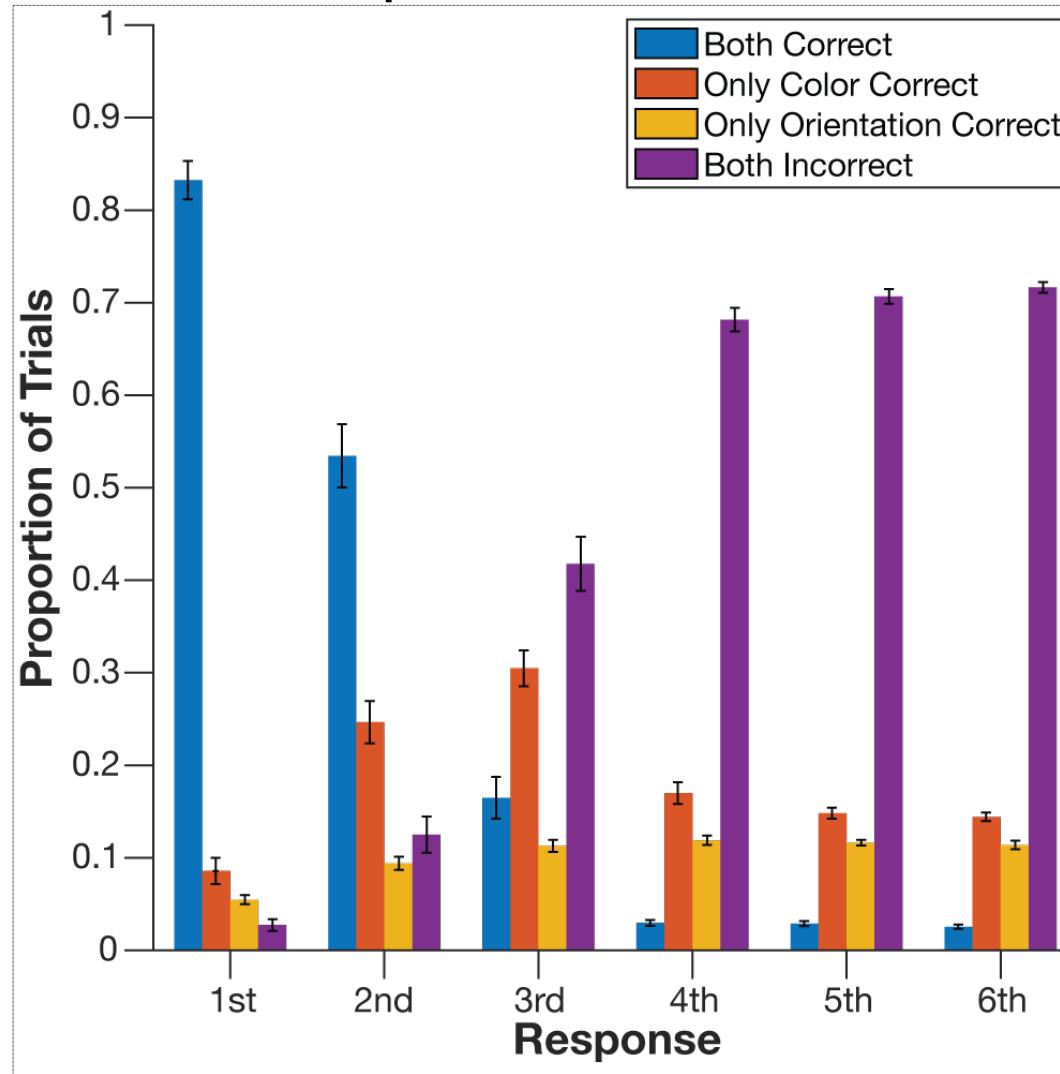
Experiment 4



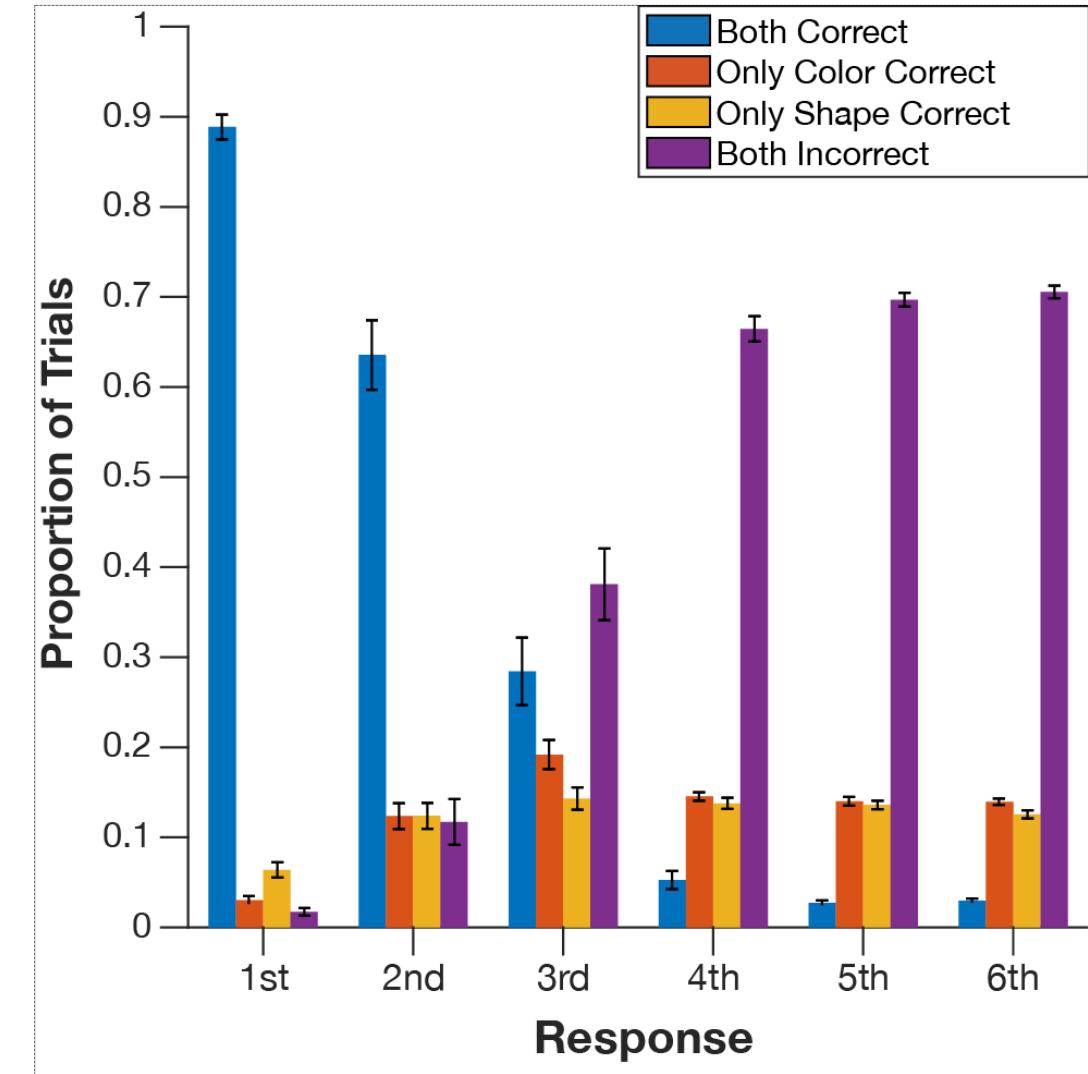
- The same empirical pattern was replicated across four experiments

Accuracy across responses

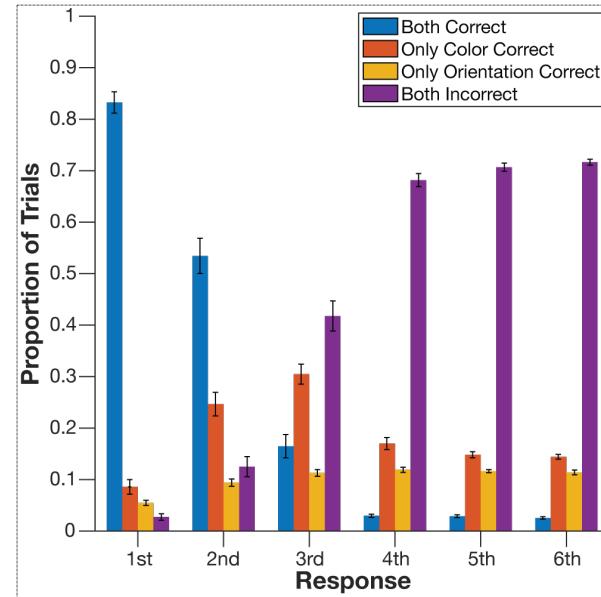
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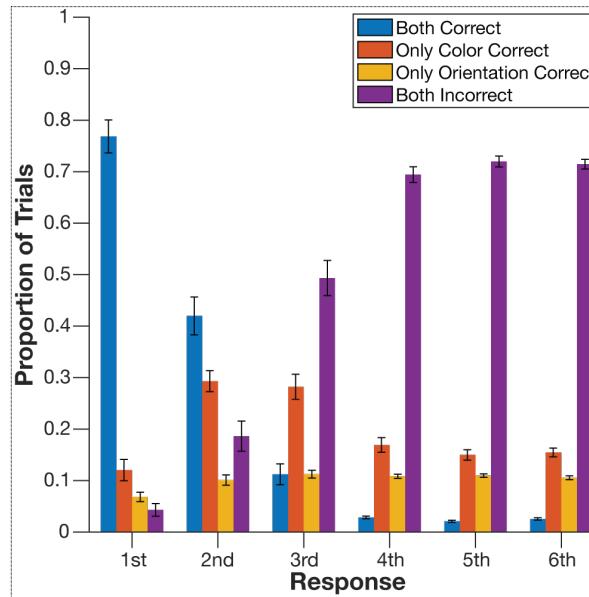
Experiment 4



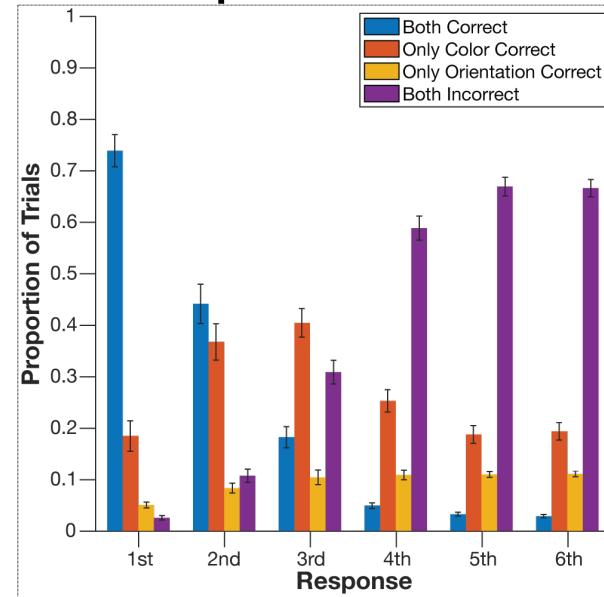
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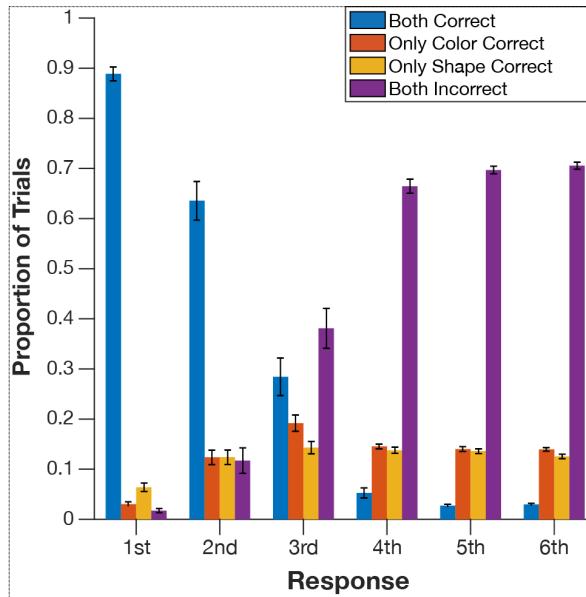
Experiment 2



Experiment 3

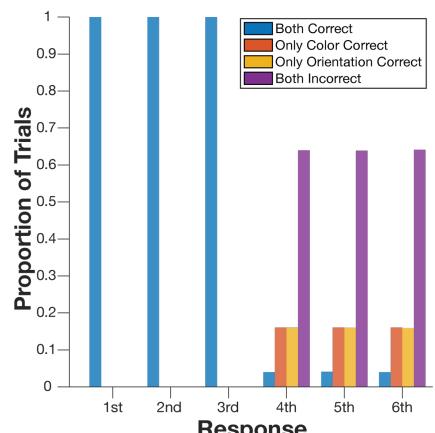


Experiment 4



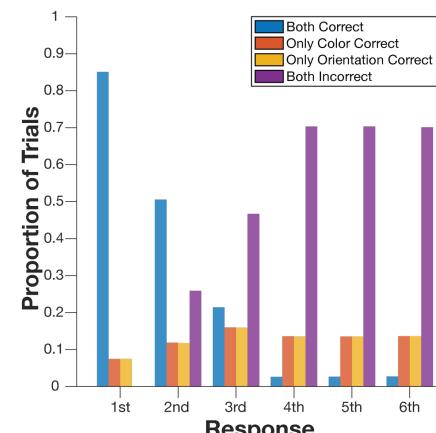
Strong Object Model

Accurate storage of
three objects



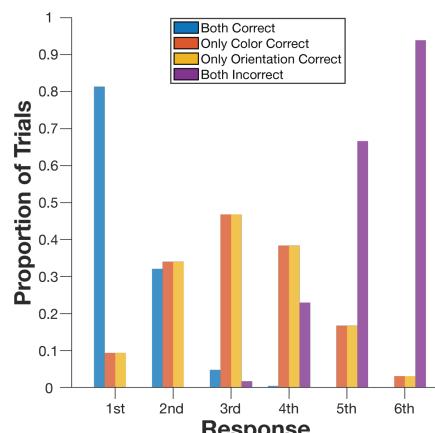
Pointer Model

Item-based storage
with feature loss

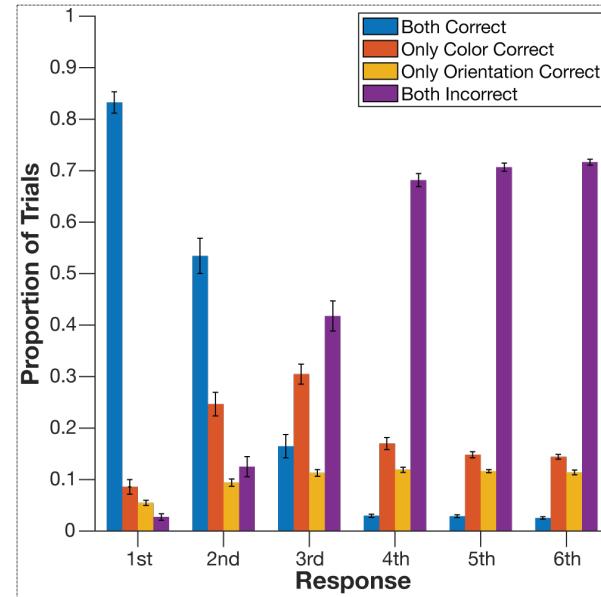


Independent Feature Model

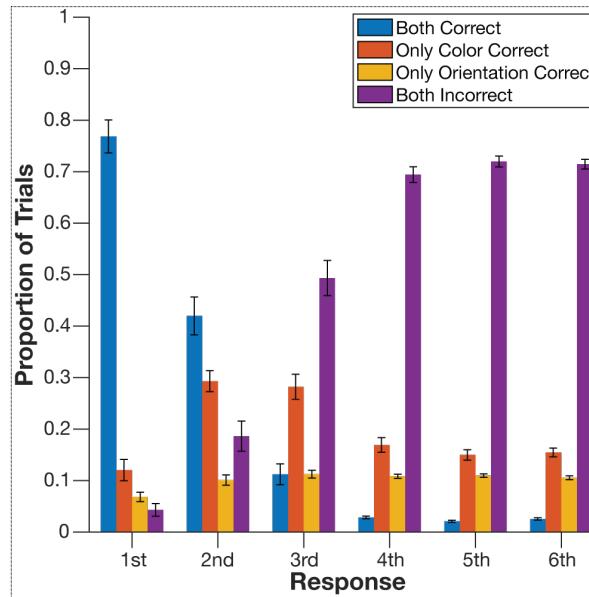
Feature storage independent
of objecthood



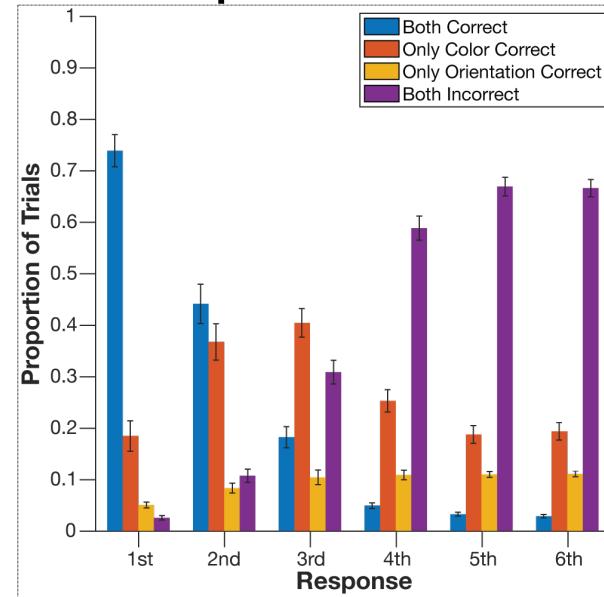
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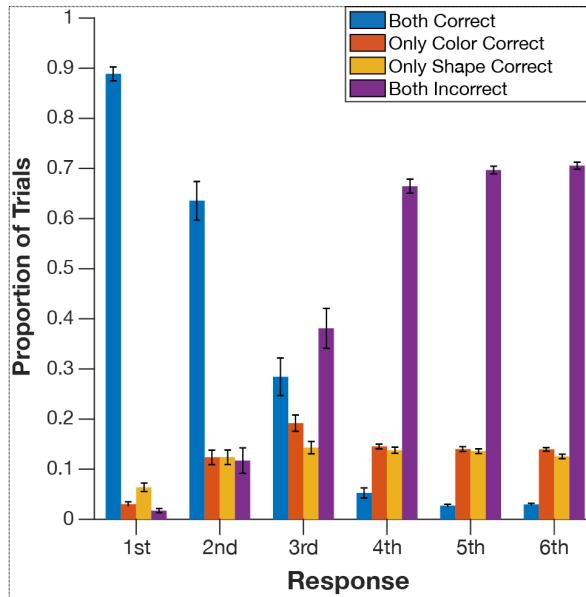
Experiment 2



Experiment 3

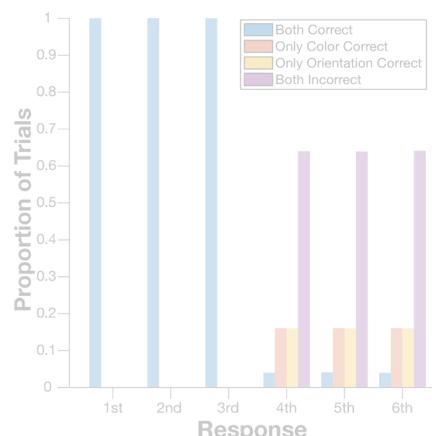


Experiment 4



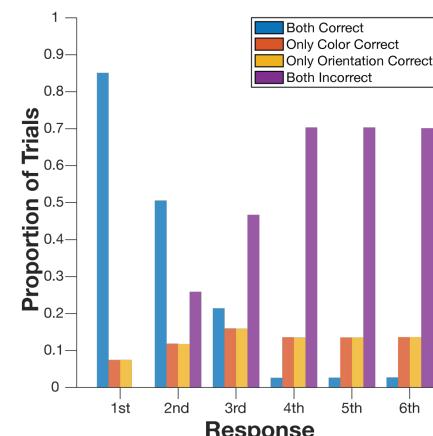
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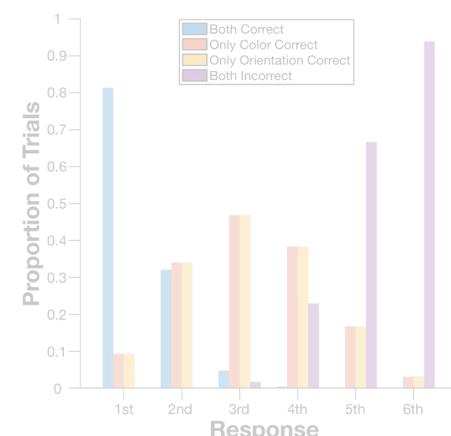
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Item-based storage
with feature loss



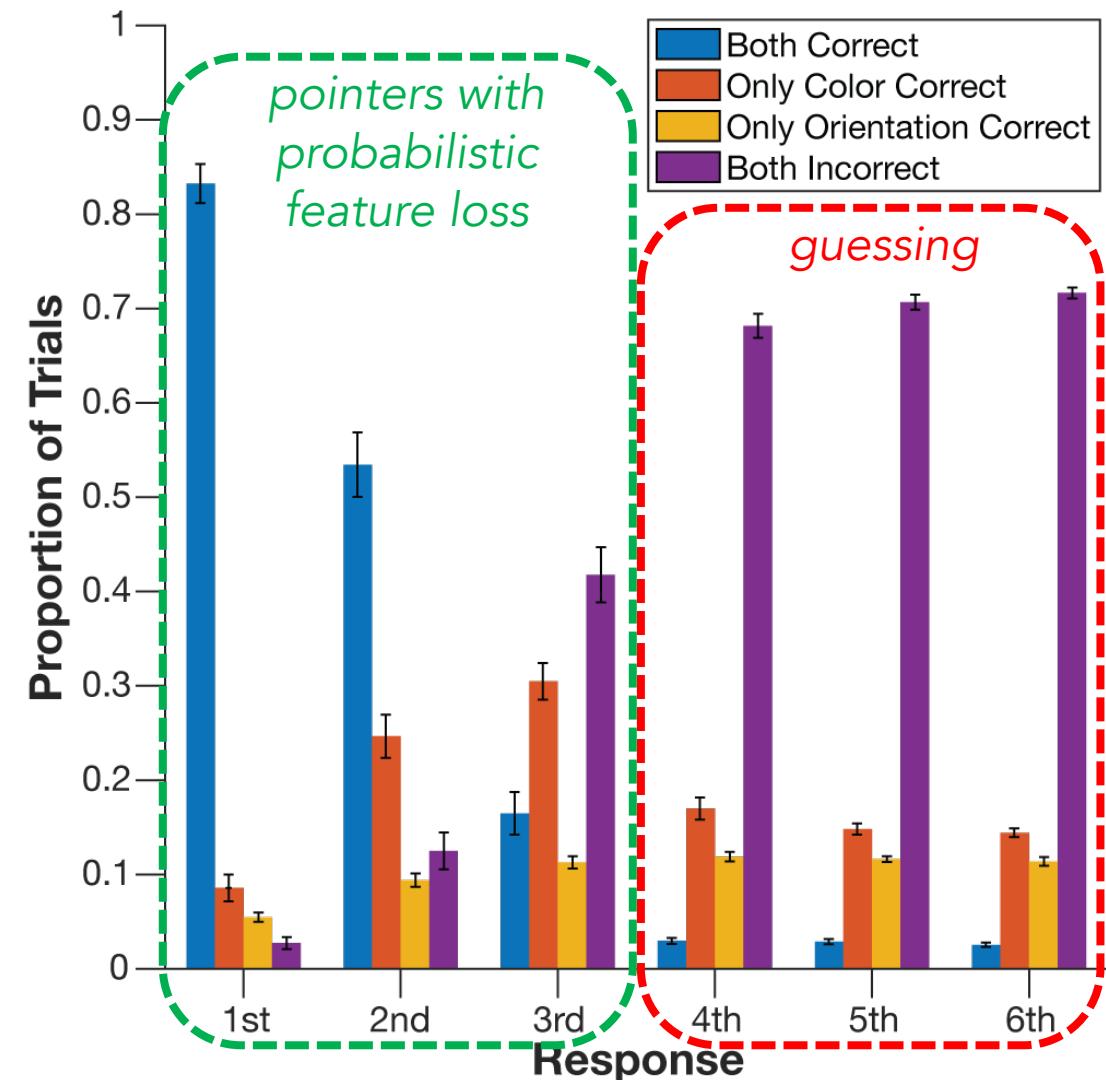
Independent Feature Model

Feature storage independent
of objecthood



A pointer model

- Pointers are a mechanism to maintain representations of objects through changes in its features
 - *FINSTs* (Pylyshyn, 1989)
 - *Object Files* (Kahneman et al., 1992)
- Not simply objects or features
 - We see object-based and feature-based phenomena **in concert**



Pylyshyn, Z. (1989). [https://doi.org/10.1016/0010-0277\(89\)90014-0](https://doi.org/10.1016/0010-0277(89)90014-0)

Kahneman, D., Treisman, A., & Gibbs, B. J. (1992). [https://doi.org/10.1016/0010-0285\(92\)90007-O](https://doi.org/10.1016/0010-0285(92)90007-O)

Thyer, W. et al. (2022). <https://doi.org/10.1177/09567976221090923>

What is visual working memory?

Object-based theory

No one truly believed in a pure
'strong object' slot model!

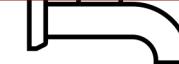
A convenient straw-man.

versus

Feature-based theory

"resource models"

The flexible notion of a 'resource'
which can explain a wide range of
empirical observations.



An academically productive
debate, maybe no longer a
scientifically productive one.

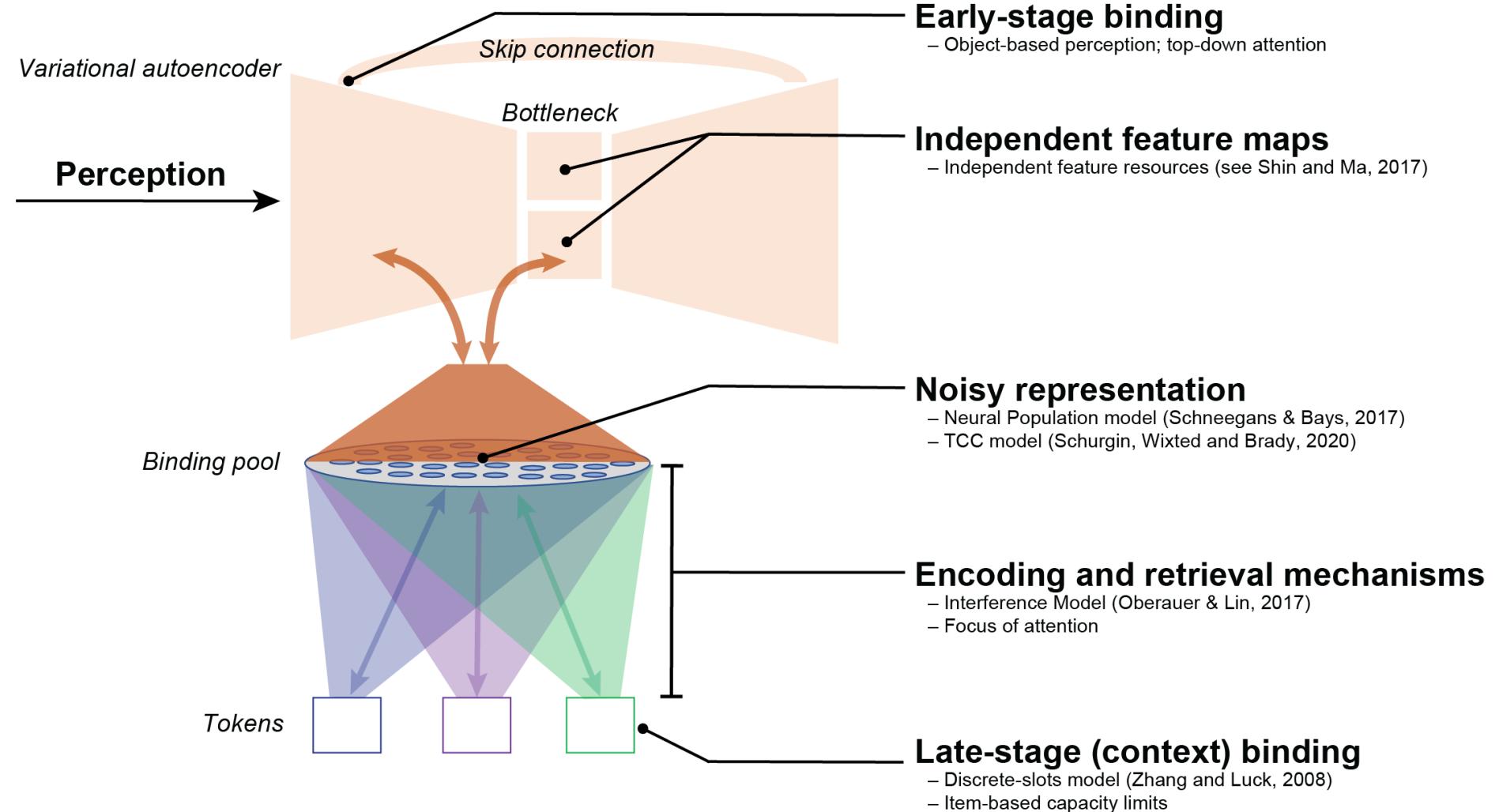
How do we right attention researchers' attention?

Ngiam (2023) PB&R

Towards a model-centric science

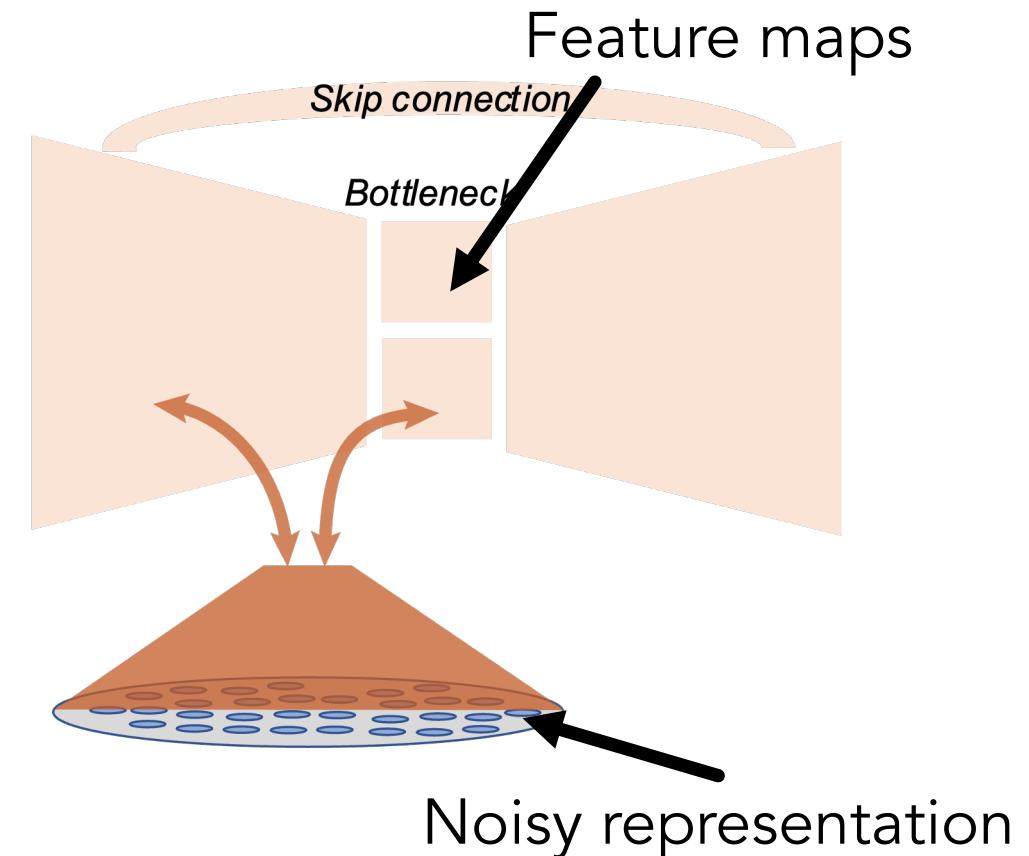
- We need to move away from dualistic experiments and a results-oriented science towards a **model-centric science**
- We need more **theory development**
 - Repeating and detailing the phenomena that we hope to explain
 - Integrating various empirical results and models
 - Clear specification of theories and models and how they relate to the phenomena
 - Careful generalization of current models (i.e. practicing intellectual humility)
 - Better thought-out methods and measures
 - Rigorous design of experiments to truly test hypotheses

Presenting a theory map for visual working memory



Binding pool as a locus for feature-based ideas

- Independent feature layers project into the binding pool (Shin and Ma, 2017)
 - But early-stage object-based attention may also be in play
- **Noisy representations** in VWM are well-captured by neural population and signal detection accounts (Bays, 2014; Schurgin et al., 2020)



Bays, P. M. (2014). Noise in neural populations accounts for errors in working memory. *Journal of Neuroscience*, 34(10), 3632-3645.
Schurgin, M. W., Wixted, J. T., & Brady, T. F. (2020). Psychophysical scaling reveals a unified theory of visual memory strength. *Nature human behaviour*, 4(11), 1156-1172.
Shin, H., & Ma, W. J. (2017). Visual short-term memory for oriented, colored objects. *Journal of Vision*, 17(9), 12-12.

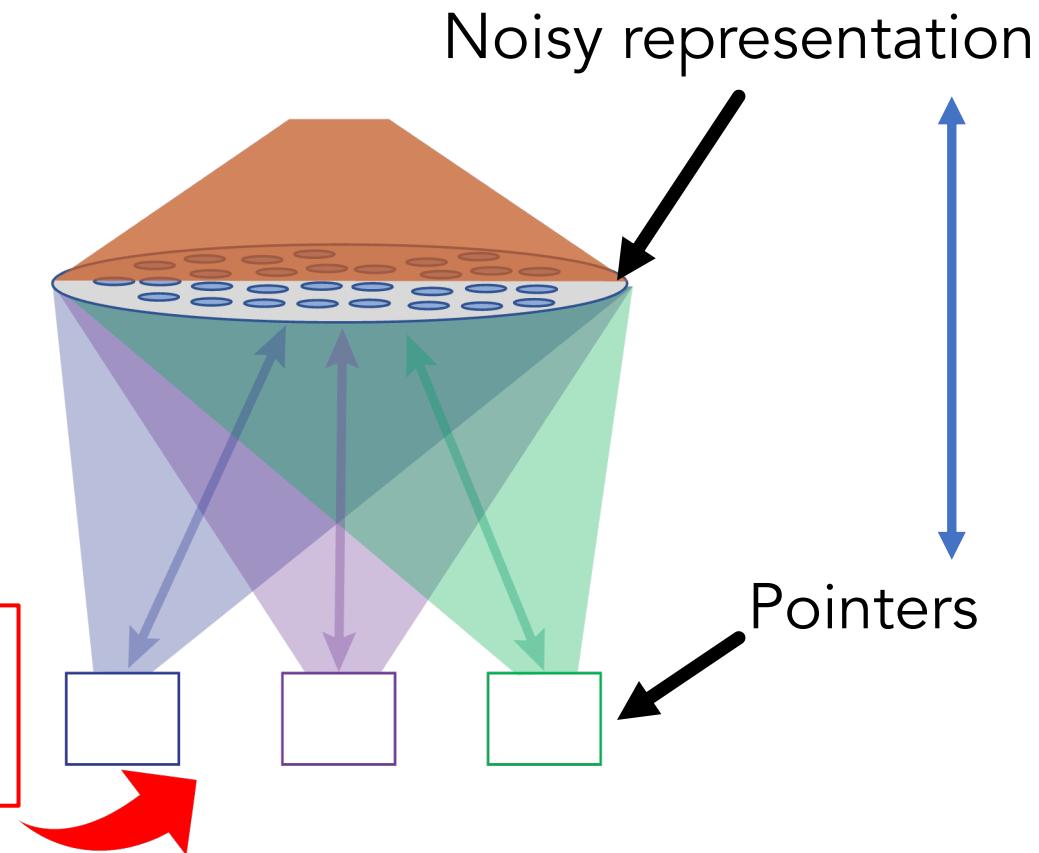
Tokens as a locus for object-based ideas

- Content-independent pointers

- Like *FINSTs* or *Object Files* (Pylyshyn, 1989; Kahneman et al., 1992)

- Evidence for a neural signature that indexes VWM load and generalizes across feature content (Thyer et al., 2022; Balaban et al., 2019)

New conception of working memory as a very late-stage of encoding and selection



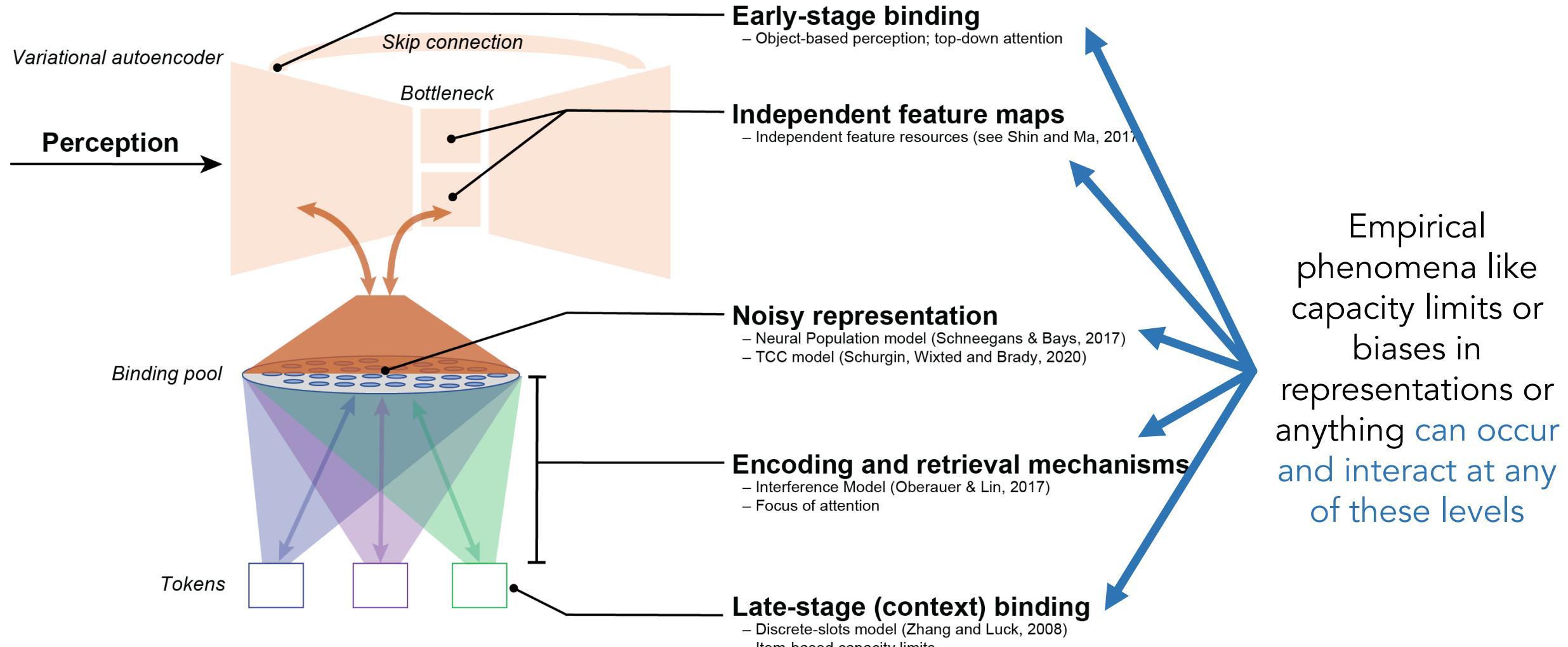
Pylyshyn, Z. (1989). The role of location indexes in spatial perception: A sketch of the FINST spatial-index model. *Cognition*, 32(1), 65-97.

Kahneman, D., Treisman, A., & Gibbs, B. J. (1992). The reviewing of object files: Object-specific integration of information. *Cognitive psychology*, 24(2), 175-219.

Thyer, W., Adam, K. C., Diaz, G. K., Velazquez Sanchez, I. N., Vogel, E. K., & Awh, E. (2022). Storage in visual working memory recruits a content-independent pointer system. *Psychological Science*, 33(10), 1680-1694.

Balaban, H., Drew, T., & Luria, R. (2019). Neural evidence for an object-based pointer system underlying working memory. *cortex*, 119, 362-372.

Presenting a theory map for visual working memory



How does a theory map help?

- Provides a **common core language and framework** to discuss theories, models, and phenomena
 - Reveals hidden intuitions
 - Prevents misunderstandings from varying definitions
 - Better specifies connection between models and phenomena
 - Reduces straw-man of various positions
 - Discourages a dualistic framework for experimental design
 - Initiates better determined model comparisons and definitive empirical tests
- Inspires **theory development**
 - Promotes **counterinduction** (the use and development of others' models)
 - Encourages **slow science** from better thought-out studies

How do we right scientists' collective
attention?

Research rigor and reproducibility
is not at the forefront of scientists'
minds.

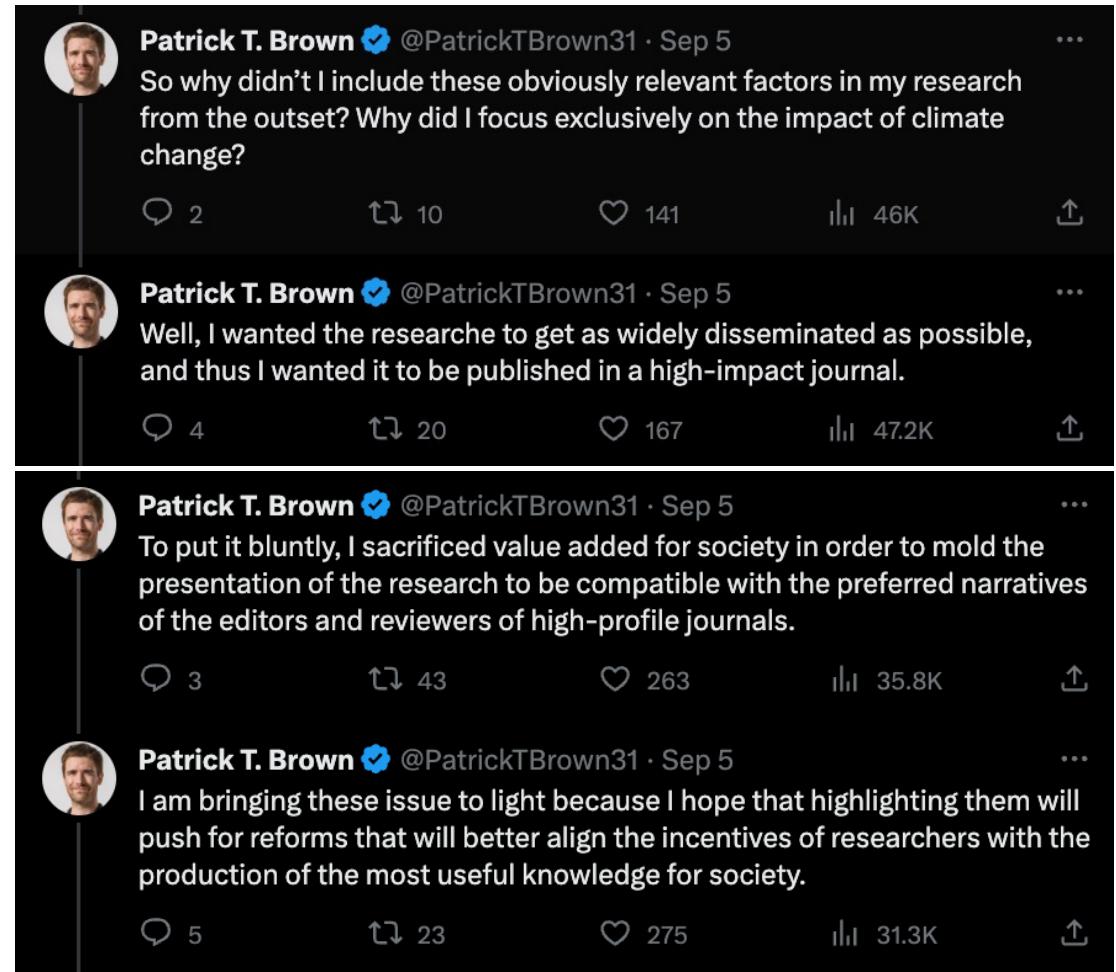
What comes at the cost of scientific rigor

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](#)



Patrick T. Brown  @PatrickTBrown31 · Sep 5
So why didn't I include these obviously relevant factors in my research from the outset? Why did I focus exclusively on the impact of climate change?

2 replies 10 retweets 141 likes 46K views

Patrick T. Brown  @PatrickTBrown31 · Sep 5
Well, I wanted the research to get as widely disseminated as possible, and thus I wanted it to be published in a high-impact journal.

4 replies 20 retweets 167 likes 47.2K views

Patrick T. Brown  @PatrickTBrown31 · Sep 5
To put it bluntly, I sacrificed value added for society in order to mold the presentation of the research to be compatible with the preferred narratives of the editors and reviewers of high-profile journals.

3 replies 43 retweets 263 likes 35.8K views

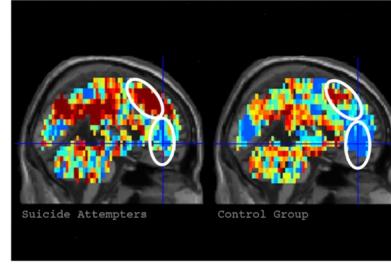
Patrick T. Brown  @PatrickTBrown31 · Sep 5
I am bringing these issue to light because I hope that highlighting them will push for reforms that will better align the incentives of researchers with the production of the most useful knowledge for society.

5 replies 23 retweets 275 likes 31.3K views

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.

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.



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

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 6th April, 2023 with retraction of the original article 6 years later.



James Heathers
@jamesheathers

...

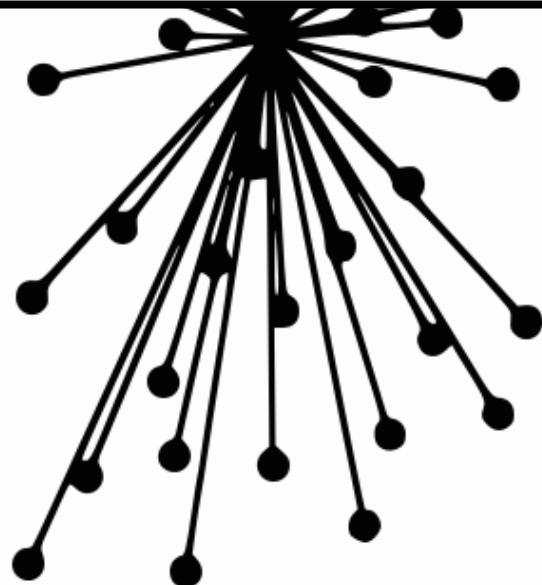
"Science is self-correcting" - sure, *when we correct it*, not because of Magical Progress (tm).

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

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

This hasn't worked.

e.g. I've seen little support from my department in the past 4 years.



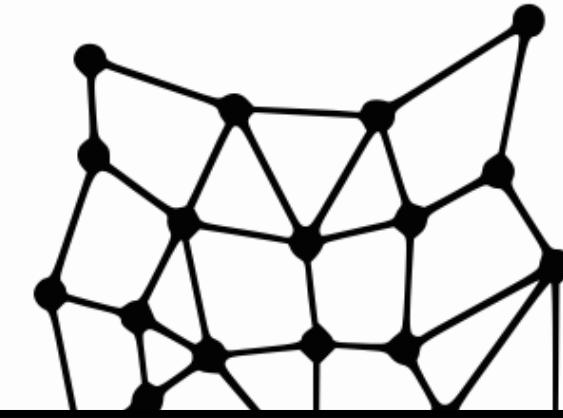
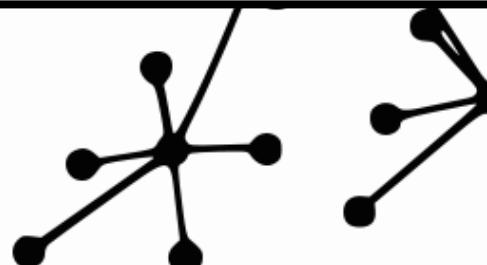
Centralized



Decentralized

This could work...

But reform is siloed, and would not spread across the network.



This is the goal.

We need reform at many levels, and changes to spread through the network.

Distributed

Early-career researchers leading with



- An initiative founded by early-career researchers in 2018 that now spans almost 100 institutions across 25 countries
- Creating **open scholarship communities** at research institutions, especially empowering **early-career researchers**



Check out <https://reproducibilitea.org/>

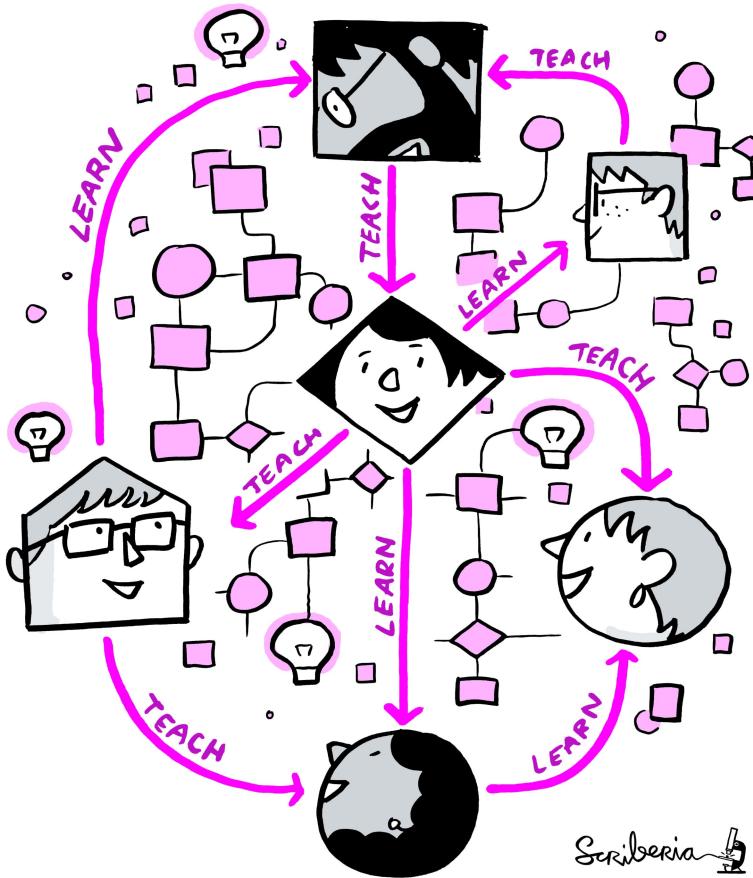


Fig. 1 Modes of change towards scientific credibility. This figure presents an overview of the three modes of change proposed in this article: structural change is often evoked at the institutional level and expressed by new norms and rules; procedural change refers to behaviours and sets of commonly 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).

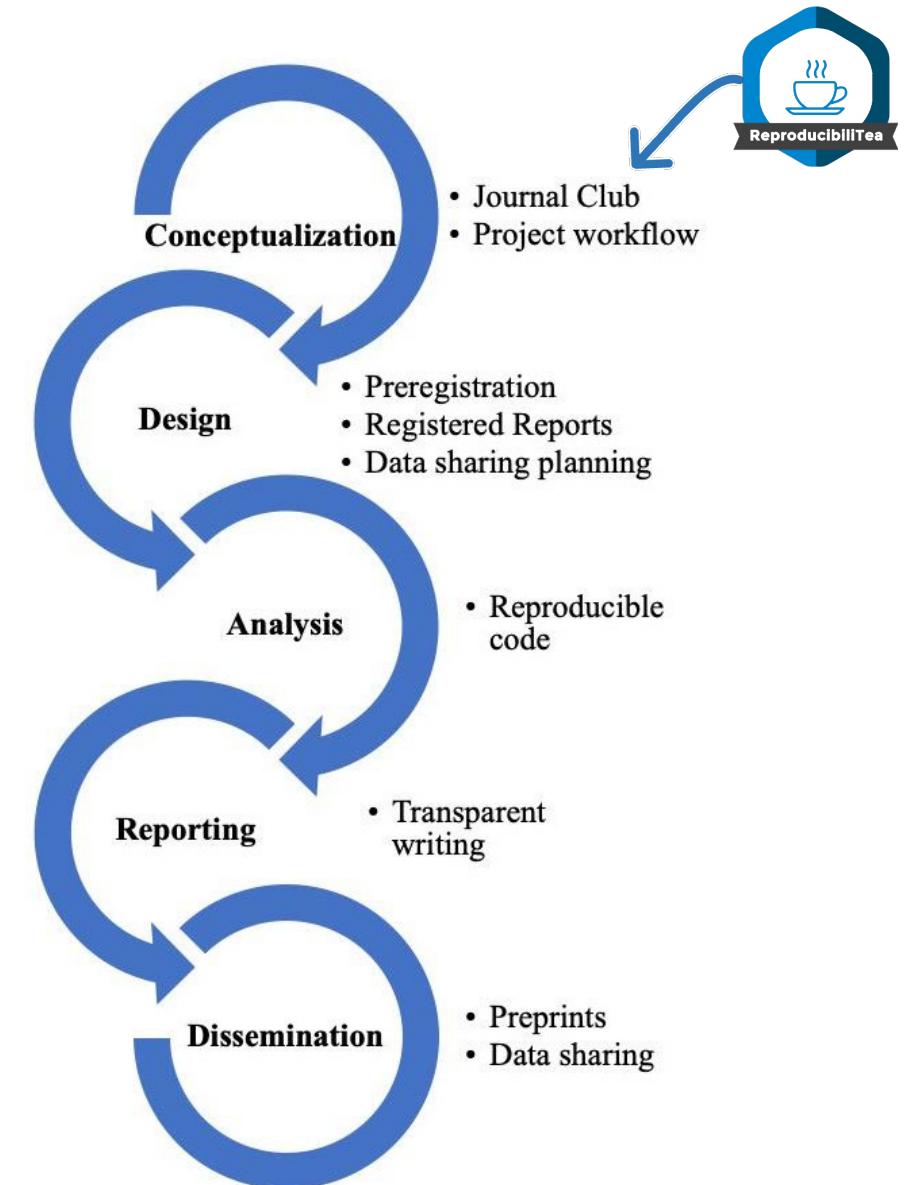
You don't have to do this on your own

- Only one hour or so out of your week
- Form community with your fellow junior scientists from otherwise siloed areas in the department
- Develop and get advice on your research and science
- Have the hidden curriculum of academia and science revealed



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.



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.

ReproducibiliTea Introductory Reading List

These are our recommendations for the papers to cover in the first term of your new ReproducibiliTea journal club! These ten papers were selected to provide an overview of the reproducibility crisis and introduction to the many aspects of Open Science. They are separated by themes that your journal club may choose to explore in further detail in following meetings! We have also provided a summary, keywords and online resources to help inform your discussions.

Order	Block	Paper	Summary	Keywords	Resources
1	The 'issues' that lead to the reproducibility crisis	Ioannidis JPA (2005). Why most published research findings are false. <i>PLoS Med</i> 2(8): e124. https://doi.org/10.1371/journal.pmed.0020124	Defining the issue. By simulating at various levels of statistical power, across different pre-study odds, the accumulation of significant results is shown to be potentially false positives predominantly. The paper introduces concepts like the positive predictive value and how it is related to the p-value, and how important having high statistical power is for the rigor of research.	p-values, positive predictive values, false positives, statistical power	Summary video (by William Ngiam): https://www.youtube.com/watch?v=eG7N_XanptI
2		Smaldino, P. E., & McElreath, R. (2016). The natural selection of bad science. Royal Society open science, 3(9), 160384. https://doi.org/10.1098/rsos.160384	The myth of self-correction. Estimates of statistical power historically in science appears to be extremely low. In addition to that, due to publication bias (the view that positive results are more likely to be published) and the incentives to publish, simulations suggest that a high false-discovery rate is naturally selected for and that replications are ineffective at correcting that rate.	statistical power, replication	Summary video (by William Ngiam): https://www.youtube.com/watch?v=EdDE2Y4exM
3		Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-Positive Psychology: Undisclosed Flexibility in Data Collection and Analysis Allows Presenting Anything as Significant. <i>Psychological Science</i> , 22(11), 1359–1366. https://doi.org/10.1177/0956797611417632	The problem of analytic flexibility. A demonstration of how decisions made by researchers in statistical analysis, such as dropping conditions or adding observations after a non-significant test, can easily produce a false positive result.	analytic flexibility, researcher degrees of freedom, questionable research practices	Summary video (by William Ngiam): https://www.youtube.com/watch?v=bf3Sqy0RgqY
4	The extent of the 'issues'	John, L. K., Loewenstein, G., & Prelec, D.	The prevalence of questionable research practices. With an	questionable research practices	
5					
6		Vazire, S. (2018). Implications of the credibility revolution for productivity, creativity, and progress. <i>Perspectives on Psychological Science</i> , 13(4), 411–417. https://doi.org/10.1177%2E1745691617751884	The credibility revolution. A reframing of the 'reproducibility crisis' that highlights the scientific reforms that have occurred with the Open Science movement, and their potential impacts on the productivity, creativity and progress of scientists.	credibility revolution, commentary, summary	NIDIMVVKQJHLM Presentation by Simine Vazire at OSC 2019: https://www.youtube.com/watch?v=Yf1Ovx-OixE
7		Yarkoni, T. (2018). Not its the Incentives - it's you. Yarkoni Blog - [citation needed]: https://www.talyarkoni.org/blog/2018/10/20/not-its-not-the-incentives-its-you/	Dealing with the incentives. A blogpost arguing that the responsibility for reproducible science rests with the individual, and that the incentives are not a good reason to be absolved of that responsibility.	incentives, commentary	
8		Kothiyal, U. K., Silverstein, P., & Syed, M. (2021). Easing into open science: A guide for graduate students (and their advisors) on some of the different ways to engage with the reproducibility movement. They are given difficulty ratings (easy, medium or difficult) and potential worries are also addressed.	Easing into Open Science. A very accessible guide for graduate students (and their advisors) on some of the different ways to engage with the reproducibility movement. They are given difficulty ratings (easy, medium or difficult) and potential worries are also addressed.	early-career researchers, guide, introductory, pre-registration	NIDIMVVKQJHLM Presentation by Priya Silverstein at RIOT Science Club: https://www.youtube.com/watch?v=ewJaD3UiseQ
9	Getting started with Open Science	Monaflo, M. R., Naseem, B. A., Bishop, D. V. M., Button, K. S., Chambers, C. D., Perce Du Sert, N., Simonsohn, U., Wagenmakers, E. J., Ware, J. J., & Ioannidis, J. P. A. (2017). A manifesto for reproducible science. <i>Nature Human Behaviour</i> , 1(1), 1–9. https://doi.org/10.1038/s41562-016-0021	A manifesto for reproducible science. A general overview of the goals of various reproducibility measures and how they can be implemented.	guide, reproducibility	
10		Criewell, S., van Doorn, J., Etz, A., Mekel, M. C., Meshman, H., Niebaum, J. C., ... & Schulte-Mecklenbeck, M. (2019). Seven easy steps to open science. <i>Zeitschrift für Psychologie</i> . http://dx.doi.org/10.1027/2151-2604/a000387	Where to next? An annotated reading list of papers from seven topics: open access, open data, preregistration, reproducible analyses, replications and teaching open science in an attempt to make those practices more understandable and actionable for readers	transparency, meta-science	

Order	Block	Paper	Summary	Keywords	Resources	
1	Does psychology have a theory problem?	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. https://doi.org/10.1080/1047840X.2020.1854011	introductory, theory development	Elko Fried on "Theory building and testing in psychological research" for the RIOT Science Club: https://youtu.be/vB1Hk3c-iZY	
2		The lack of theory development in psychology.	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> 1978, Vol. 46, 806-834. https://www3.nd.edu/~gheffel/Meehl/1978.pdf	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 science' of psychology. https://youtu.be/AEPbzCTneDs	
3		A crisis in replication or beyond?	Klein, S. B. (2014). What can recent replication failures tell us about the theoretical commitments of psychology?. <i>Theory & Psychology</i> , 24(3), 326–338. https://doi.org/10.1177/0959354314529616	reproducibility crisis, replications, theory development	A personal commentary by Daniel Nettle on the pretense of having a theory in psychology: "Theories and models are not the only fruit" https://eoneditioikhin.medium.com/theories-and-models-are-not-the-only-fruit-a057cf188fe	
4		Are we ready to test?	Scheel, A. M., Tiokhin, 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. https://doi.org/10.1177/1745691620966795	exploratory versus confirmatory, derivation chain	Anne Scheel on "Equivalence testing for psychological research" for the RIOT Science Club https://youtu.be/T9pZORPTXFU	
5		Note: presentation by Olivia Hartmann on "What makes a good theory, and how do we make a theory good?" https://youtu.be/67X0TpNQeO0				
6	Perspectives on the reproducibility crisis	Reform.			video recording of a talk by Olivia Hartmann and Andrea Martin on their work "How computational modeling can force theory building in psychological science". https://youtu.be/8Aa9_GahQ48	
7		The credibility revolution. A reframing of the 'reproducibility crisis' that highlights the scientific reforms that have occurred with the Open Science movement, and their potential impacts on the productivity, creativity and progress of scientists.	credibility revolution, commentary, summary	Psychological Science, 16(4), 789-802. https://doi.org/10.1177/1745691620970585	theories as abstract constructs are formalized, and underlying intuitions and predictions are made open and transparent.	can force theory building in psychological science". https://youtu.be/8Aa9_GahQ48
8	Taking steps to improve psychological theory	Maatman, F. O. (2021). Psychology's Theory Crisis, and Why Formal Modelling Cannot Solve It.	Maatman, F. O. (2021). Psychology's Theory Crisis, and Why Formal Modelling Cannot Solve It. https://psyarxiv.com/puvq/	proto-theory, formal theory, theory building, theory specification	Formal theories are helpful but first be determined. The cause of the theory crisis stems from tests of experiments not being specific enough as 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.	A Twitter thread by Freek Maatman (@psychedfreek) summarizing their paper. https://twitter.com/psychedfreek/status/141498260302506242
9		Flake, J. K., & Fried, E. I. (2020). Measurement schmeasurement: Questionable measurement practices and how to avoid them.	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. https://doi.org/10.1177/2515245920952393	guide, measurement, transparency, construct validity	Better measures to inform theory building. Developing and testing theories requires construct measures to be scrutinized and valid. Echoing questionable research practices, questionable measurement 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.	Jessica Flake on "Measurement schmeasurement: Questionable measurement practices and how to avoid them" for the RIOT Science Club: https://youtu.be/Cq6n7AS_r8w
10	Are we ready to test our theories?	van Rooij, I., & Blokpoel, M. (2020). Formalizing verbal theories: A tutorial by dialogue.	van Rooij, I., & Blokpoel, M. (2020). Formalizing verbal theories: A tutorial by dialogue. <i>Social Psychology</i> , 51(5), 285. https://doi.org/10.1027/1864-9335/a000428	guide, theory building, formal modeling	Formalizing verbal theories. 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.	Smaldino, P. E. (2020). How to translate a verbal theory into a formal model. <i>Social Psychology</i> , 51(4), 207. https://osf.io/preprints/metaarxiv/n7qsh/
		Oberauer, K., & Lewandowsky, S. (2019). Addressing the theory crisis in psychology.	Oberauer, K., & Lewandowsky, S. (2019). Addressing the theory crisis in psychology. <i>Psychonomic bulletin & review</i> , 26(5), 1596–1618. https://doi.org/10.3758/s13423-019-01645-2	Discovery-oriented research versus theory-testing research	Discovery-oriented research versus theory-testing research. A critical and comprehensive revisit 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 as to close the gap between theory and hypothesis.	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. https://elko-fried.com/on-theory/

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

William X. Q. Ngiam¹  | Kirsten C. S. Adam²  | Colin Quirk¹  | Edward K. Vogel¹ | Edward Awh¹

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

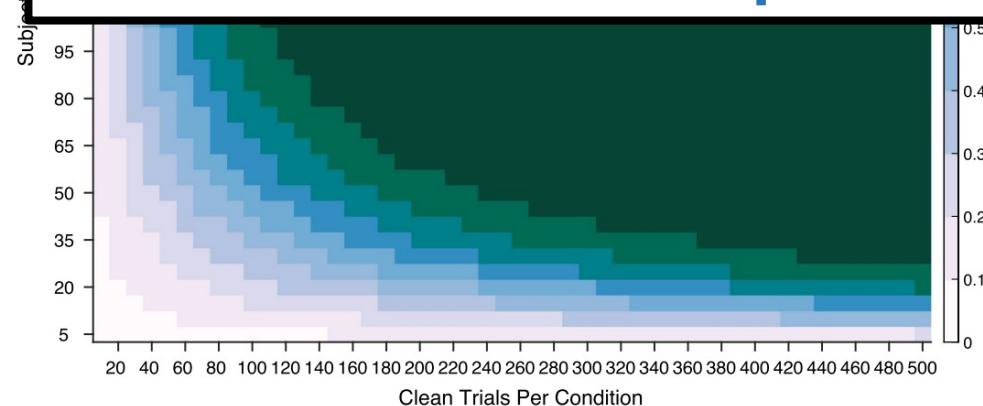


FIGURE 6 Simulated statistical power for observing a significant difference in CDA amplitude between set sizes 2 and 4 beyond the bounds of the Hakim et al. (2019) dataset

AUTHORS

William X. Q. Ngiam

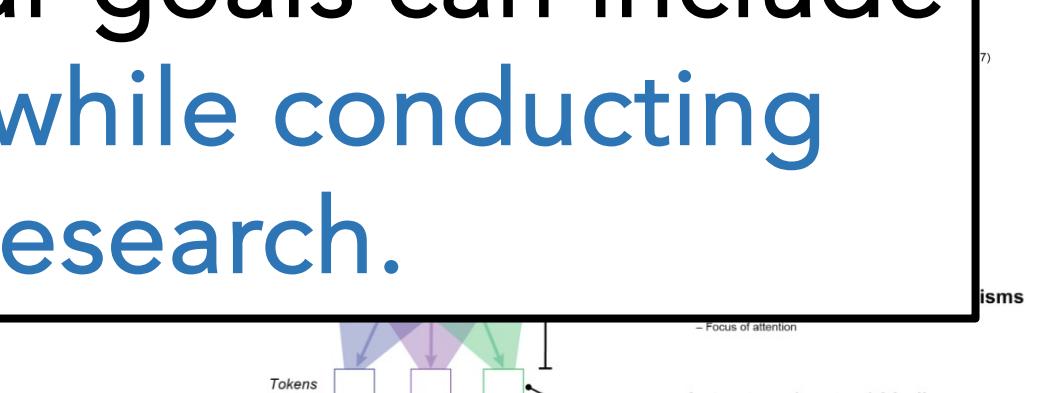


Figure 1. A simplified schematic of the Memory for Latent Representations (MLR) model architecture (Hedayati et al., 2022) with visual working memory phenomena and current models mapped on to its components: the variational autoencoder (VAE), the binding pool, and the tokens. This theory map aims to 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.

This seems like a lot more work...

- Rigor
- Savings
- Ease
- Credit
- Redundancy
- Credibility
- Being cited
- Being rewarded
- Being noticed
- Being remembered
- Being used
- Being cited
- Being noticed
- Being remembered
- Being used

What is **your goal** in science?

Do you want your attention taken up by
the *Incentives*?

Or do you want your work to pave the
way towards better understanding?

Personal benefits of Open Science

- May 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

Exponential growth of scientific publications

Feeding a capitalistic academic system devalues the work.

Slow down, refocus, think again, test carefully.



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

