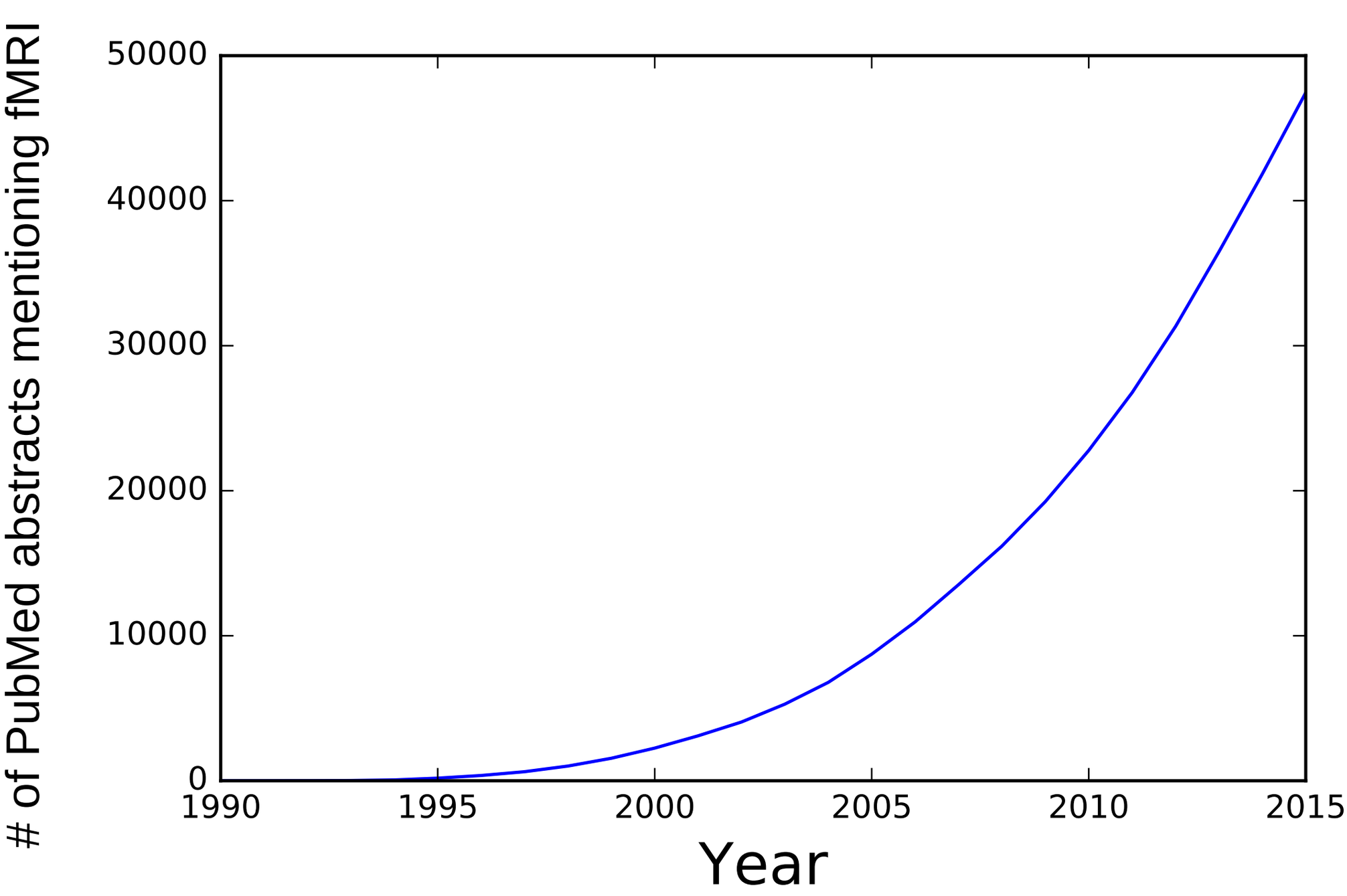
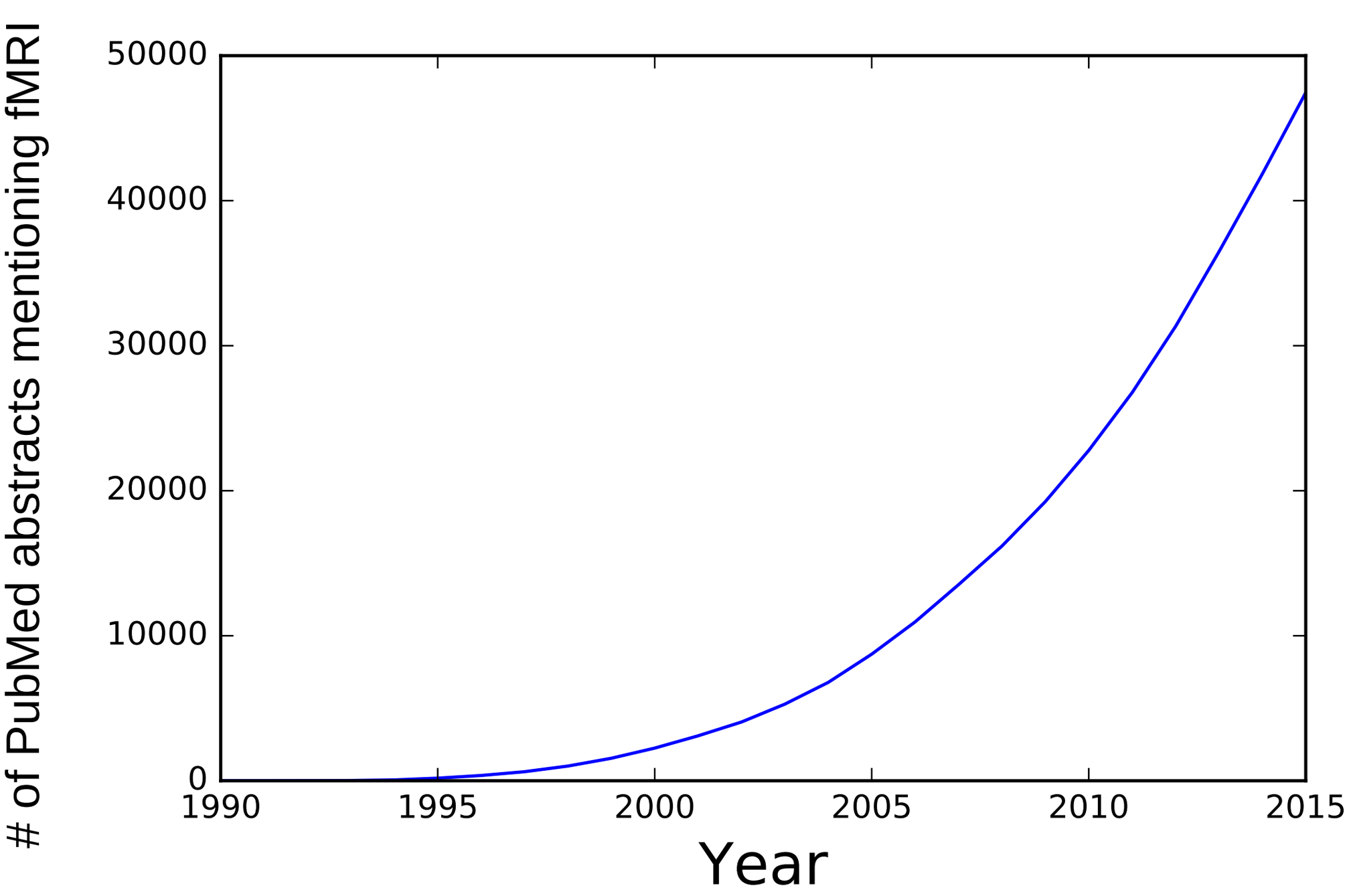
How can fMRI inform the structure of the mind?

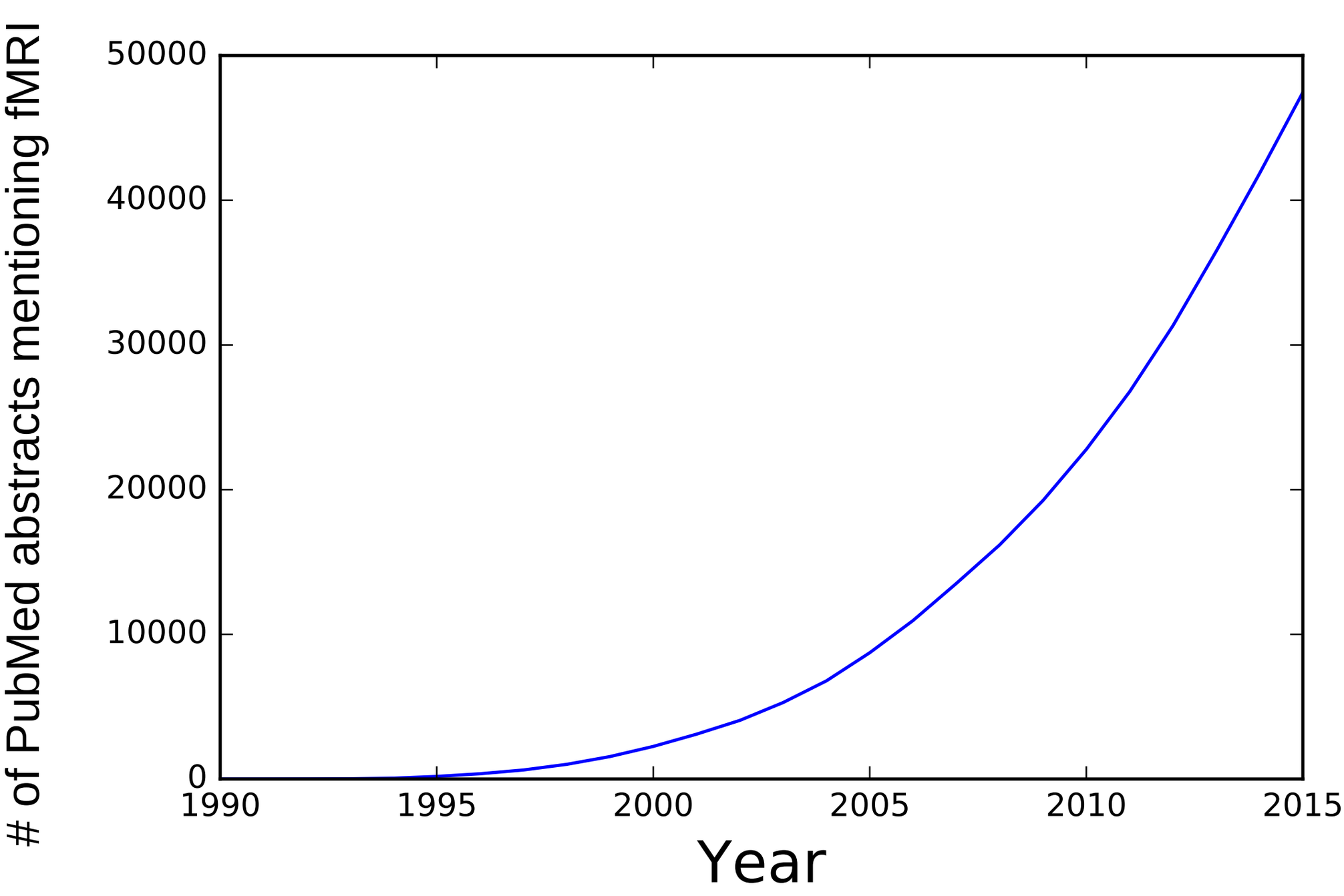
Russell Poldrack

Department of Psychology
Stanford University


# of PubMed abstracts mentioning fMRI
50000
40000
30000
20000
10000
0
1990
1995
2000
2005
2010
2015
Year



Do we really know an order of magnitude more now than we did in 2002?



Do we really know an order of magnitude more now than we did in 2002?

Will 45,000 more of the same kind of fMRI papers give us twice the understanding we have now?

Questions we would hope we could answer

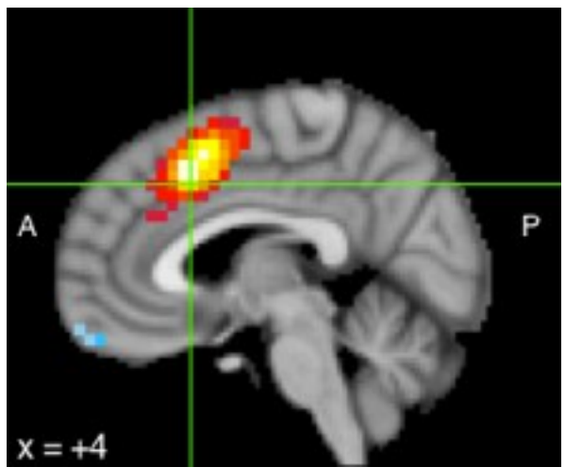
- What does <insert brain area or system> do?
- How is <insert psychological process> implemented in the brain?

What does the anterior cingulate cortex do?

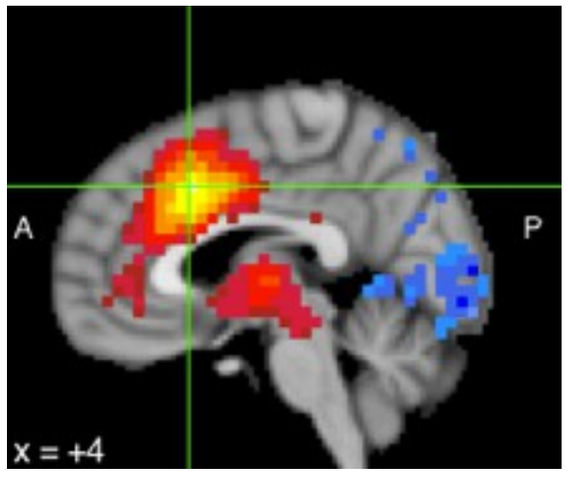
- "anterior cingulate" and fMRI
  - 3683 abstracts in PubMed
  - under conservative assumptions, ~$22M USD

What does the ACC do?

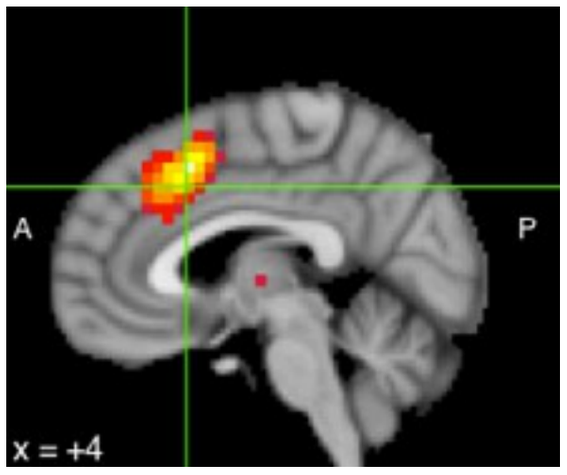
maintenance



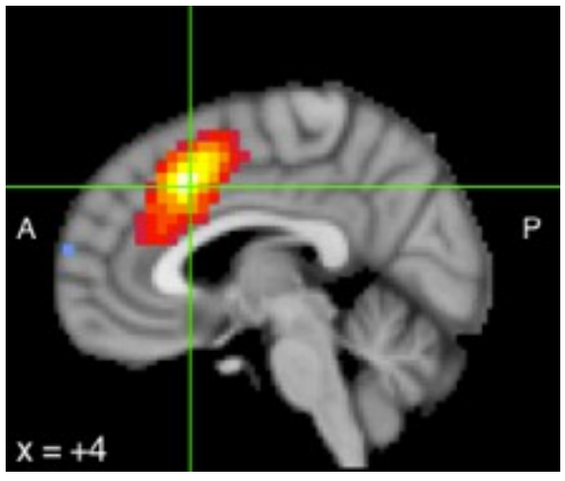
pain



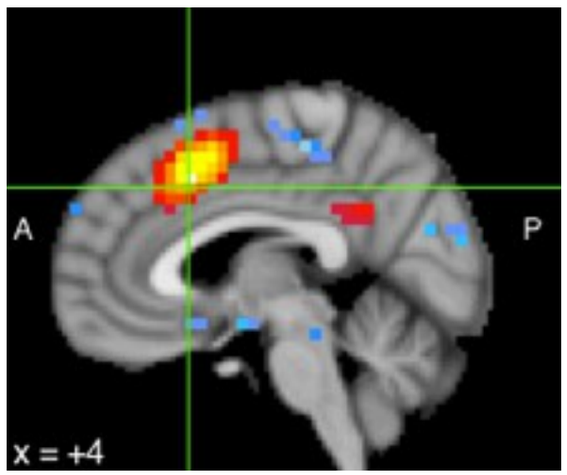
phonology



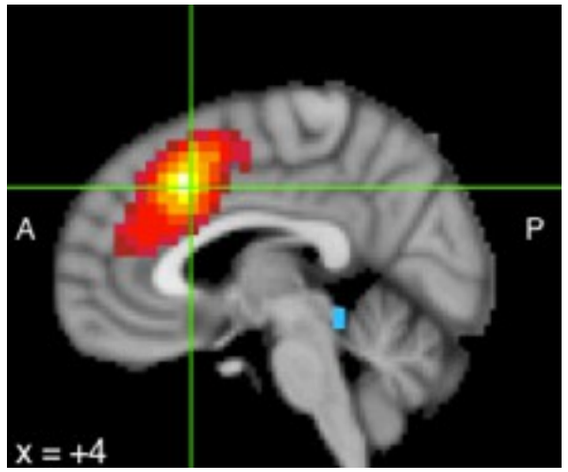
interference



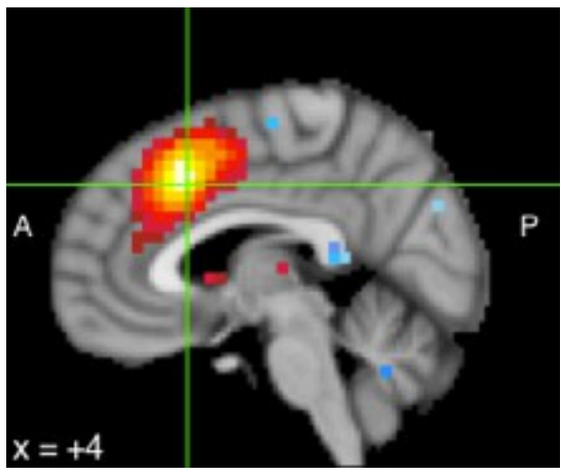
difficulty



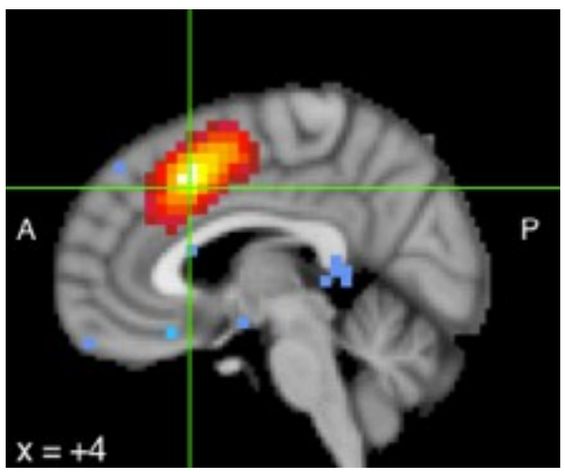
conflict



errors



attention



forward inference Z estimated using neurosynth.org

playing 20 questions with nature is a bad strategy

YOU CAN'T PLAY 20 QUESTIONS WITH NATURE
AND WIN:
PROJECTIVE COMMENTS ON THE PAPERS OF THIS
SYMPOSIUM

Allen Newell
May, 1973

I am distressed. I can illustrate it by the way I was going to start my comments, though I could not in fact bring myself to do so. I was going to draw a line on the blackboard and, picking one of the speakers of the day at random, note on the line the time at which he got his PhD and the current time (in mid-career). Then,taking his total production of papers like those in the present symposium, I was going to compute a rate of productivity of such excellent work.. Moving, finally, to the date of my chosen target's retirement, I was going to compute the total future addition of such papers to the (putative) end of this man's scientific career. Then I was going to pose, in my role as discussant, a question: Suppose you had all those additional papers, just like those of today (except being on new aspects of the problem), where will psychology then be? Will we have achieved a science of man adequate in power and commensurate with his complexity? And if so, how will this have happened via these papers that I have just granted you?

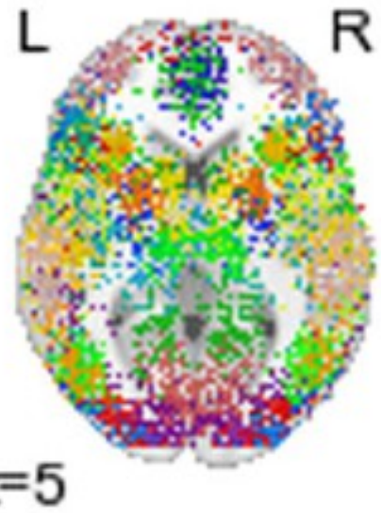
Establishing selective inference

Manipulate a wide range of mental processes

Observe associated brain activation

Identify which processes can be decoded from brain activity

working memory maintenance
pain
phonology
effort
visual selective attention
fear



working memory maintenance (p>0.98)

Establishes a selective association between mental states/processes and brain activity

Poldrack & Yarkoni, 2016, *Annual Review in Psychology*

Decoding tasks from fMRI

PSYCHOLOGICAL SCIENCE

Research Article

Decoding the Large-Scale Structure of Brain Function by Classifying Mental States Across Individuals

Russell A. Poldrack,[1] Yaroslav O. Halchenko,[2] and Stephen José Hanson[3]

[1]University of California, Los Angeles; [2]Dartmouth University; and [3]Rutgers University

8 tasks, 130 individuals

Task chosen by classfier

True task	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8
Task 1	**87.5**	6.0	0.0	0.0	6.0	0.0	0.0	0.0
Task 2	0.0	**90.0**	0.0	0.0	0.0	0.0	5.0	5.0
Task 3	8.0	23.0	**61.5**	0.0	0.0	8.0	0.0	0.0
Task 4	0.0	0.0	0.0	**82.4**	0.0	0.0	0.0	18.0
Task 5	0.0	38.0	0.0	0.0	**43.8**	18.2	0.0	0.0
Task 6	0.0	28.0	0.0	0.0	0.0	**71.4**	0.0	0.0
Task 7	0.0	11.0	0.0	0.0	0.0	0.0	**84.0**	5.0
Task 8	0.0	0.0	7.0	0.0	0.0	0.0	27.0	**63.0**

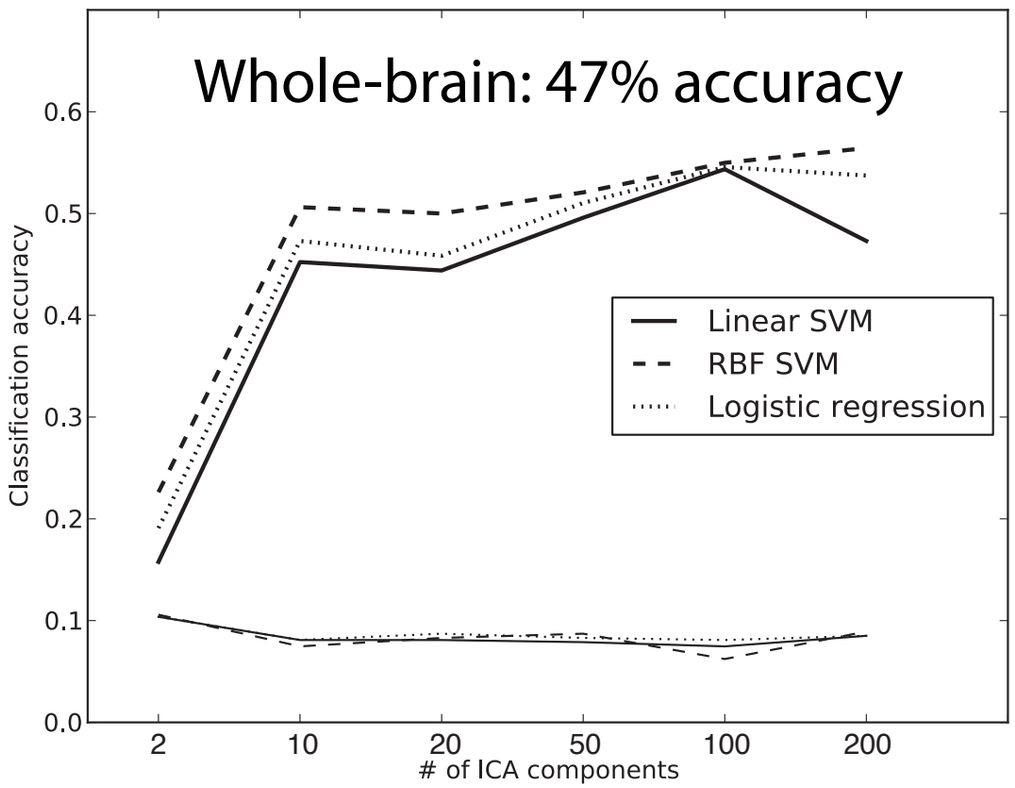
frontiers in NEUROINFORMATICS

METHODS ARTICLE
published: 08 July 2013
doi: 10.3389/fninf.2013.00012

Toward open sharing of task-based fMRI data: the OpenfMRI project

Russell A. Poldrack[1]*, Deanna M. Barch[2], Jason P. Mitchell[3], Tor D. Wager[4], Anthony D. Wagner[5], Joseph T. Devlin[6], Chad Cumba[1], Oluwasanmi Koyejo[7] and Michael P. Milham[8]

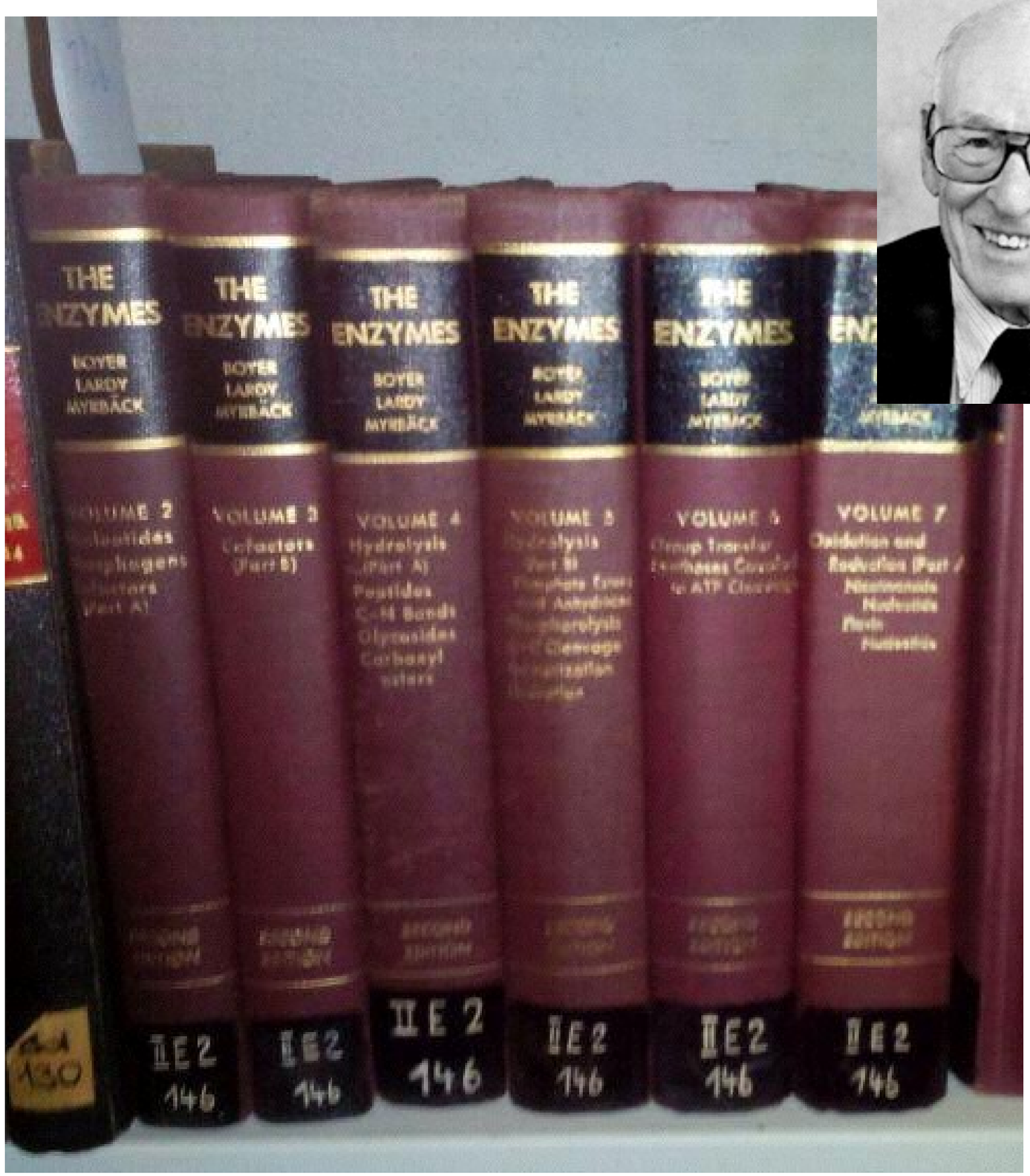
26 tasks, 338 individuals

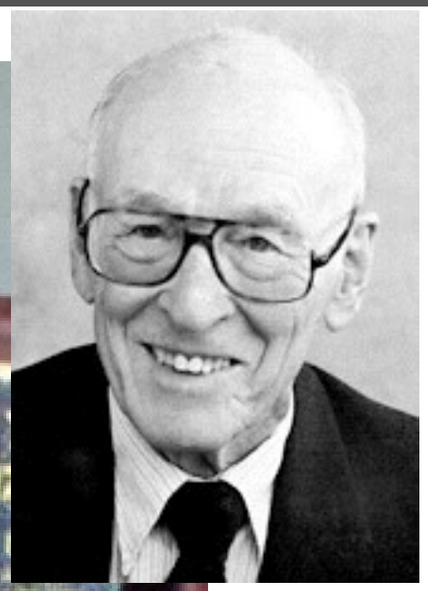


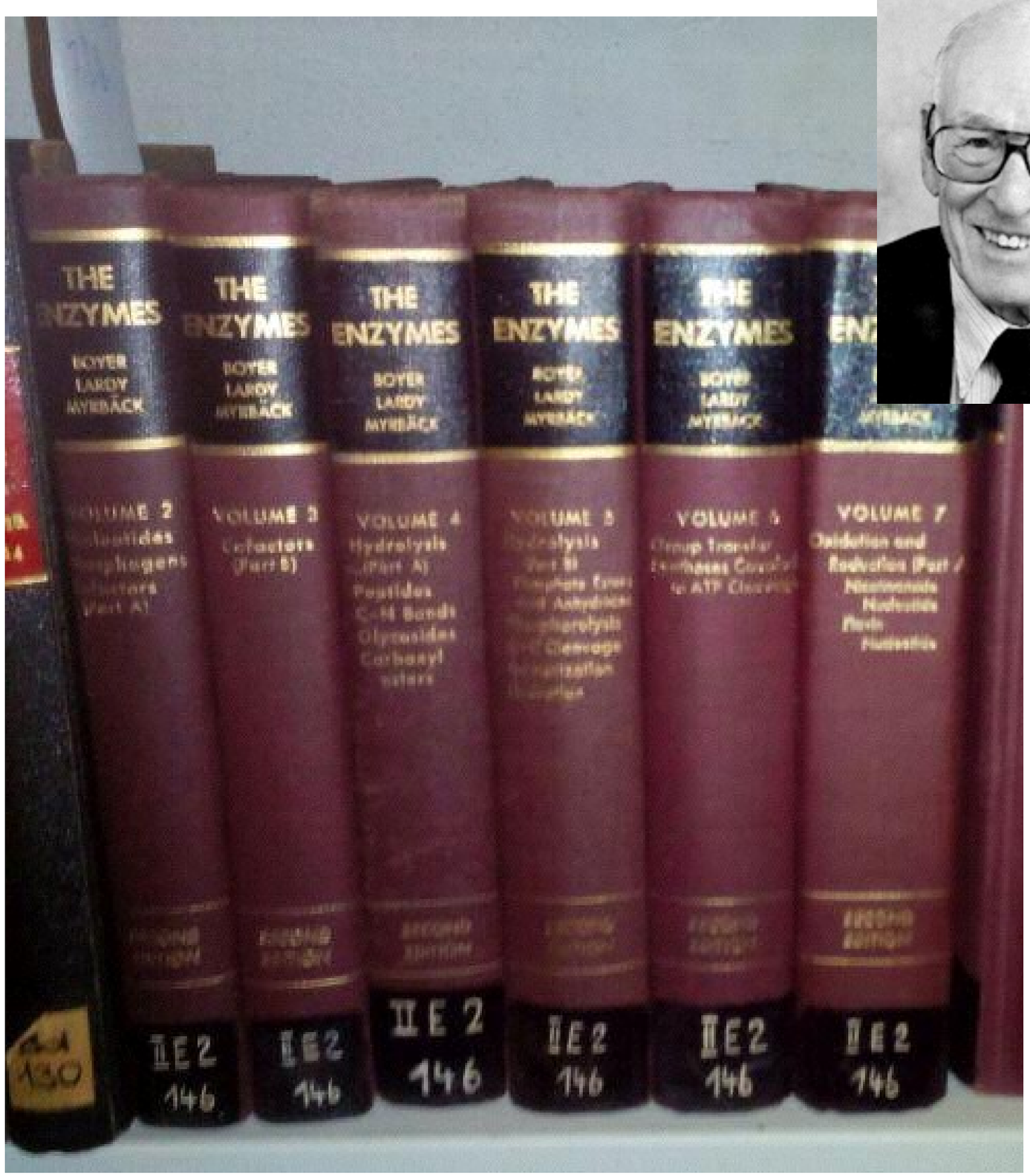
- It’s not tasks we ultimately want to decode
  - It’s cognitive processes/states/functions
  - First we need to know what those are!

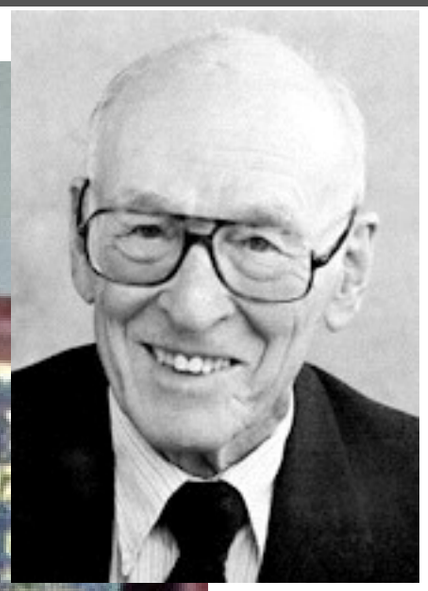
OH
HO
CH2OH
OH

- What are all the enzymes?

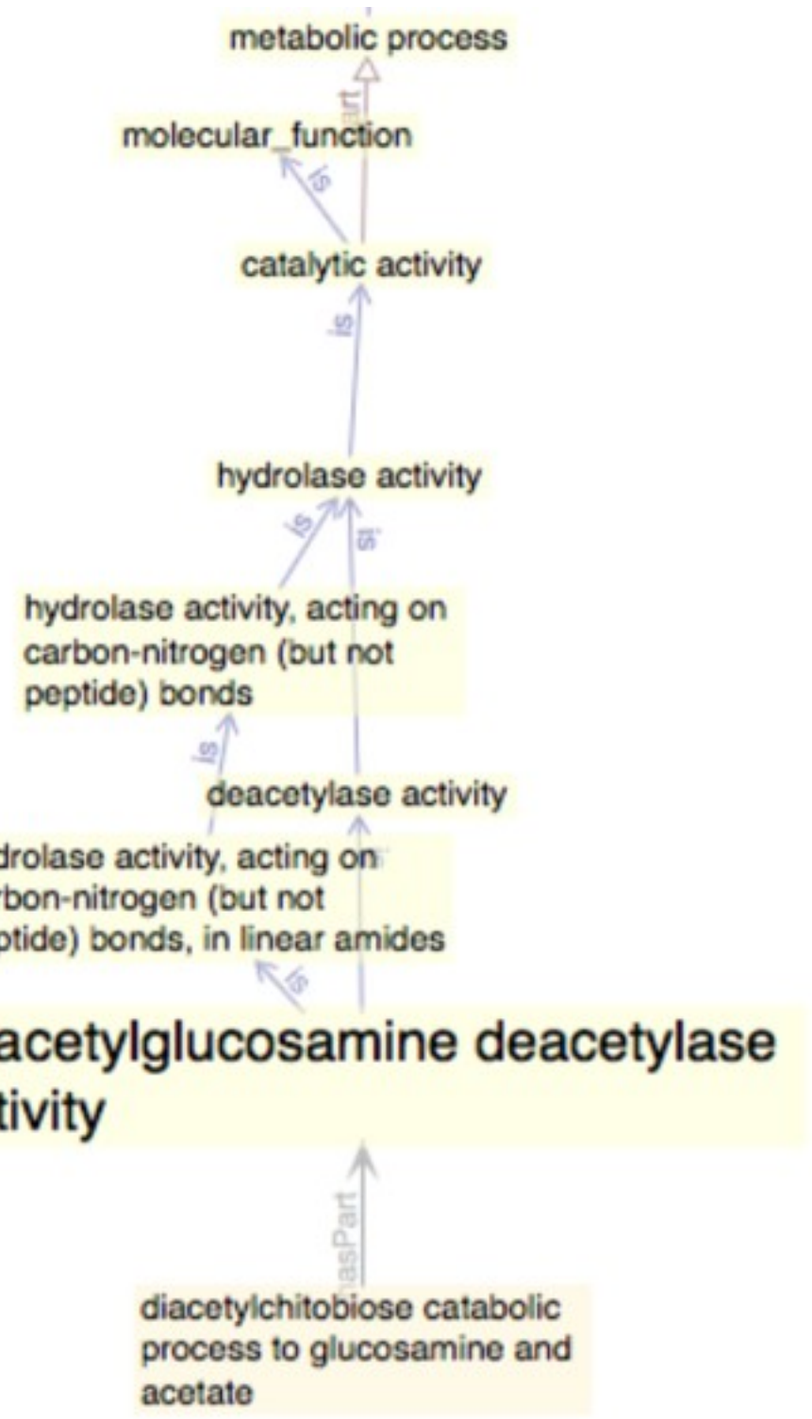

THE ENZYMES
BOYER LARDY MYRBÄCK
VOLUME 2
VOLUME 3
VOLUME 4
Hydrolysis
VOLUME 5
VOLUME 7
Oxidation and
II E 2
146



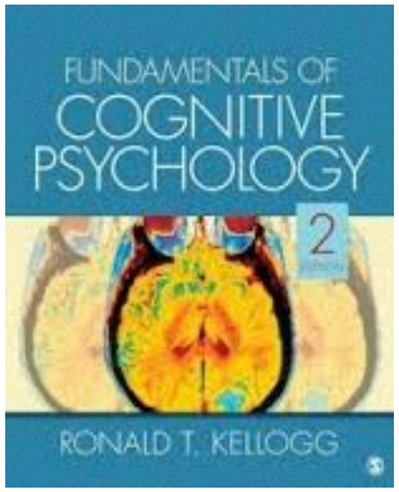


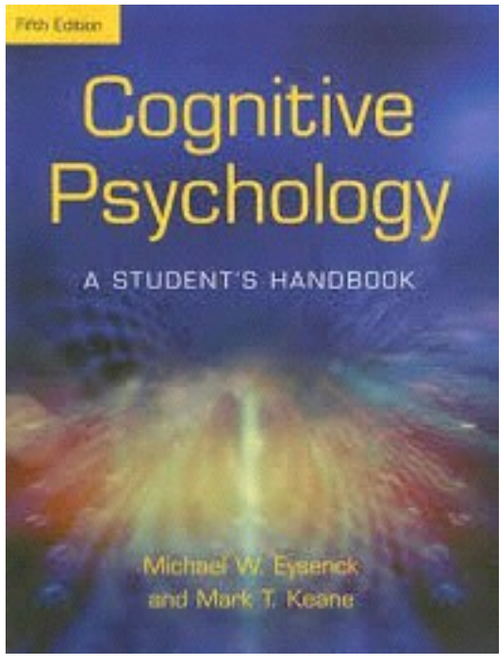


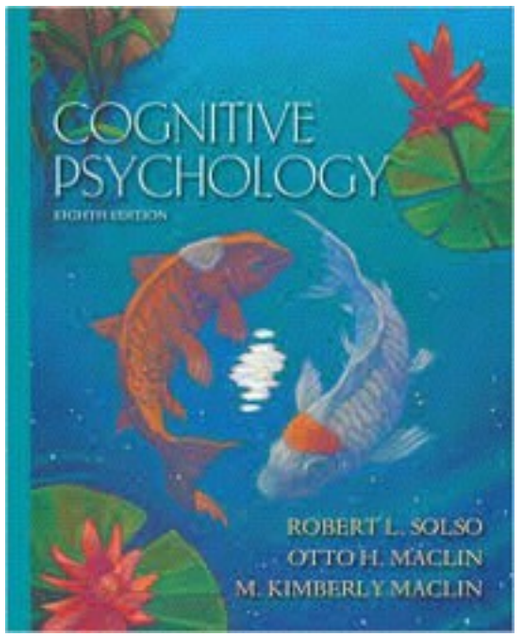
Gene Ontology

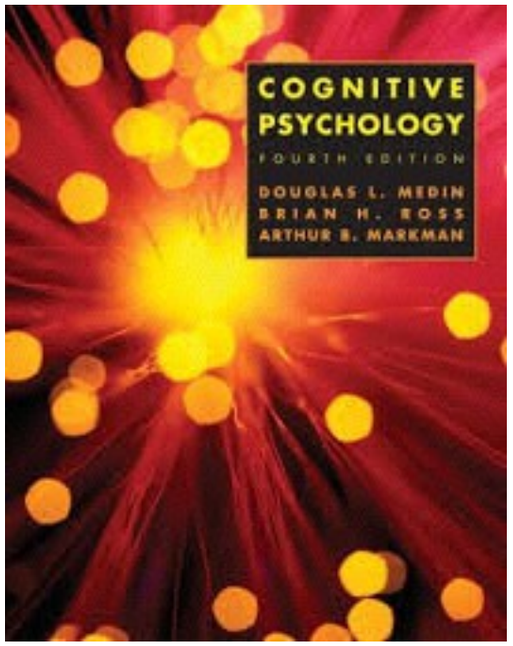


- What are all the psychological functions that we are mapping to the brain?









Task decompositions

	Task Pair I		Task Pair II		Task Pair III		Task Pair IV	
	Words		**Letters**		**Objects**		**Colours**	
Tasks:	A	B	A	B	A	B	A	B
	1	2	3	4	5	6	7	8
Cognitive Processes								
Form processing	■	■	■	■	■	■	■	■
Colour processing					■	■	■	■
Lexical orthography	■							
Sublexical orthography	■		■					
Object structure					■	■		
Semantics	■				■	■		
Phonology	■		■		■		■	
Articulation	■	■	■	■	■	■	■	■

Price & Friston, 1997

cognitive atlas

a collaborative knowledge base characterizing the state of current thought in Cognitive Science.

CONCEPTS / 802 | TASKS / 707 | DISORDERS / 217 | COLLECTIONS / 41 | ABOUT | BLOG

Welcome to Cognitive Atlas

The Cognitive Atlas is a collaborative knowledge building project that aims to develop a knowledge base (or ontology) that characterizes the state of current thought in cognitive science. The project is led by Russell Poldrack, Professor of Psychology at Stanford University. Development of the project was supported by grant RO1MH082795 from the National Institute of Mental Health.

Sign In

Registered users may edit and contribute to the Cognitive Atlas

your email address

••••••••••••••

Keep me logged in ☐ SIGN IN

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Recently updated mental **CONCEPTS**

- *kindness priming*
- *auditory recognition*

Recently updated experimental **TASKS**

- *Multidimensional Personality Questionnaire*

Recently updated **DISORDERS**

- *Semantic Dementia*
- *surface dyslexia*

Recently updated **COLLECTIONS**

- *NCANDA Speed - General Ability*

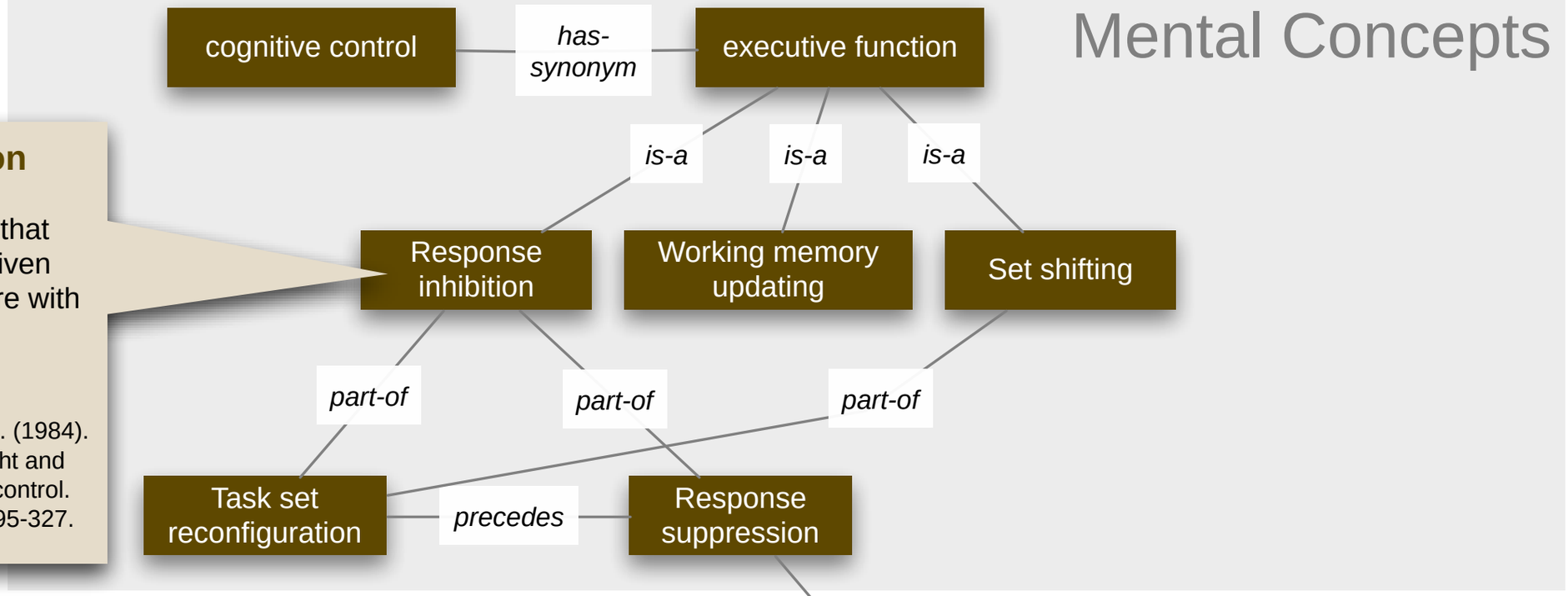
Poldrack et al., 2011, *Frontiers in Neuroinformatics*

Response inhibition

Suppression of actions that are inappropriate in a given context and that interfere with goal-driven behavior.

Bibliography

Logan, G. D. & Cowan, W. B. (1984). On the ability to inhibit thought and action: A theory of an act of control. Psychological Review, 91, 295-327.

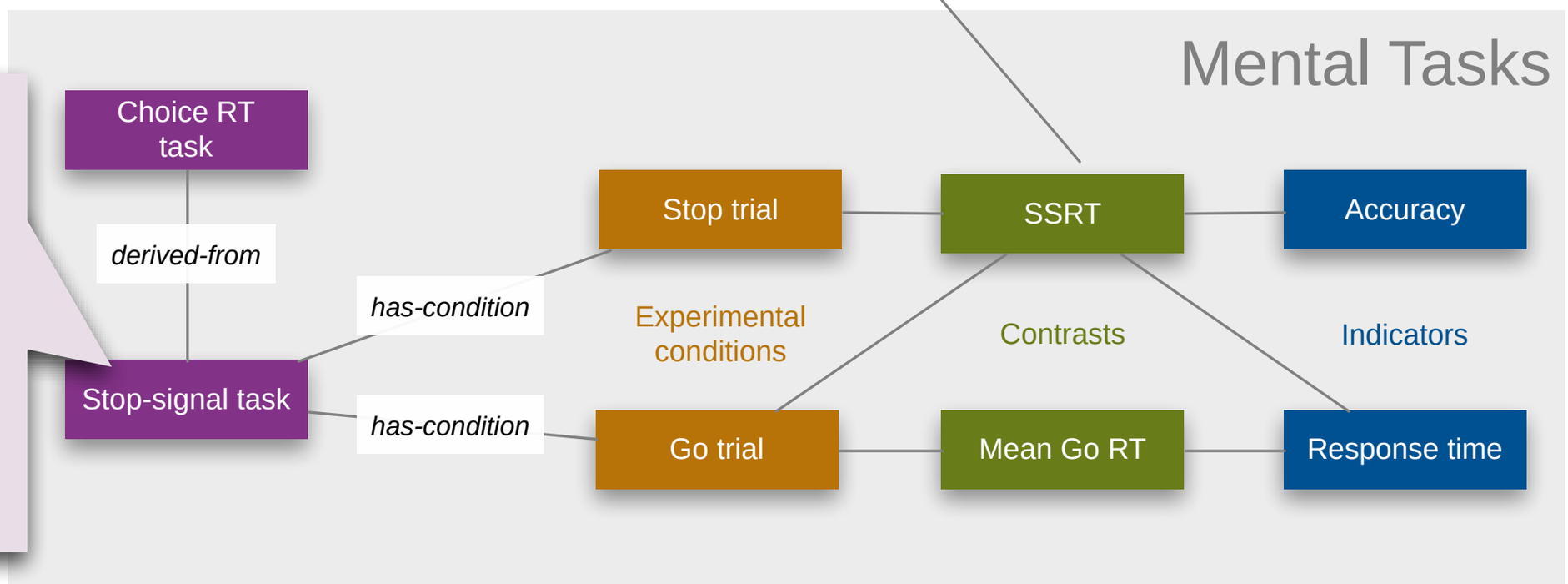


Stop-signal task

A task in which an external stimulus signals the participant to interrupt an already-initiated motor response.

Bibliography

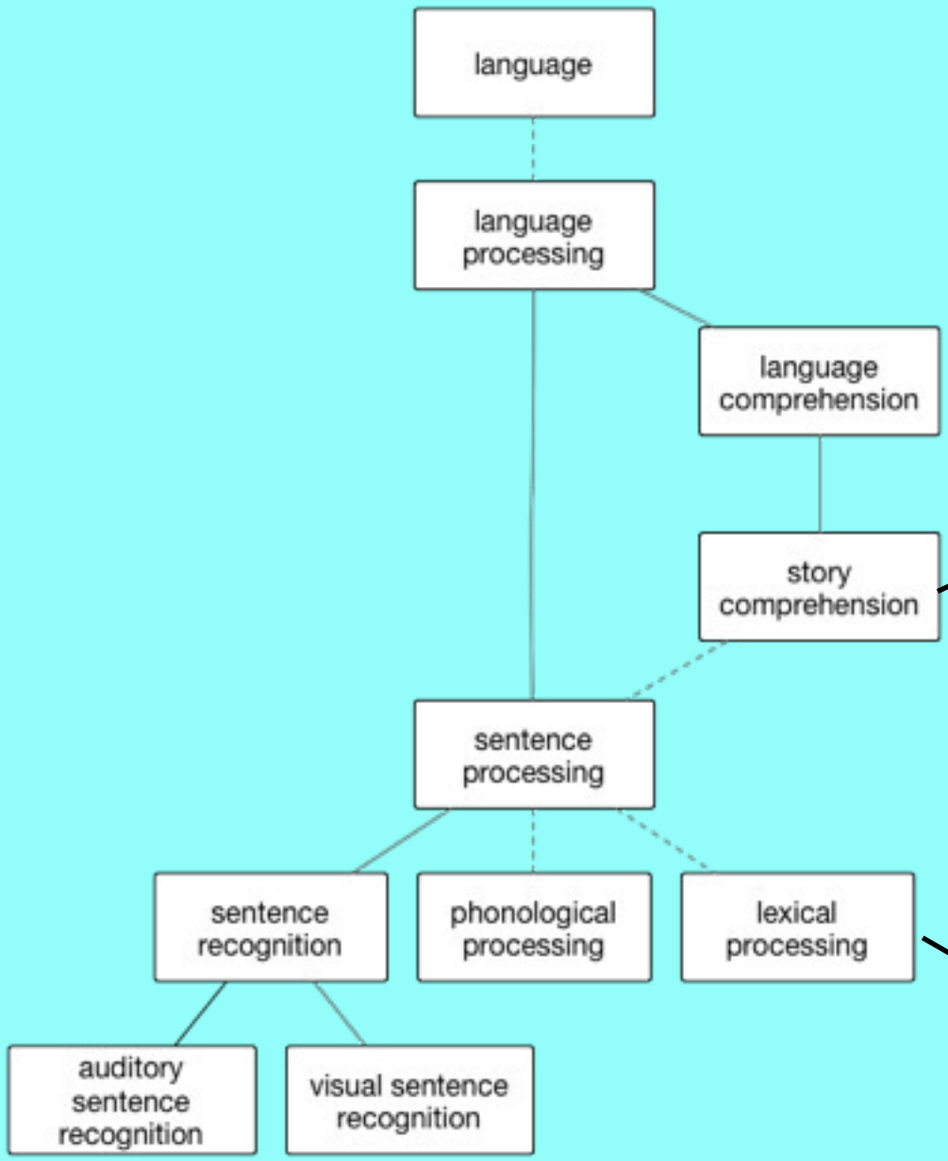
Verbruggen, F., & Logan, G. D. (2008). Response inhibition in the stop-signal paradigm. Trends in Cognitive Sciences, 12, 418-424.



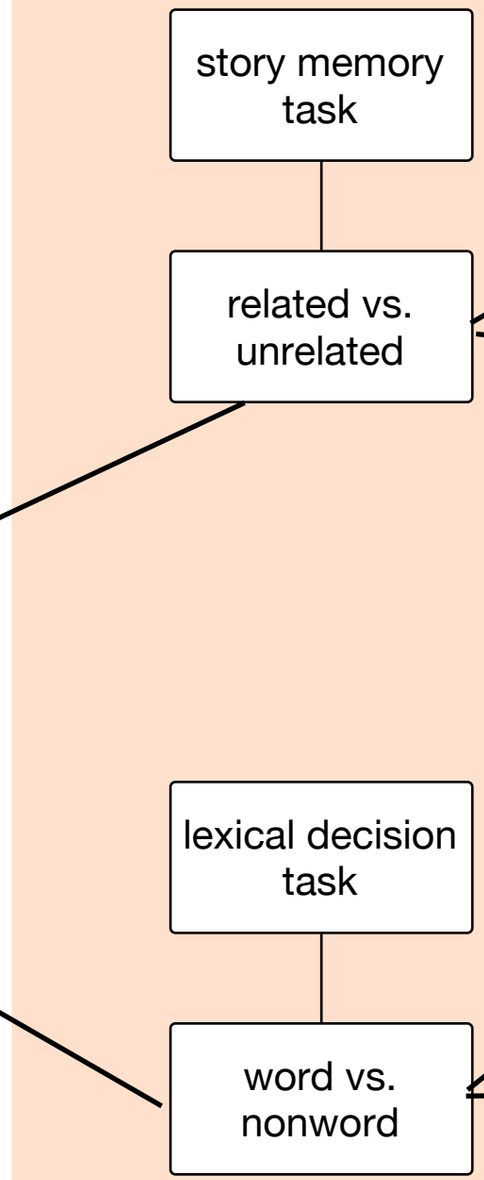
Poldrack et al., 2011, *Frontiers in Neuroinformatics*

Ultimate goal: ontology-enabled meta-analysis

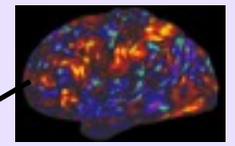
Cognitive processes

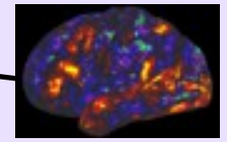


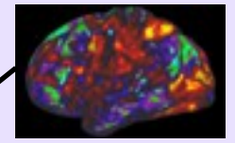
Cognitive tasks

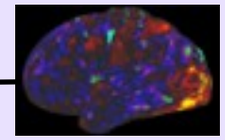


Data

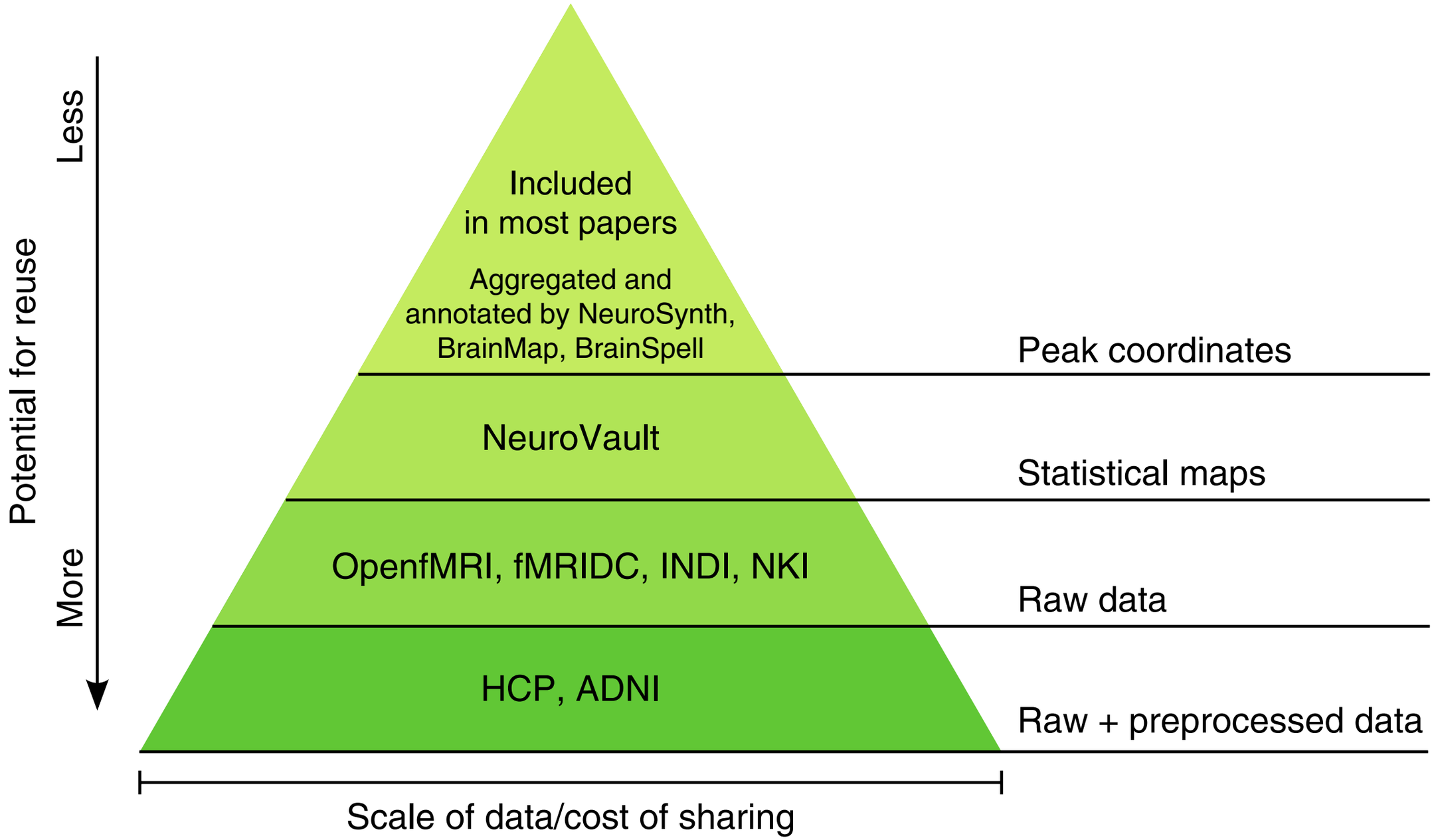








Where will the data come from?



Poldrack & Gorgolewski, 2014

Sharing statistical maps: neurovault.org

NeuroVault Collections FAQ Give feedback Log in

NEUROVAULT

A public repository of unthresholded statistical maps, parcellations, and atlases of the human brain

What is it?

A place where researchers can publicly store and share unthresholded statistical maps, parcellations, and atlases produced by MRI and PET studies.

Why use it?

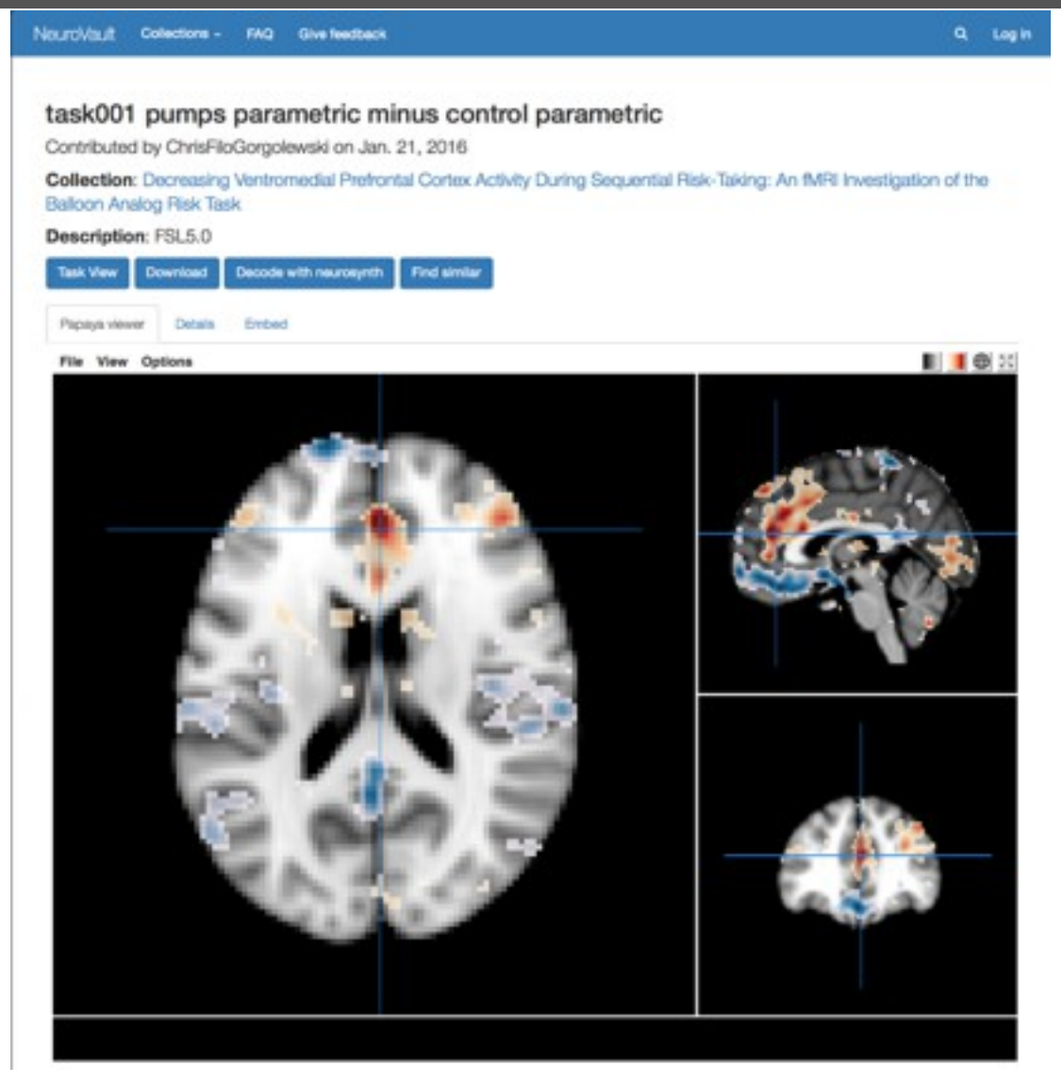
- Interactive visualization
- A permanent URL
- Publicly shareable
- Improves meta-analyses

Supported by

incf Stanford University

Get started and upload an image!

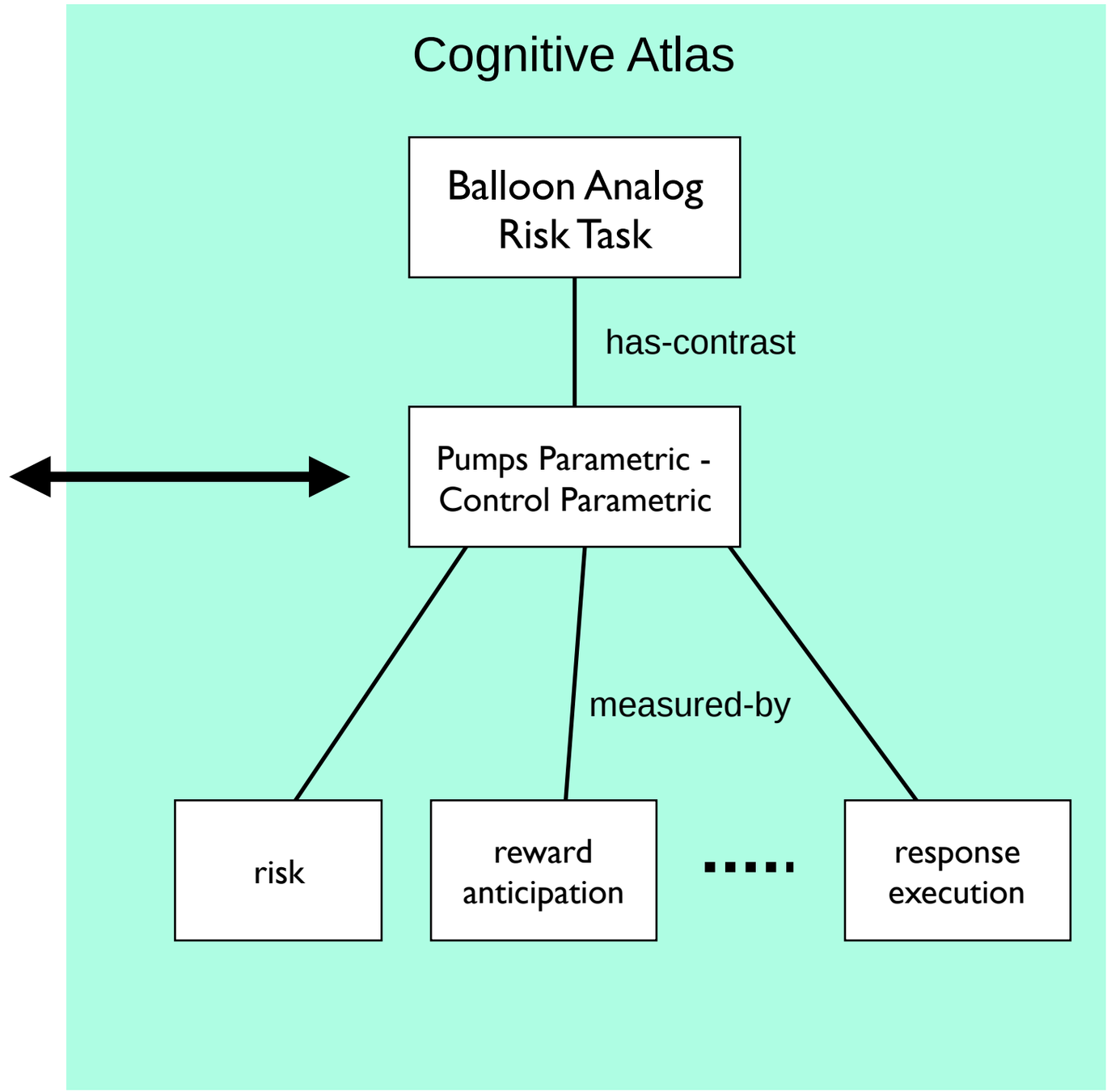
Cognitive Atlas annotation of neurovault data



Papaya viewer | Details | Embed

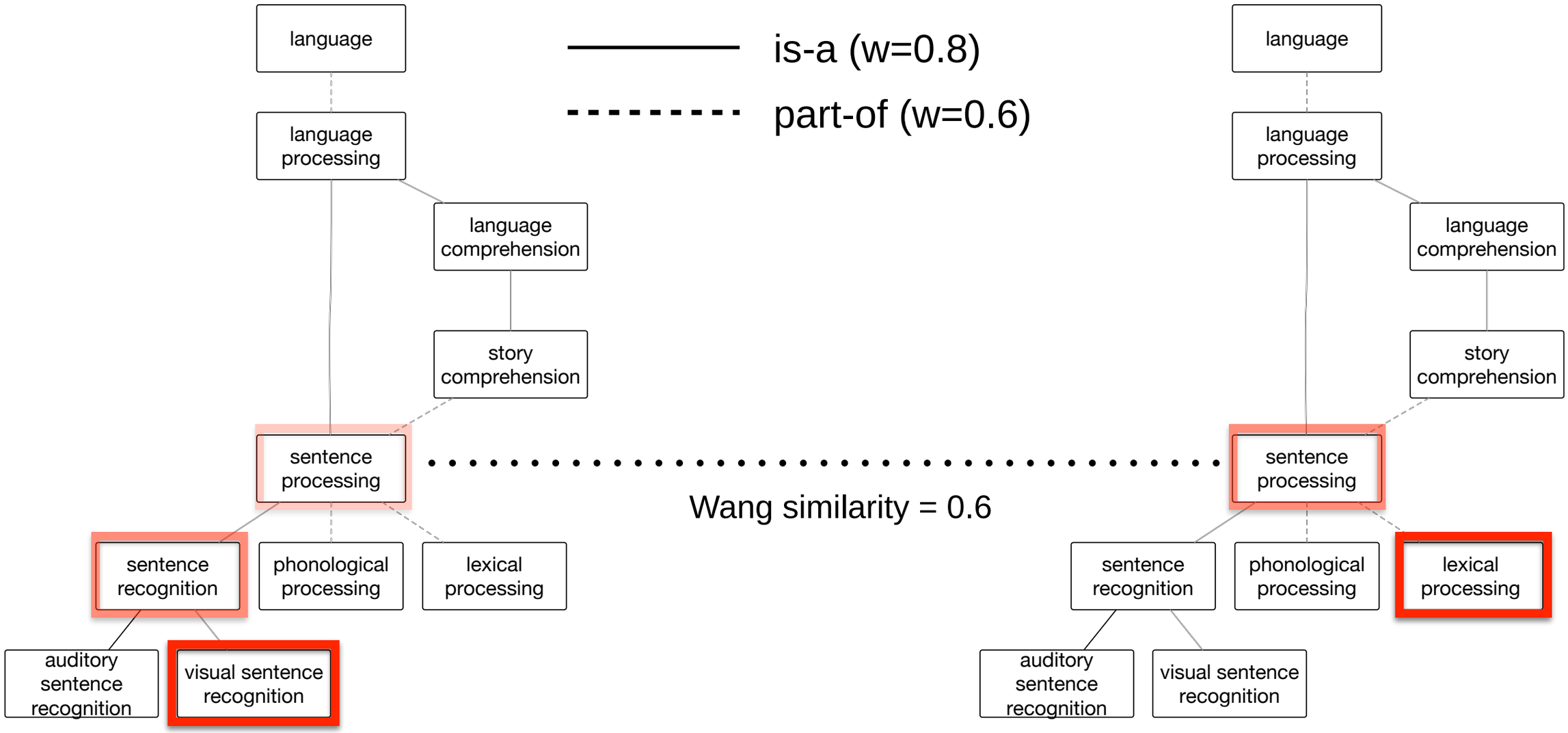
Show 25 entries

Field	Value
analysis_level	group
brain_coverage	99.9623604381945
cognitive_contrast_cogatlas	pumps average
cognitive_contrast_cogatlas_id	cnt_55399f7c60721
cognitive_paradigm_cogatlas	balloon analogue risk task (BART)
cognitive_paradigm_cogatlas_id	trm_4d559bcd67c18



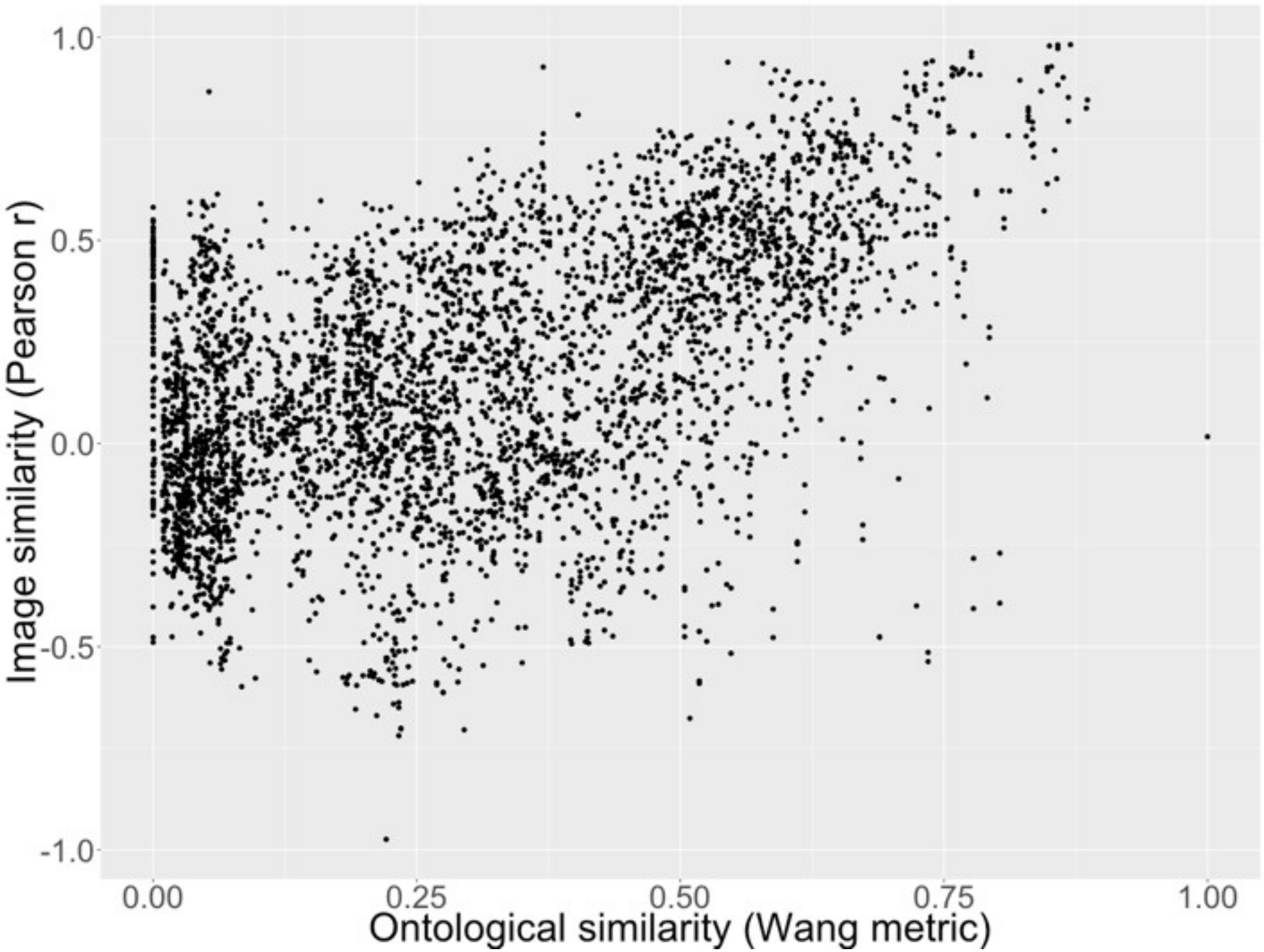
93 task contrasts annotated manually

Does image similarity relate to ontological similarity?



Wang et al., 2007, *Bioinformatics;* Sochat et al., 2015, *Frontiers in Brain Imaging Methods*

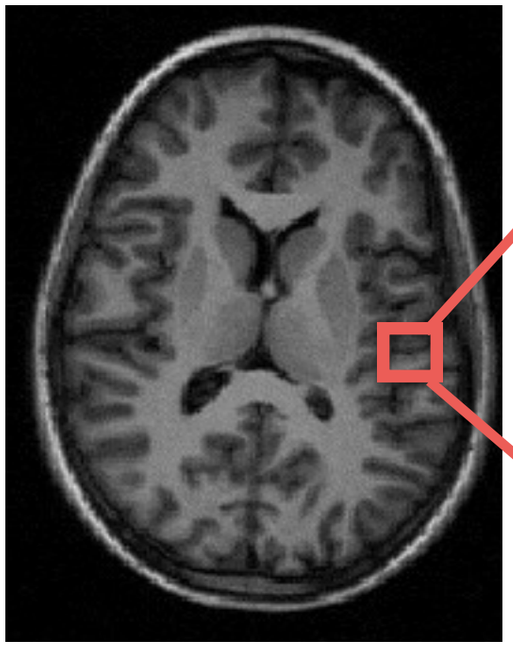
Ontological similarity and image similarity



r=0.514

Sochat et al., in prep

Voxelwise encoding model for cognitive processes



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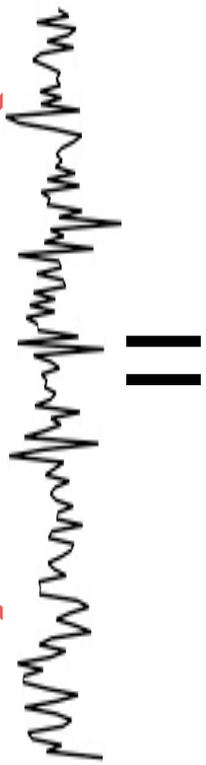
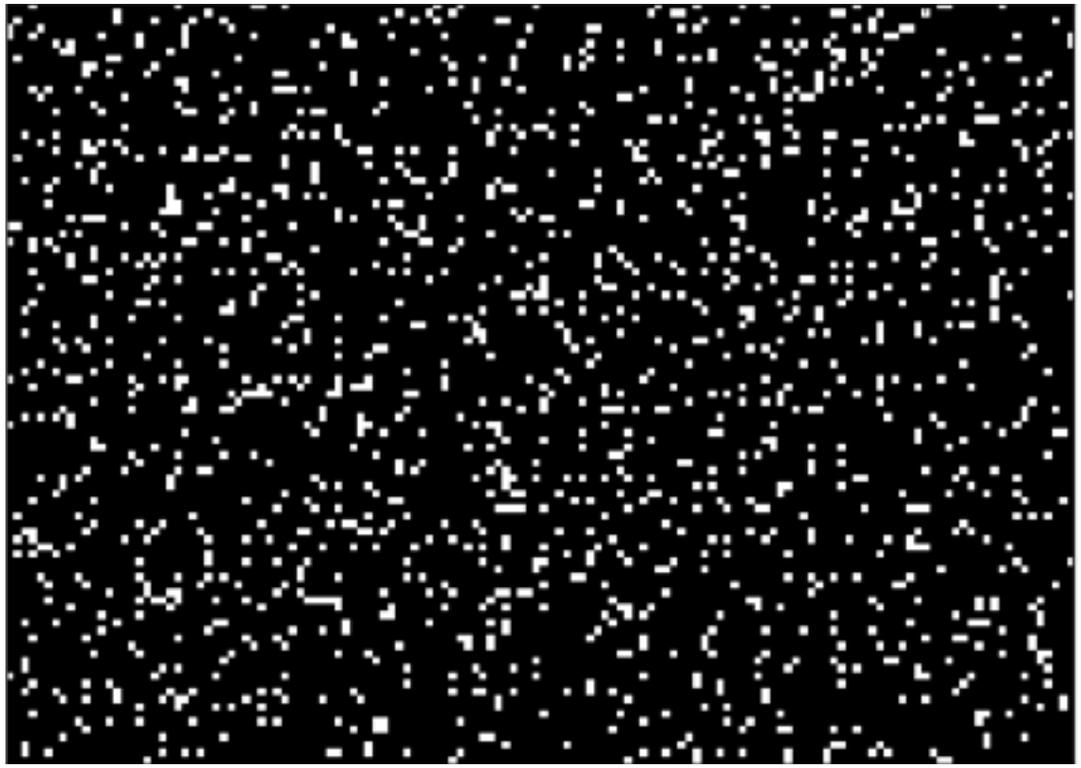


Voxel response
(Z-score)
for each task
contrast

cognitive processes

task contrasts



Ontology encoding for each task contrast
(expanded to include all parent terms)

x **β**

Weighting for
each ontology
element

Estimate **β** using regularized regression (elastic net)

Sochat et al., in prep

Predicting activation maps from cognitive processes

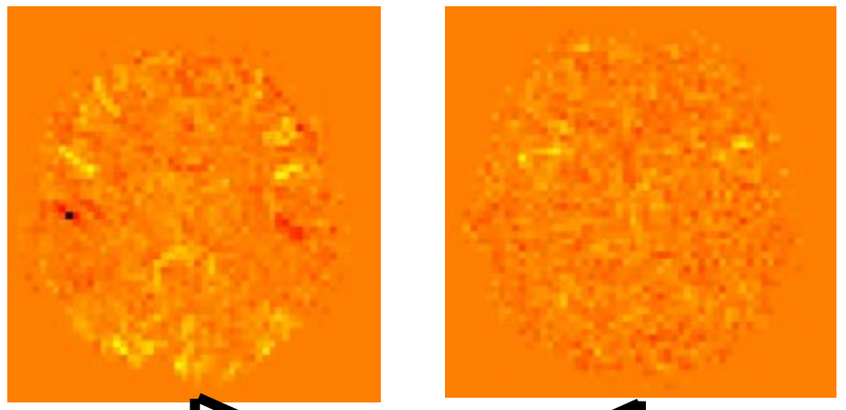
Train encoding model at each voxel (leave-2-out)

β_{voxel}

Test set (2 images)

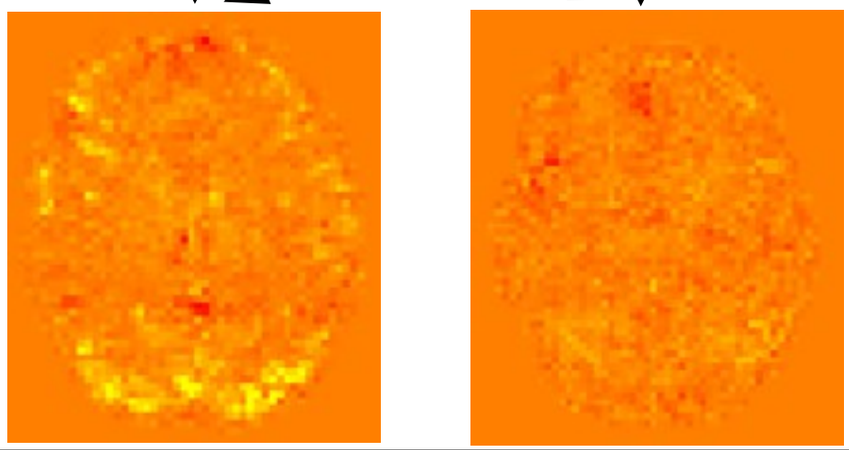
$pred = X_* \beta_{voxel}$

Predicted images



$r_{1,1}$ $r_{1,2}$ $r_{2,1}$ $r_{2,2}$

Actual images



Success:

$r_{1,1} > r_{1,2}$

$r_{2,2} > r_{2,1}$

Sochat et al., in prep

Predicting activation maps from cognitive processes

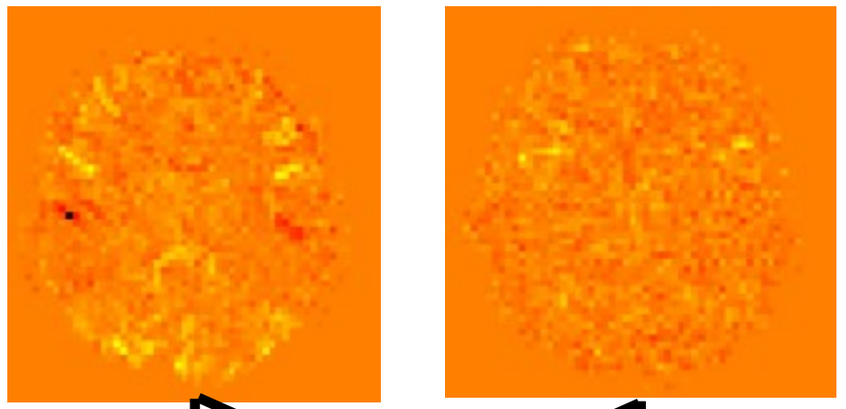
Train encoding model at each voxel (leave-2-out)

β_{voxel}

Test set (2 images)

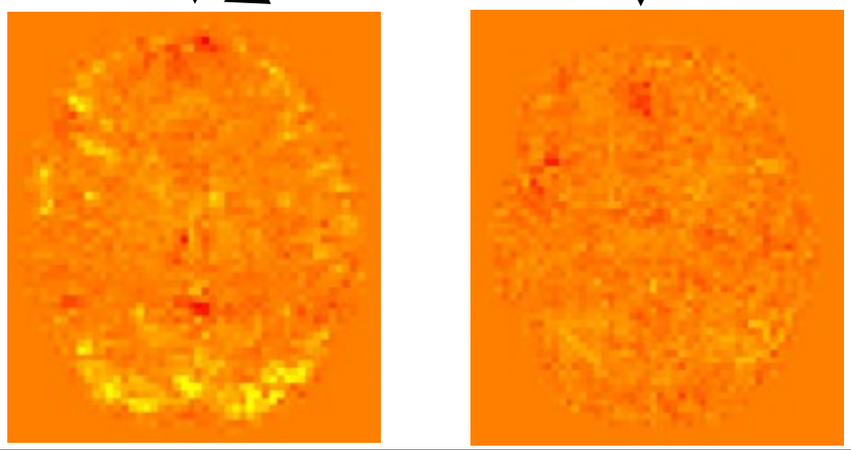
$pred = X_* \beta_{voxel}$

Predicted images



$r_{1,1}$ $r_{1,2}$ $r_{2,1}$ $r_{2,2}$

Actual images



Success:

$r_{1,1} > r_{1,2}$

$r_{2,2} > r_{2,1}$

- 81% correct
  - p<.001 vs null model
- Without ontology expansion:
  - 56% correct

Sochat et al., in prep

Term accuracy (for terms with 10+ images)

response execution	0.95	48
visual object recognition	0.95	11
object recognition	0.93	12
working memory maintenance	0.93	12
decision making	0.92	18
response selection	0.91	45
visual recognition	0.90	52
recognition	0.89	58
memory	0.89	58
visual perception	0.88	56
form perception	0.86	34
visual form recognition	0.86	33
maintenance	0.86	15
perception	0.85	62
proactive control	0.83	10
visual word recognition	0.80	12
word recognition	0.80	12
detection	0.78	12
updating	0.78	14
cognitive control	0.77	27
auditory perception	0.74	10

Sochat et al., in prep

Selective inference: Summary

- Ontology-based meta-analysis provides basis for prediction of maps based on cognitive processes
- To advance we need:
  - More data
  - Better annotated data
  - A better ontology?
    - How would we know if ours is wrong?

What if the phrenologists had fMRI?

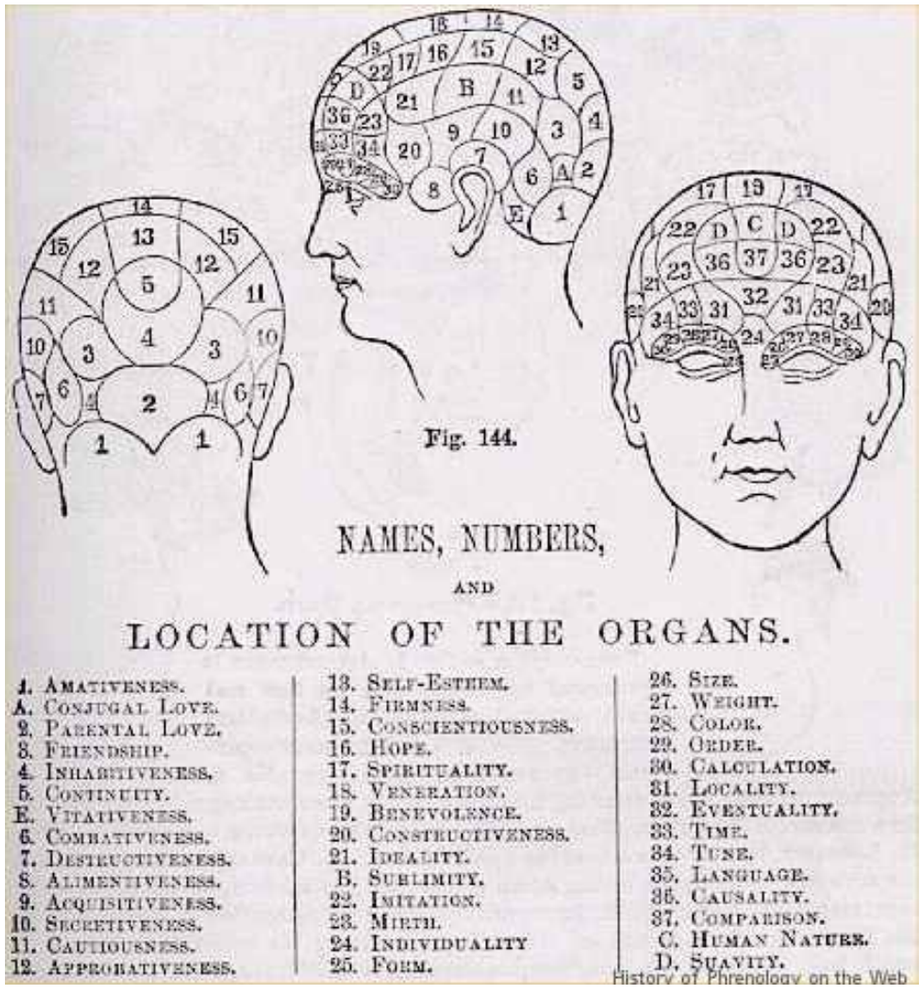


Fig. 144.

NAMES, NUMBERS,

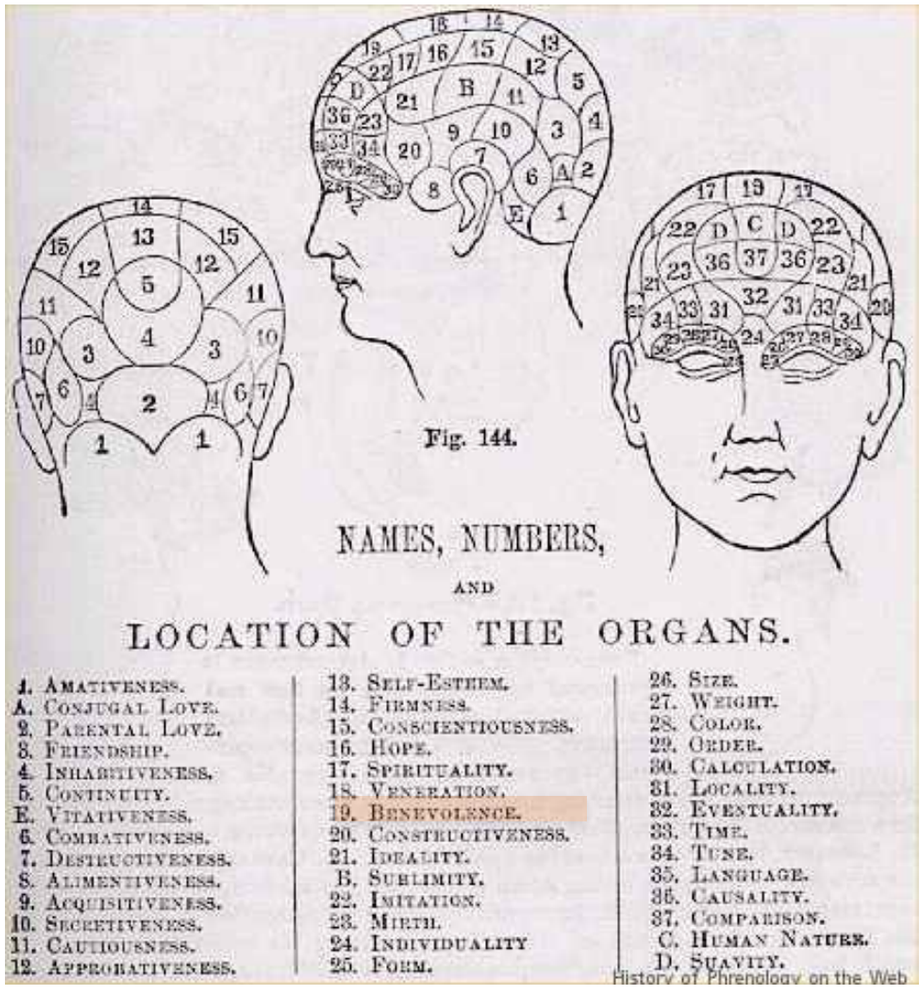
AND

LOCATION OF THE ORGANS.

1. Amativeness.
A. Conjugal Love.
2. Parental Love.
3. Friendship.
4. Inhabitiveness.
5. Continuity.
E. Vitativeness.
6. Combativeness.
7. Destructiveness.
8. Alimentiveness.
9. Acquisitiveness.
10. Secretiveness.
11. Cautiousness.
12. Approbativeness.
13. Self-Esteem.
14. Firmness.
15. Conscientiousness.
16. Hope.
17. Spirituality.
18. Veneration.
19. Benevolence.
20. Constructiveness.
21. Ideality.
B. Sublimity.
22. Imitation.
23. Mirth.
24. Individuality
25. Form.
26. Size.
27. Weight.
28. Color.
29. Order.
30. Calculation.
31. Locality.
32. Eventuality.
33. Time.
34. Tune.
35. Language.
36. Causality.
37. Comparison.
C. Human Nature.
D. Suavity.

History of Phrenology on the Web

What if the phrenologists had fMRI?



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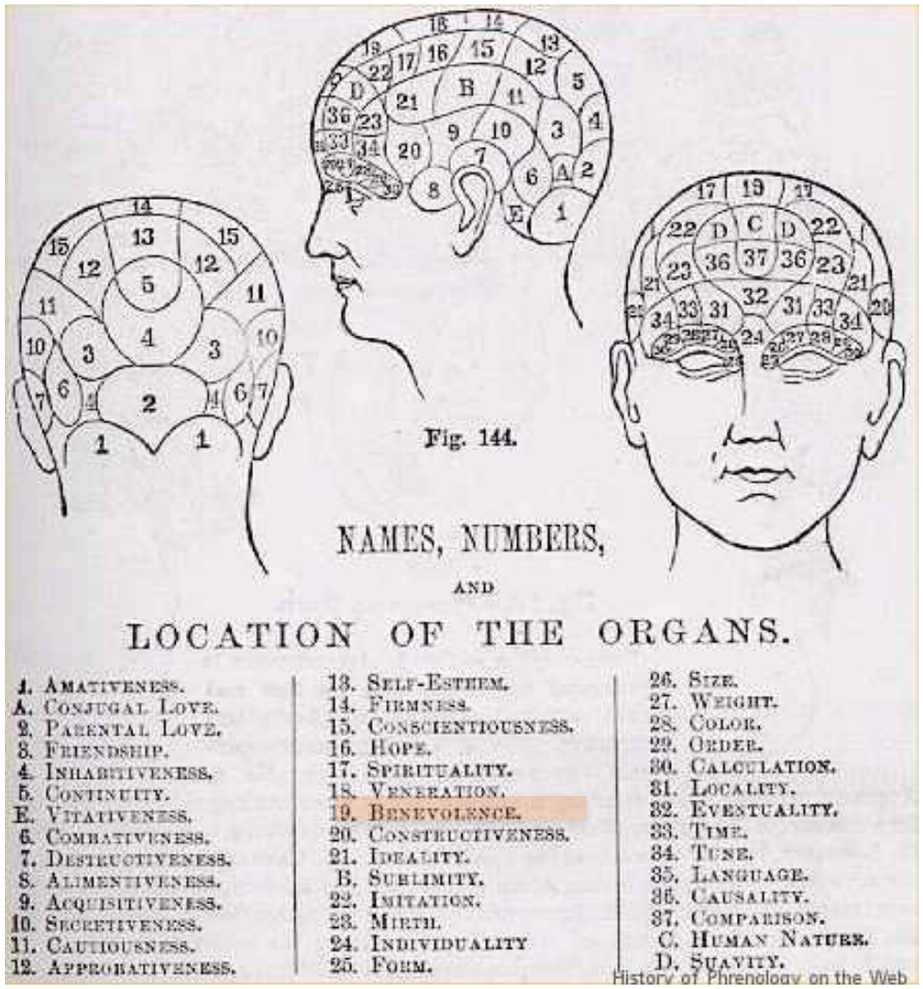

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History of Phrenology on the Web

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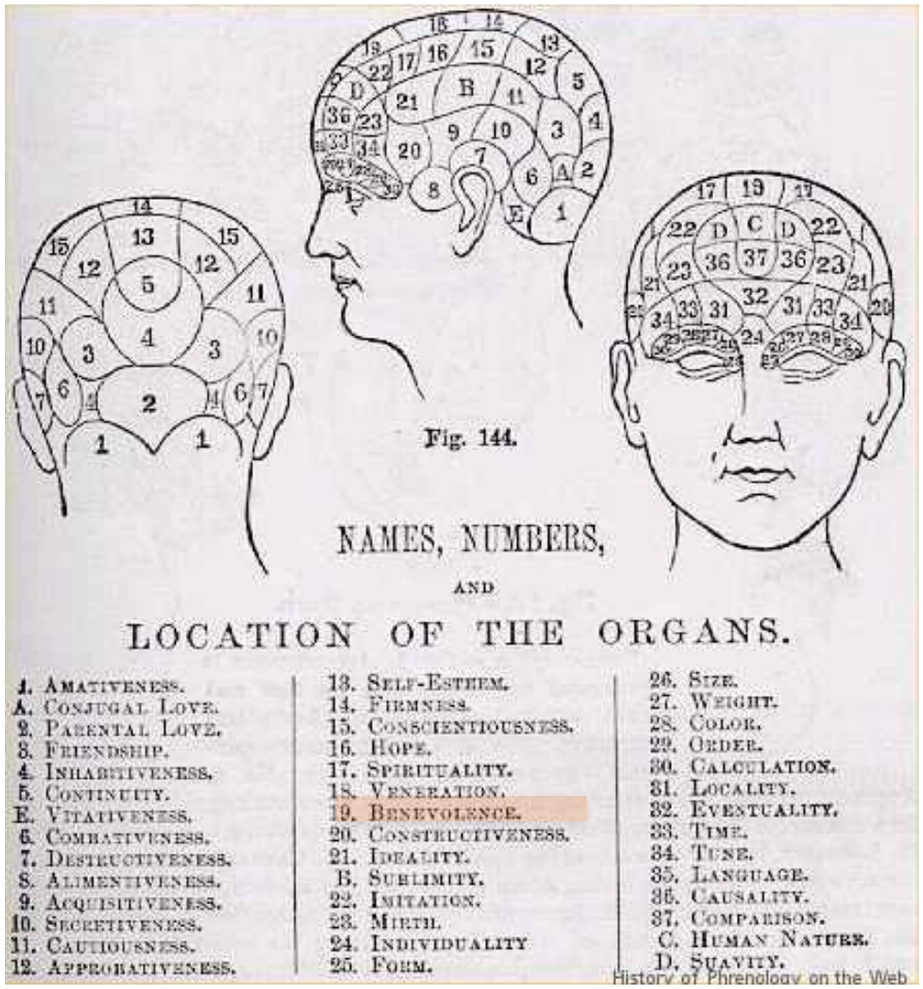

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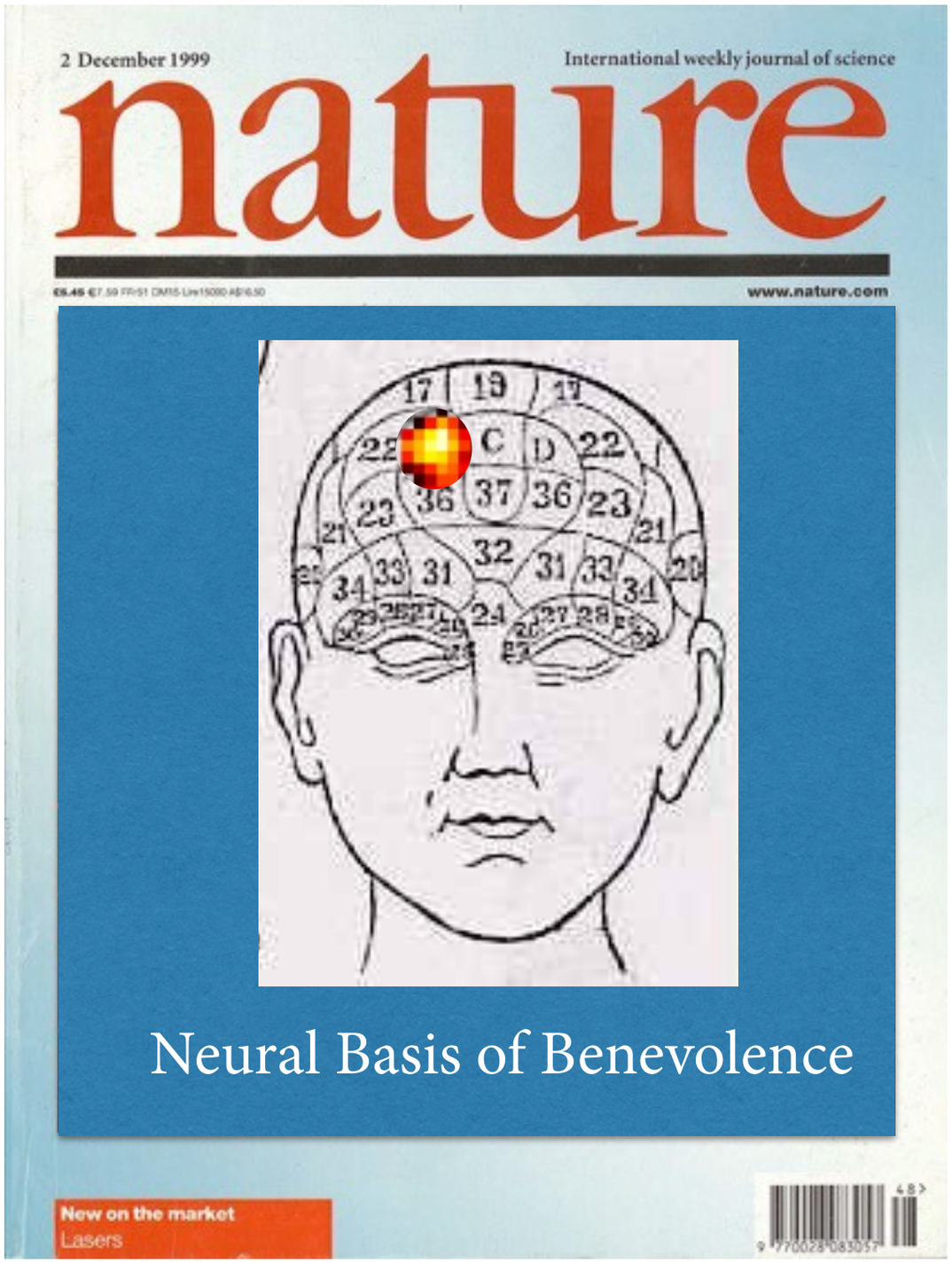
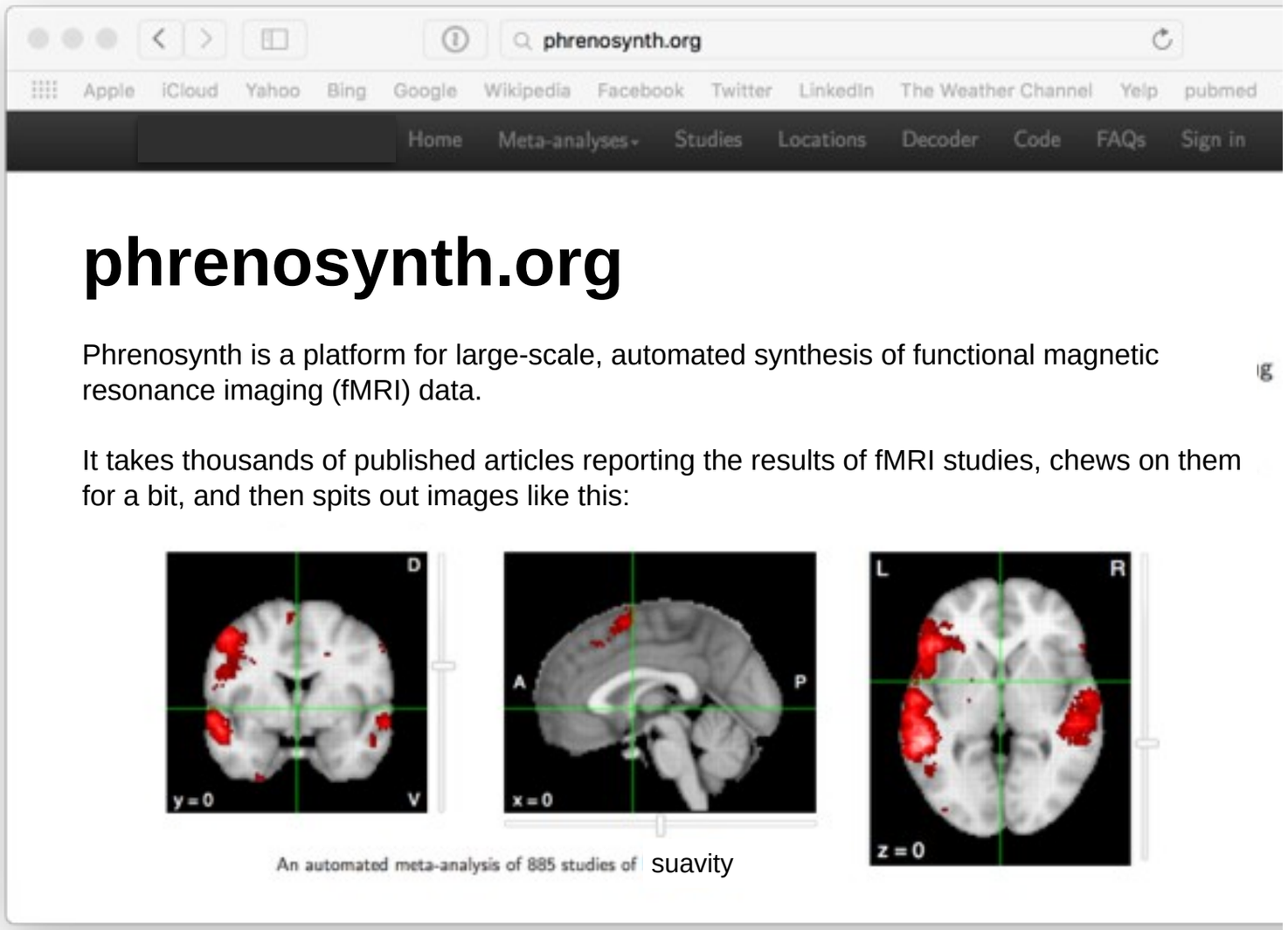
History of Phrenology on the Web

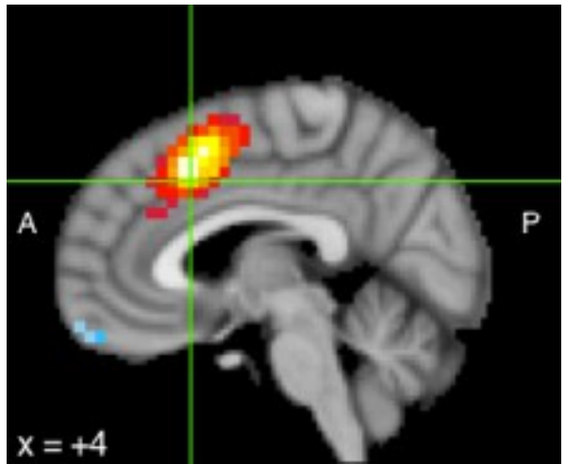


Franz Yarkoni

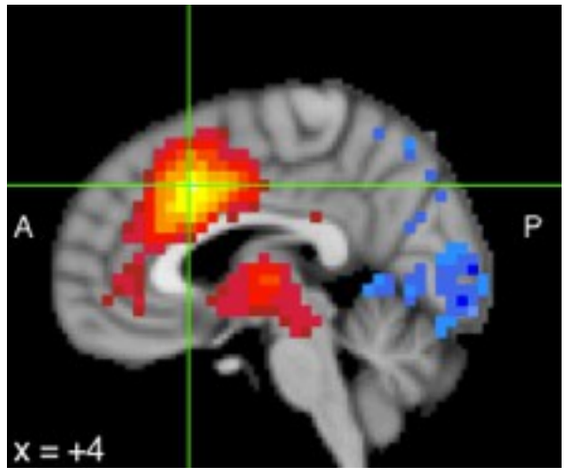


“Multiple demand” areas: Phrenosynth

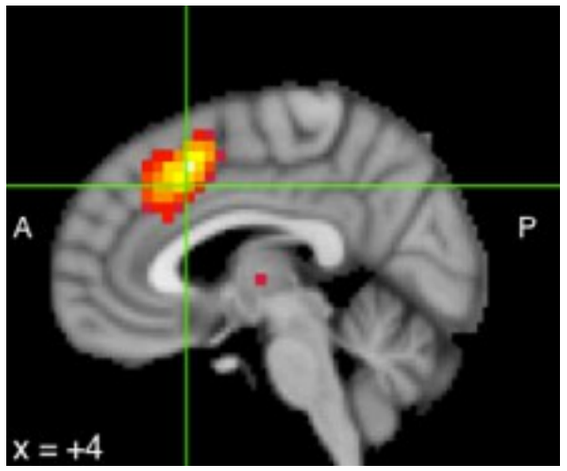
benevolence



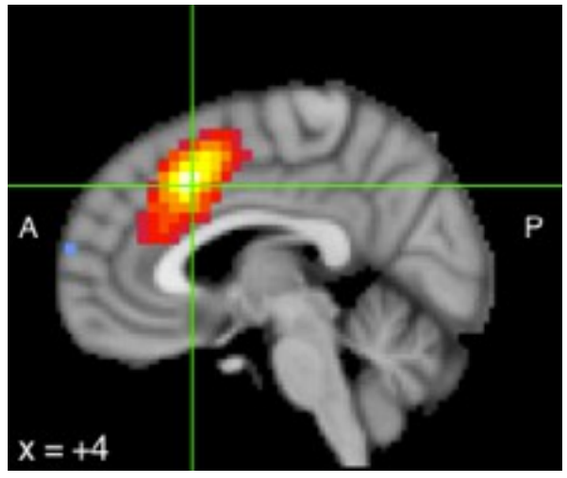
mirth



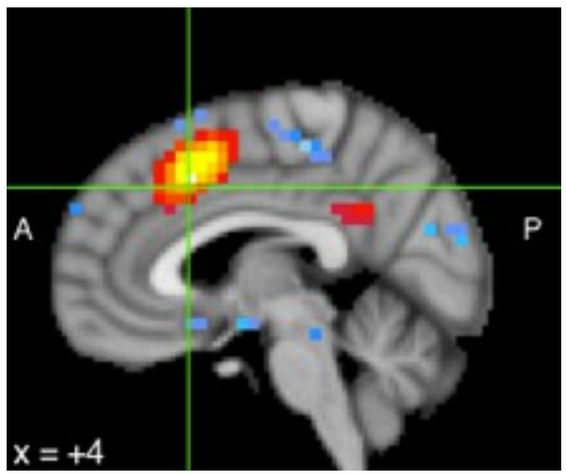
ideality



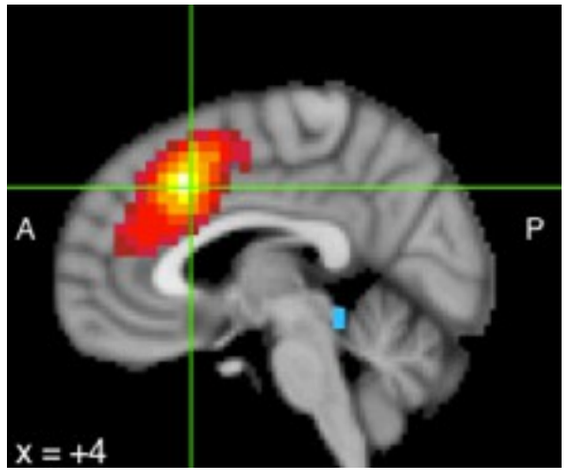
sublimity



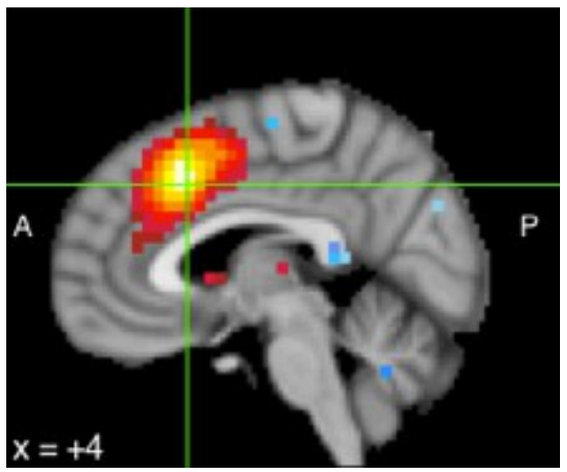
conjugal love



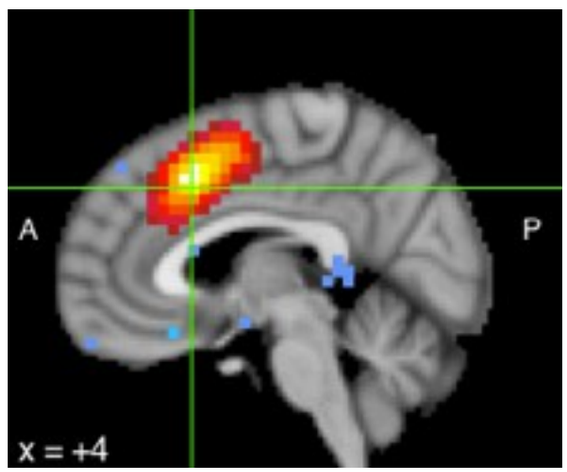
firmness



human nature

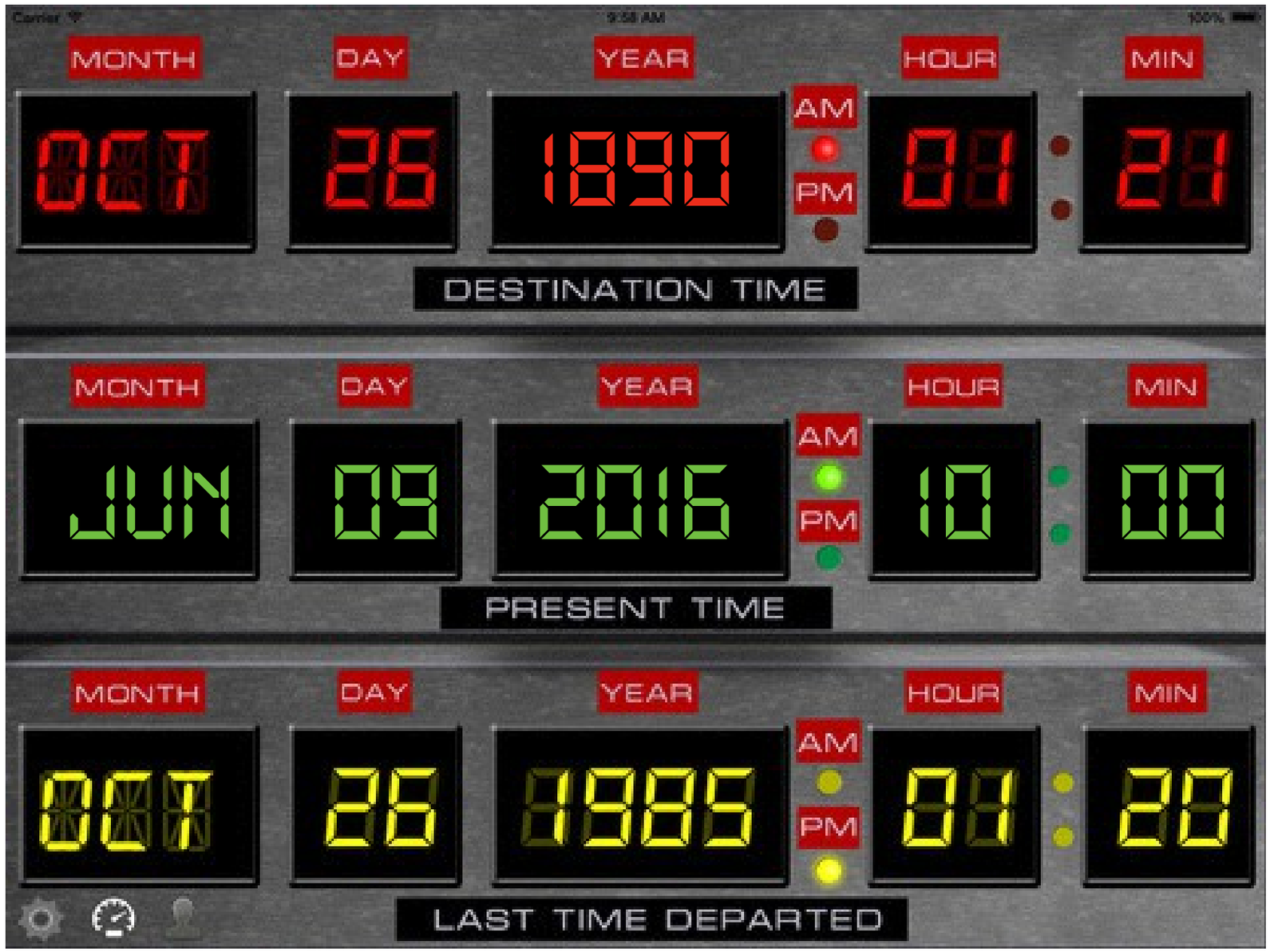


suavity



- Activation imaging may not tell us whether our current ontology is wrong
  - Or maybe it already is telling us that!
- What reason do we have to think that our ontology might be wrong or incomplete?

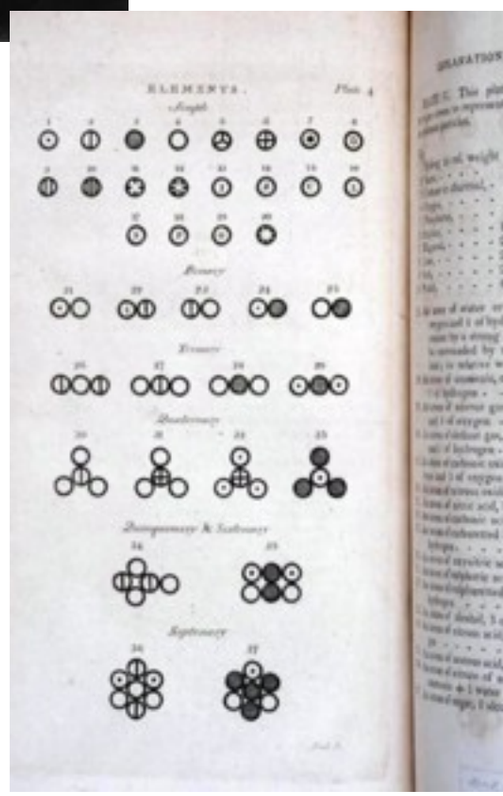
Hop in the time machine…



1890 in science

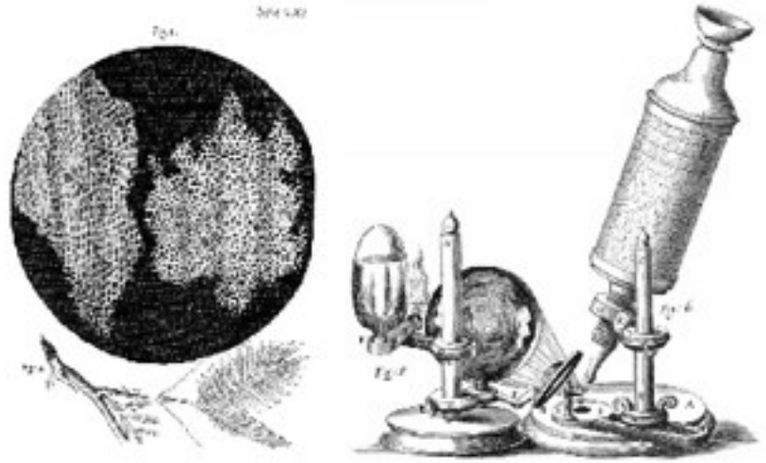
- Chemistry:
  - Intense debate over the atomic theory
  - Ernst Mach (1897): “"I don't believe that atoms exist!”
  - not settled until Einstein (1905)

John Dalton
(credit: wikipedia.org)



1890 in science

- Biology
  - Cell theory (proposed in 1839) and germ theory of disease (1860's) finally accepted by most biologists

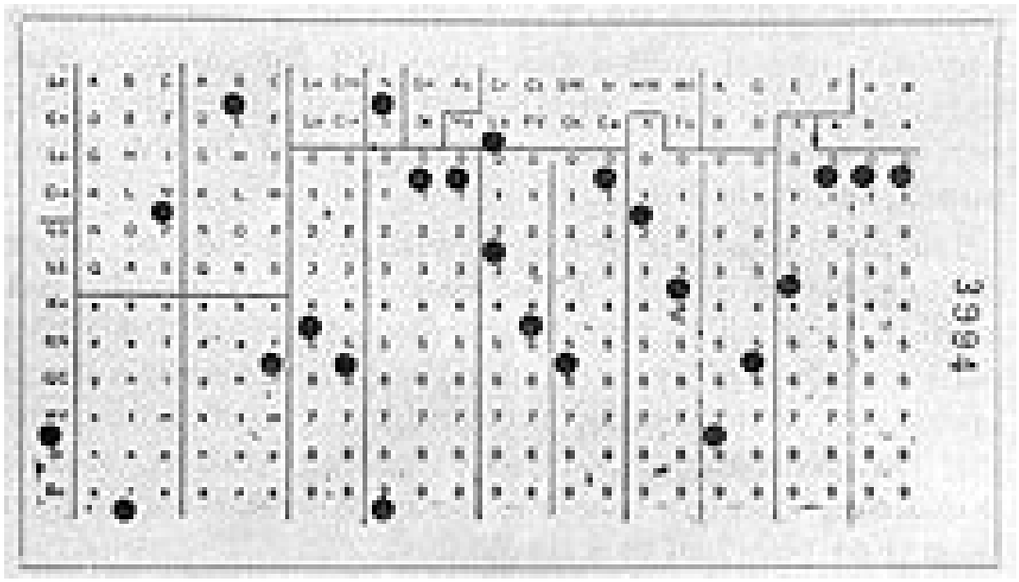


  - Heredity not understood
    - Mendel's work would not be rediscovered for 10 more years

1890 in science

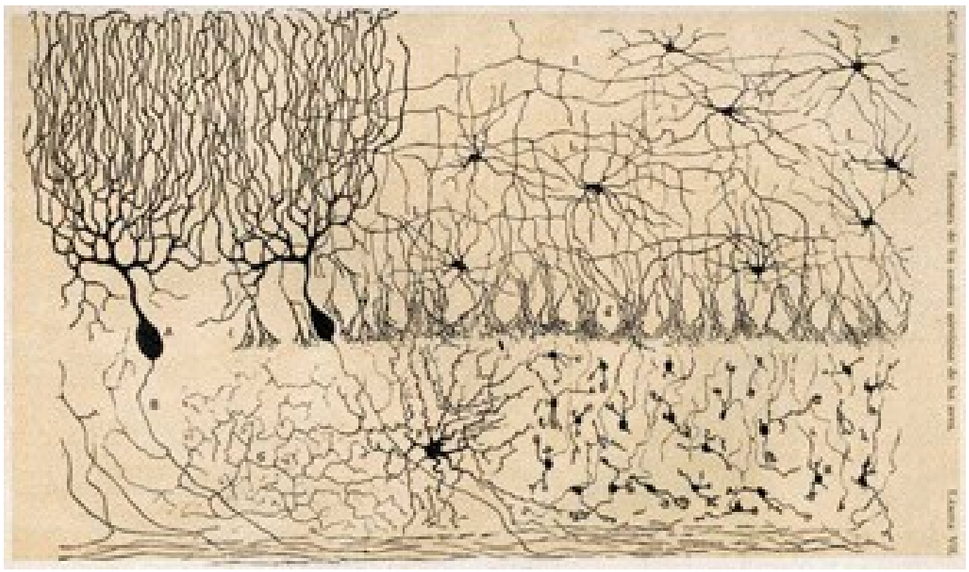
- Computer science
  - Hollerith's mechanical "tabulating machine" used by US Census for first time
  - General-purpose programming languages would not appear for 50 more years

credit: wikipedia.org



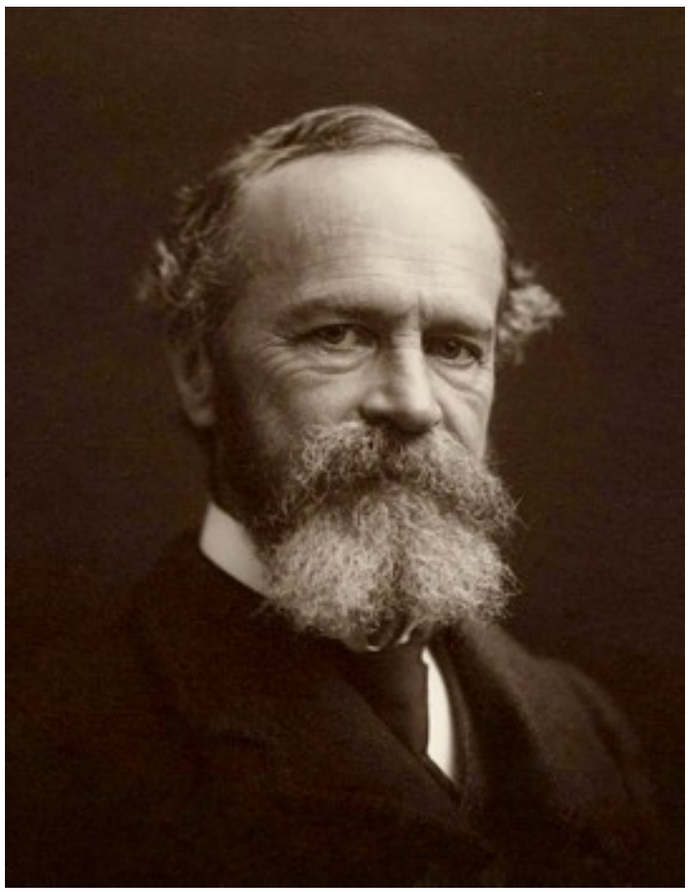
1890 in science

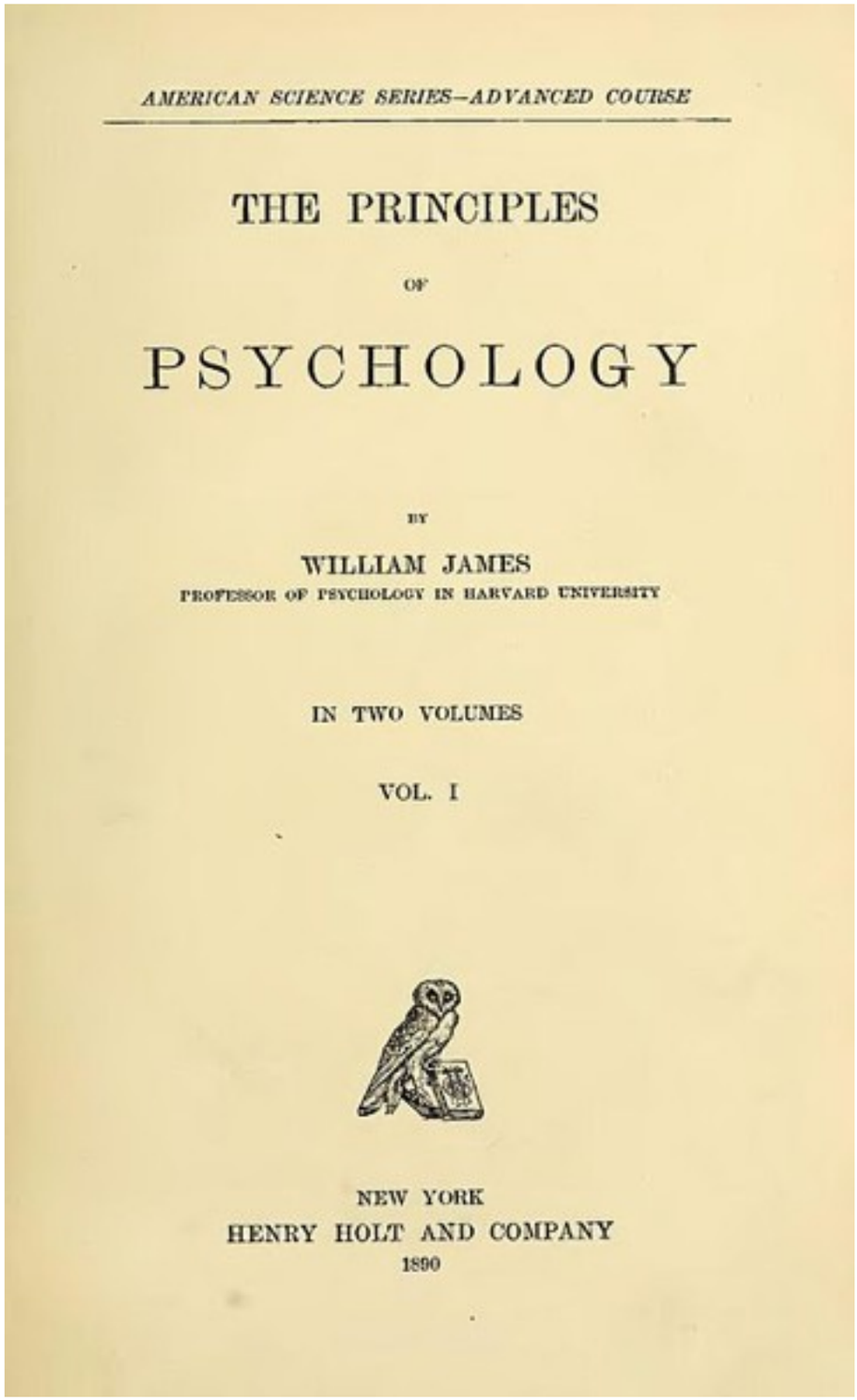
- Neuroscience
  - Ramon y Cajal (1888) provides first evidence for neuron doctrine over the reticular theory



The 1890's in science

- Psychology
  - William James' *Principles of Psychology*





AMERICAN SCIENCE SERIES—ADVANCED COURSE

THE PRINCIPLES

OF

PSYCHOLOGY

BY

WILLIAM JAMES

PROFESSOR OF PSYCHOLOGY IN HARVARD UNIVERSITY

IN TWO VOLUMES

VOL. I

NEW YORK

HENRY HOLT AND COMPANY

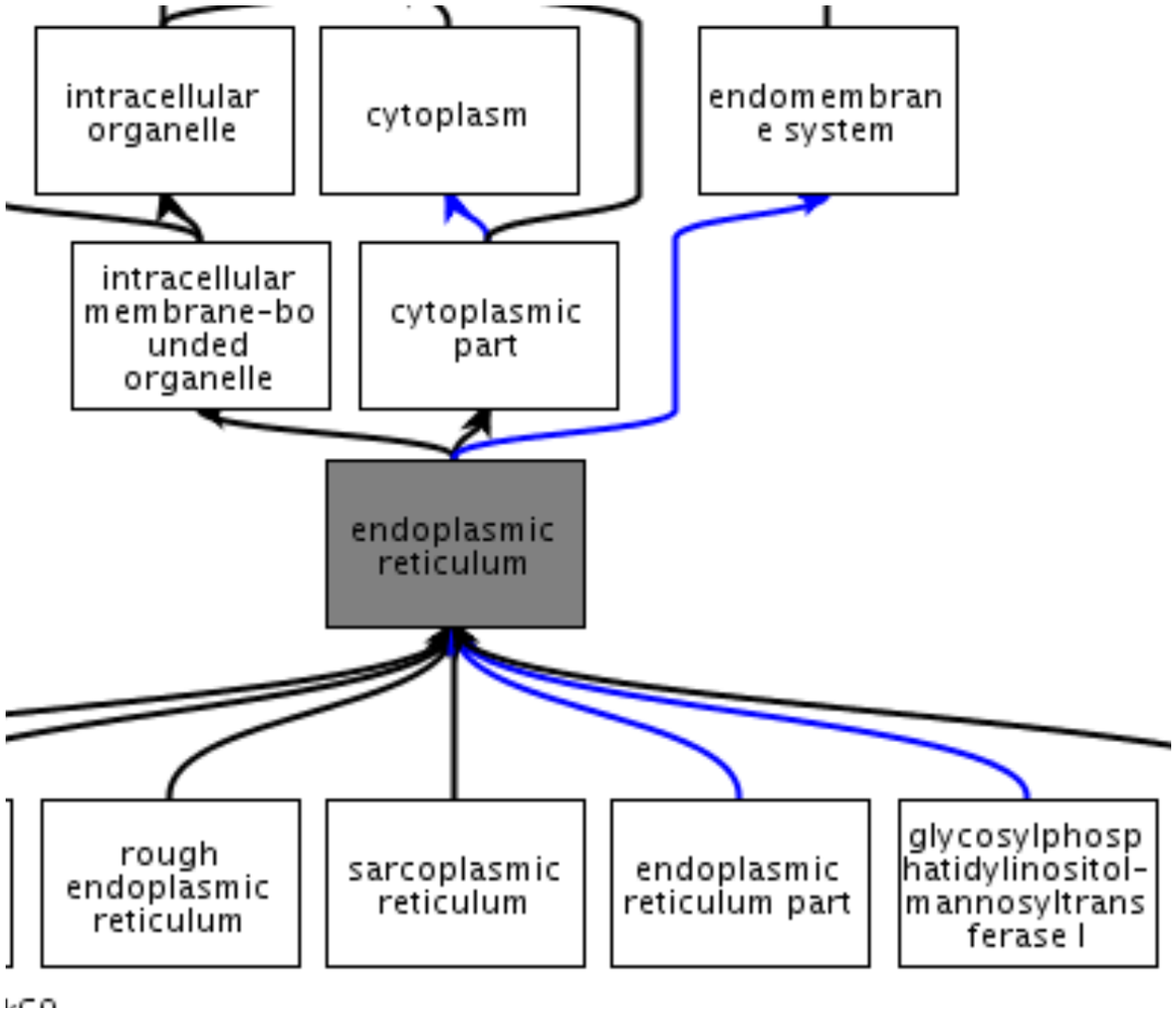
1890

Topic headings from James, 1890

- “To How Many Things Can We Attend At Once?”
- “The Varieties Of Attention.”
- “The Improvement Of Discrimination By Practice”
- “The Perception Of Time.”
- “Accuracy Of Our Estimate Of Short Durations”
- “To What Cerebral Process Is The Sense Of Time Due?”
- “Forgetting.”
- “The Neural Process Which Underlies Imagination”
- “Is Perception Unconscious Inference?”
- “How The Blind Perceive Space.”
- “Emotion Follows Upon The Bodily Expression In The Coarser Emotions At Least.”
- “No Special Brain-Centres For Emotion”
- “Action After Deliberation”

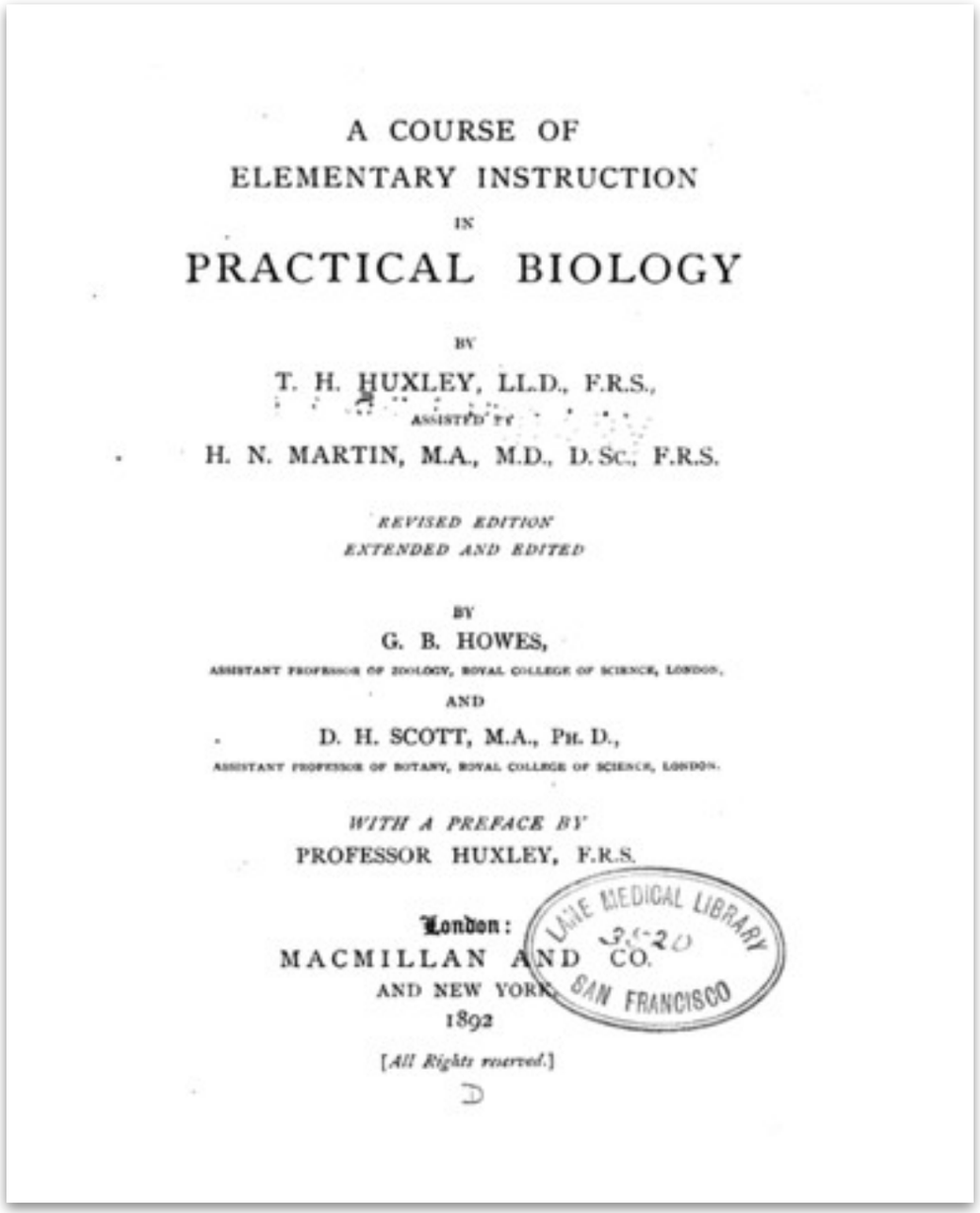
What does a conceptual revolution look like?

- Gene Ontology
  - A formal description of concepts in biology and their relations
    - biological processes (28,566)
      - MAPK cascade *is-a-kind-of* intracellular signal transduction
      - signal transduction *is-a-part-of* cell communication
    - molecular functions (10,057)
      - RNA polymerase II core binding *is-a-kind-of* protein complex binding
    - cellular components (3,903)
      - endoplasmic reticulum *is-a-kind-of* cytoplasmic part
      - Golgi apparatus *is-a-part-of* endomembrane system



from QuickGO: http://www.ebi.ac.uk/QuickGO/

1890's biology textbooks



A COURSE OF
ELEMENTARY INSTRUCTION
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PRACTICAL BIOLOGY

BY
T. H. HUXLEY, LL.D., F.R.S.,
ASSISTED BY
H. N. MARTIN, M.A., M.D., D.Sc., F.R.S.

REVISED EDITION
EXTENDED AND EDITED

BY
G. B. HOWES,
ASSISTANT PROFESSOR OF ZOOLOGY, ROYAL COLLEGE OF SCIENCE, LONDON,
AND
D. H. SCOTT, M.A., PH. D.,
ASSISTANT PROFESSOR OF BOTANY, ROYAL COLLEGE OF SCIENCE, LONDON.

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1892

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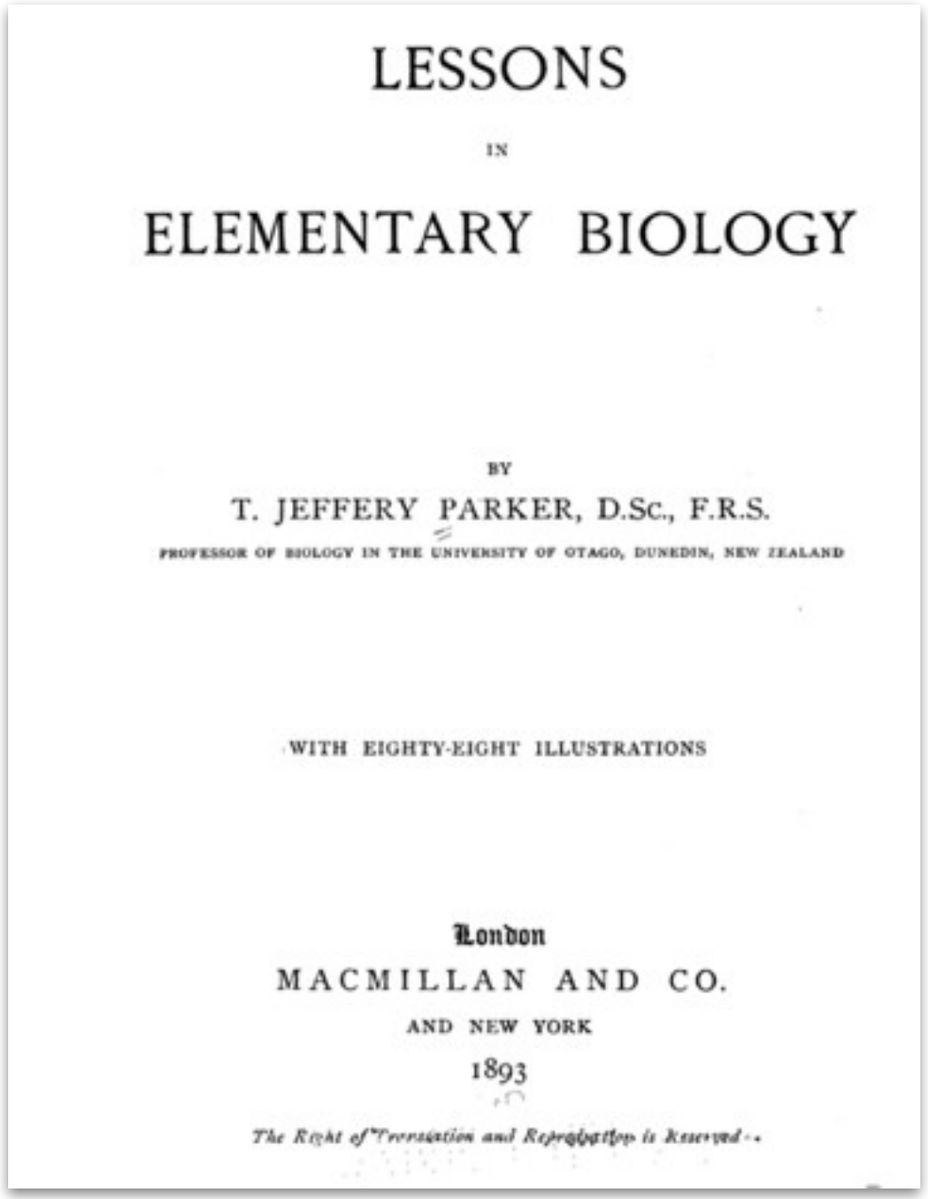

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BY
T. JEFFERY PARKER, D.Sc., F.R.S.
PROFESSOR OF BIOLOGY IN THE UNIVERSITY OF OTAGO, DUNEDIN, NEW ZEALAND

WITH EIGHTY-EIGHT ILLUSTRATIONS

London
MACMILLAN AND CO.
AND NEW YORK
1893

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408 pages

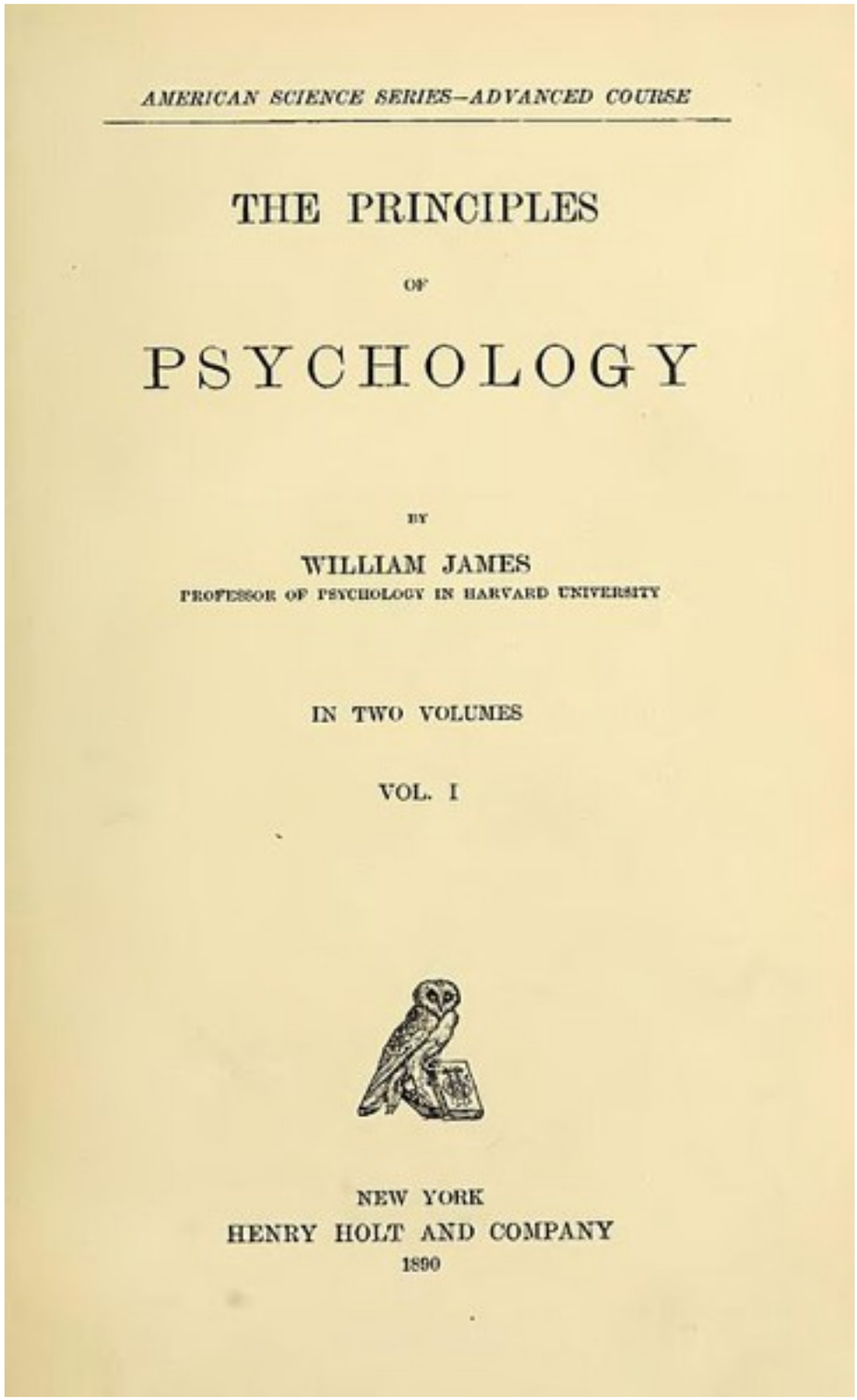
Linguistic evidence for conceptual revolution

- What proportion of Gene Ontology terms are mentioned in these books?

	Huxley	Parker	Overlap
biological process (28,566)	0.09% (26)	0.1% (32)	20
molecular function (10,057)	0 (0)	0 (0)	—
cellular component (3,903)	1.05% (41)	1.01% (40)	25

How much conceptual progress has psychology made?

- 22.9% of all Cognitive Atlas mental concepts are used at least once in James' Principles of Psychology
- Examples:
  - goal, deductive reasoning, effort, false memory, object perception, visual attention, task set, anxiety, mental imagery, unconscious perception, internal speech, primary memory, theory of mind, judgment



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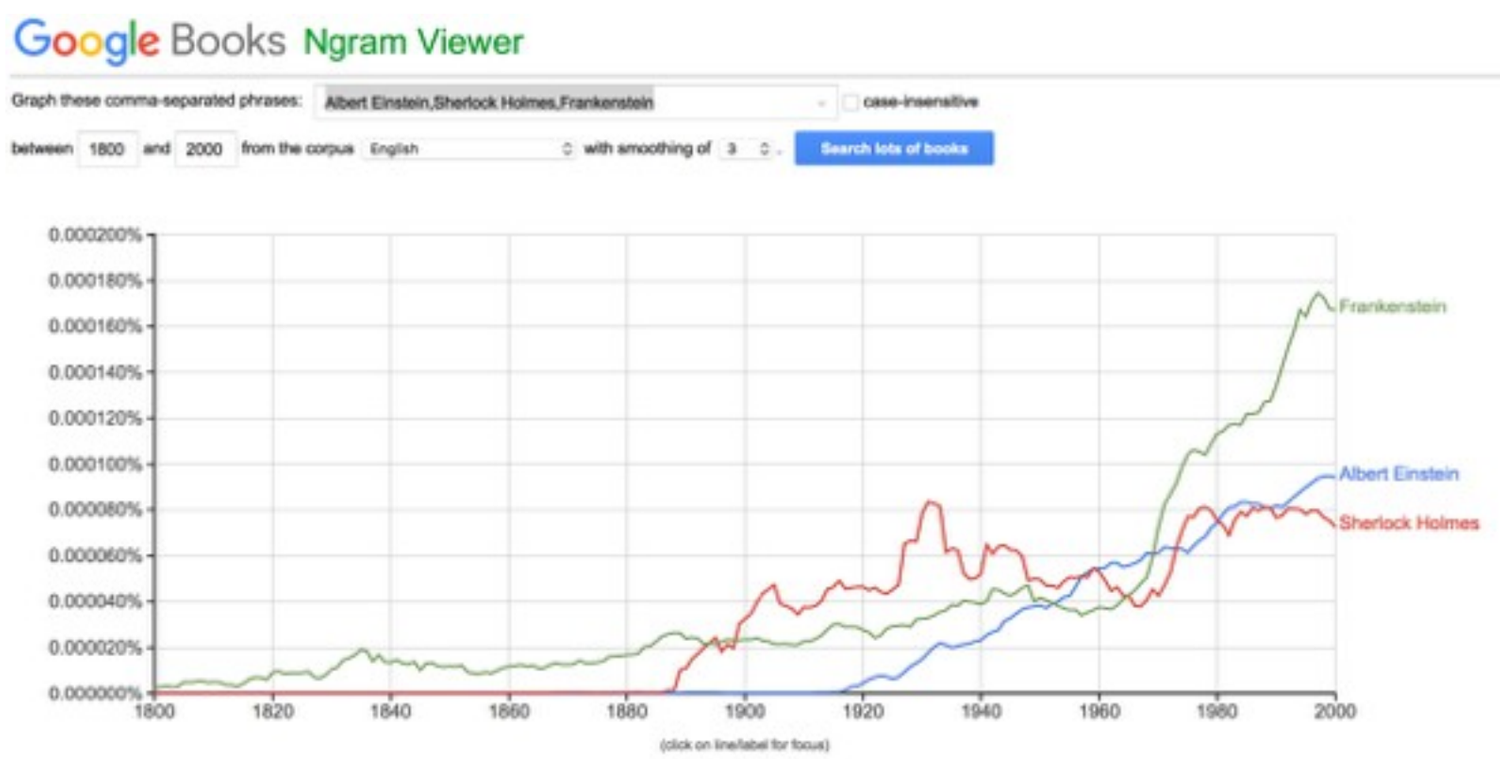
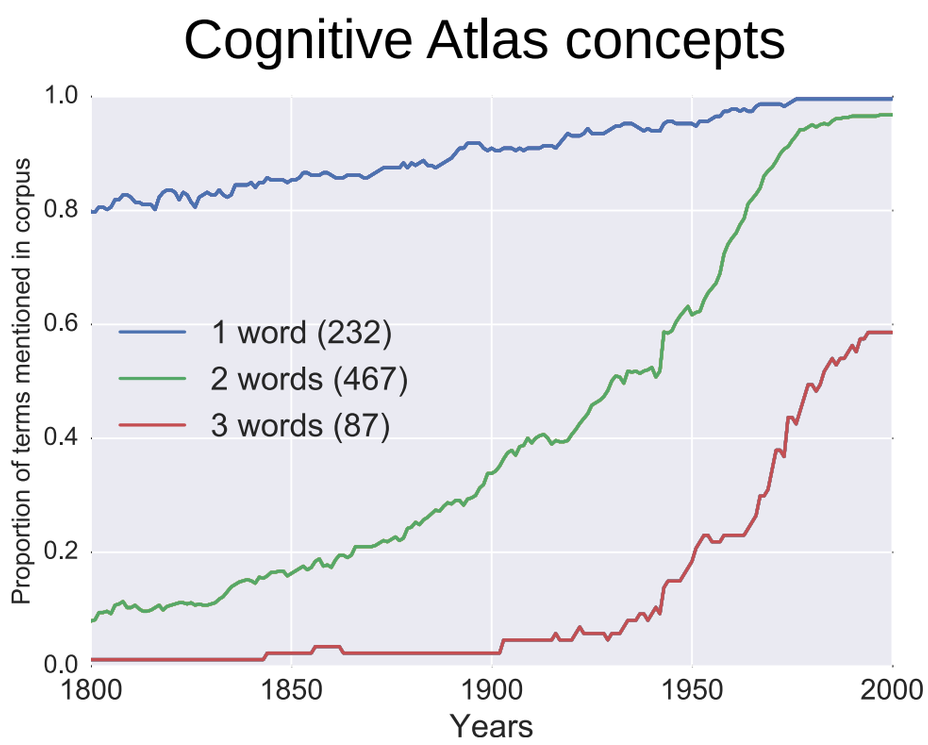
A broader view: Folk usage of ontology terms

- Analyzed Google N-Gram corpus (3.38 million books) for term mentions from 1800-2000

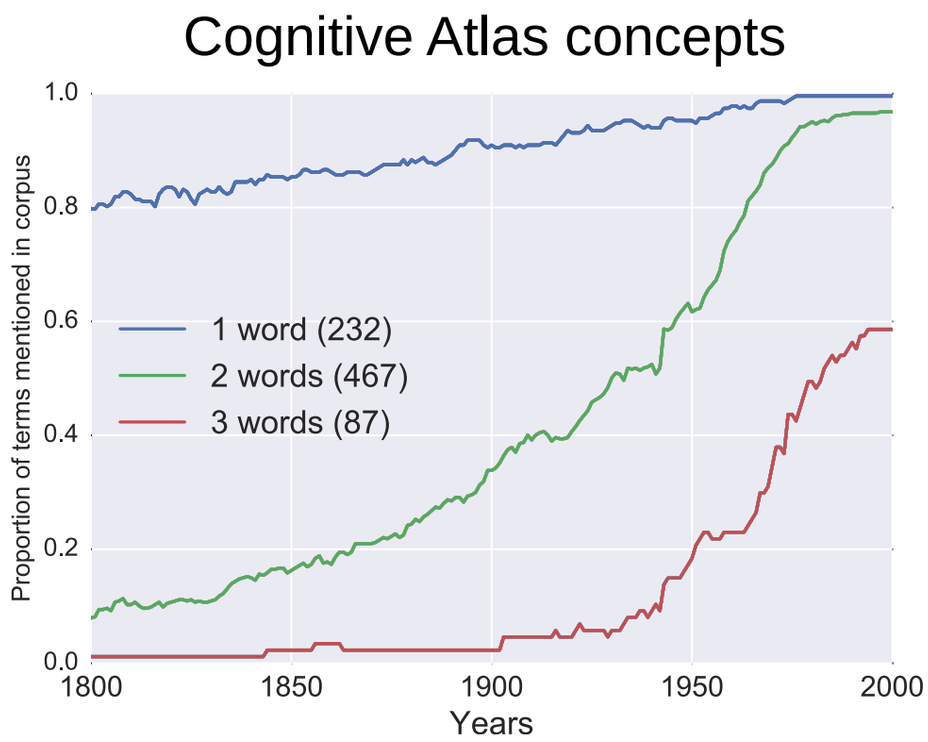


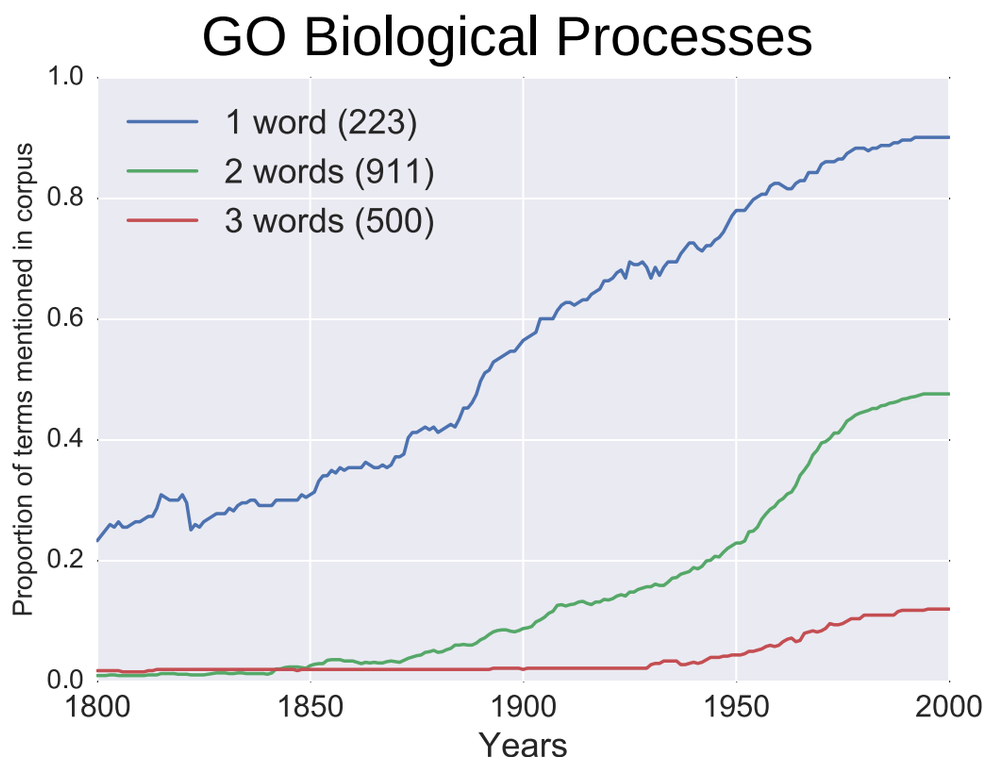
- Separated by phrase length
  - Random sample from GO terms

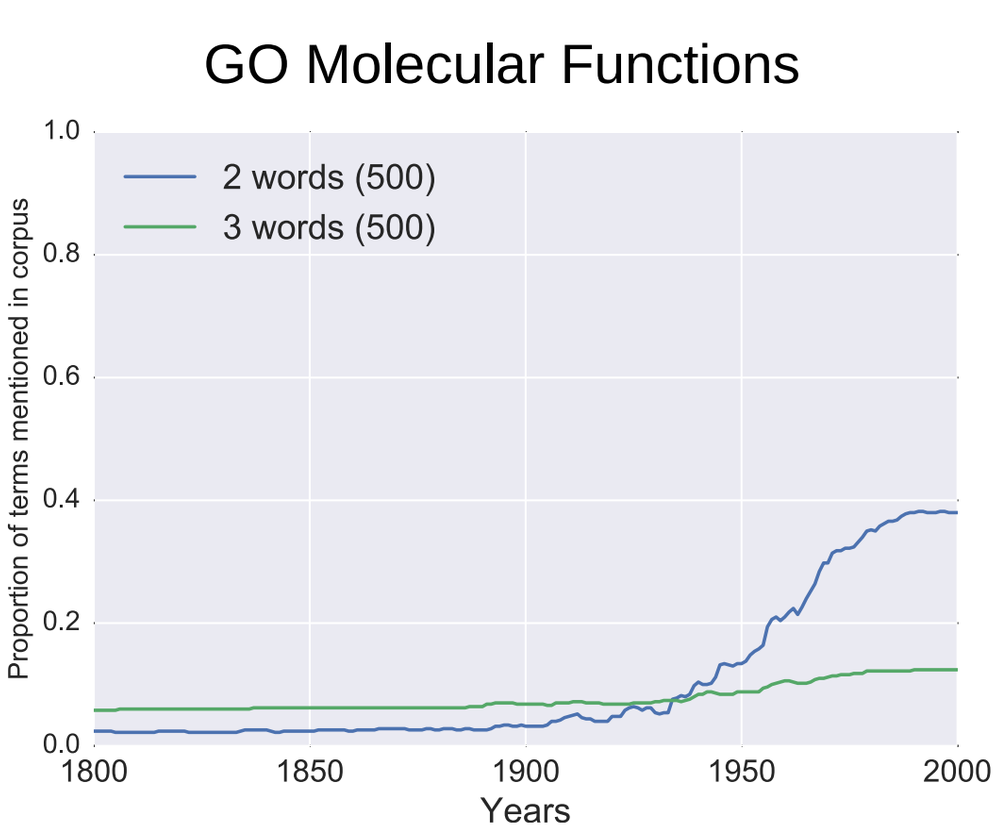
Many psychological concepts are linguistically ancient

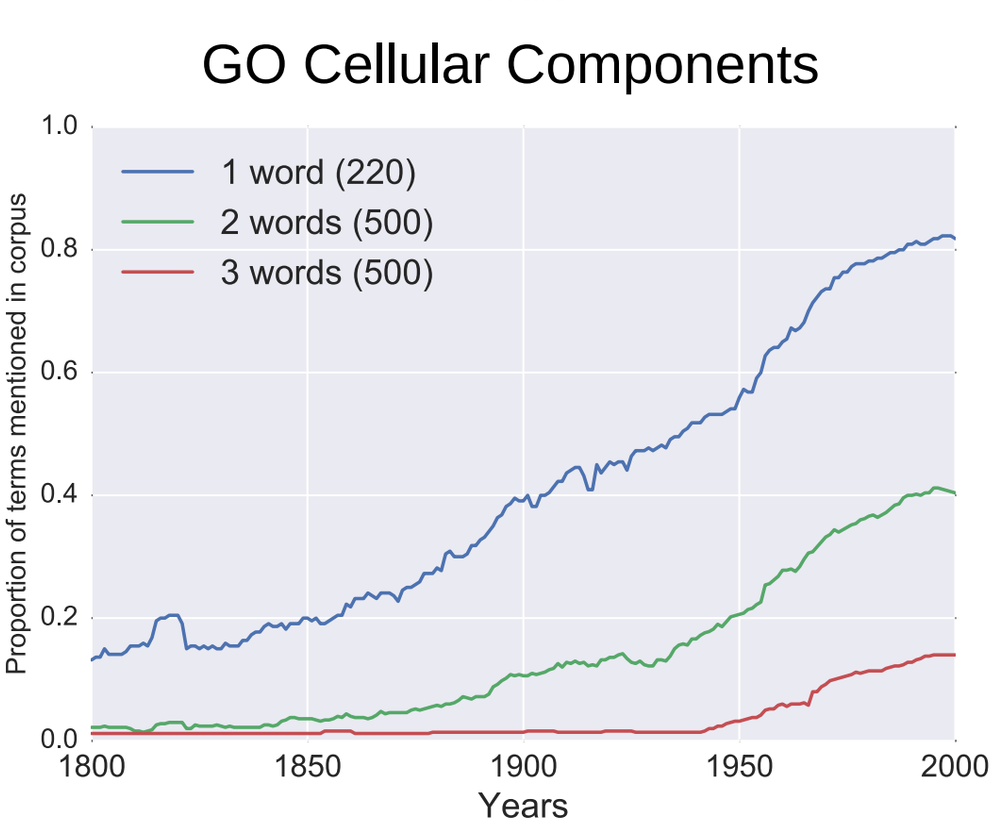


Many psychological concepts are linguistically ancient



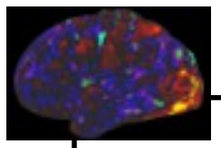




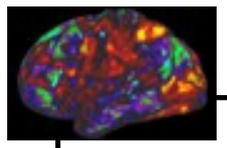


- We would hope that our psychological ontology would align with data from neuroscience
- How can we test this?

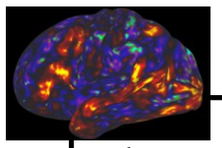
Towards meta-analytic testing of cognitive ontologies



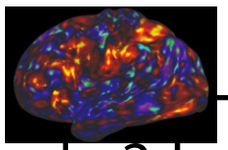
antisaccade task



stop signal task



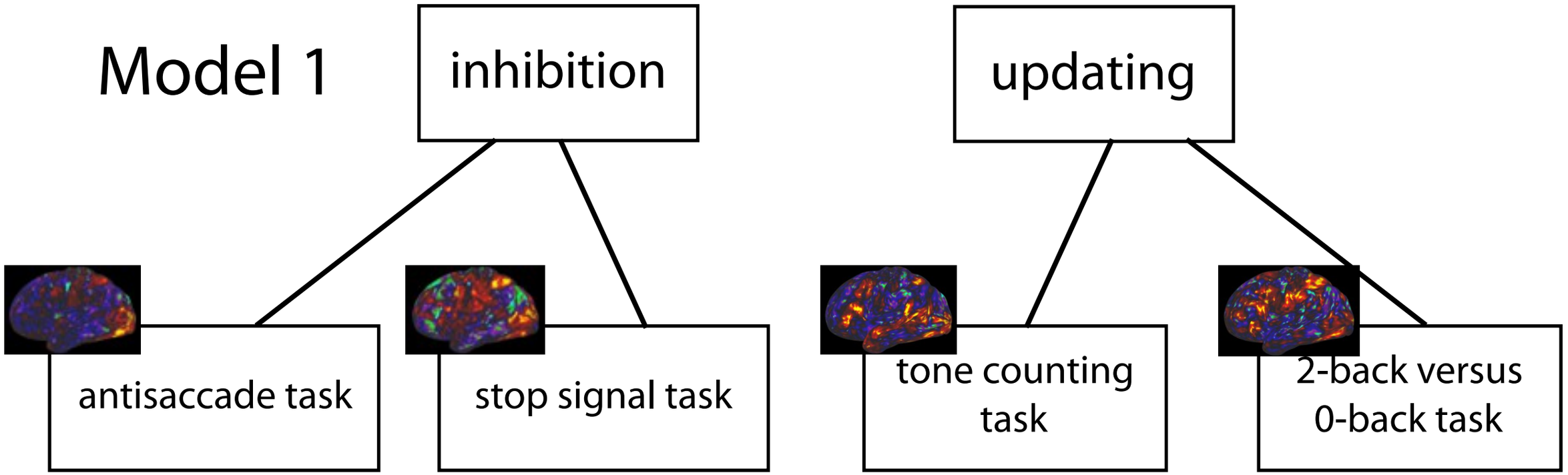
tone counting task



2-back versus 0-back task

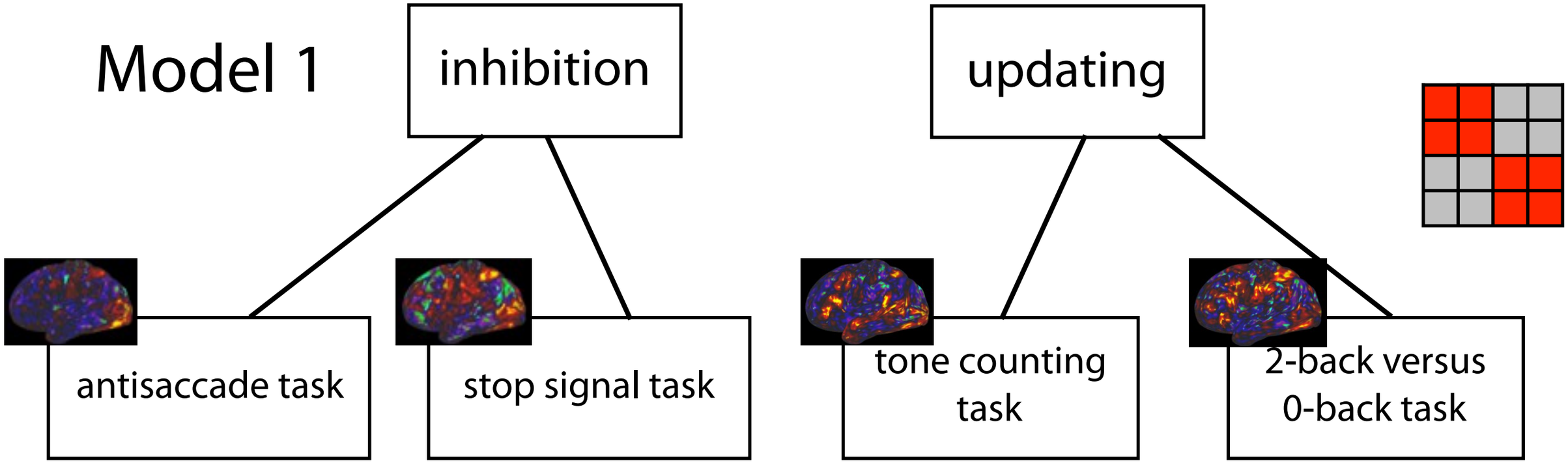
Towards meta-analytic testing of cognitive ontologies

Model 1



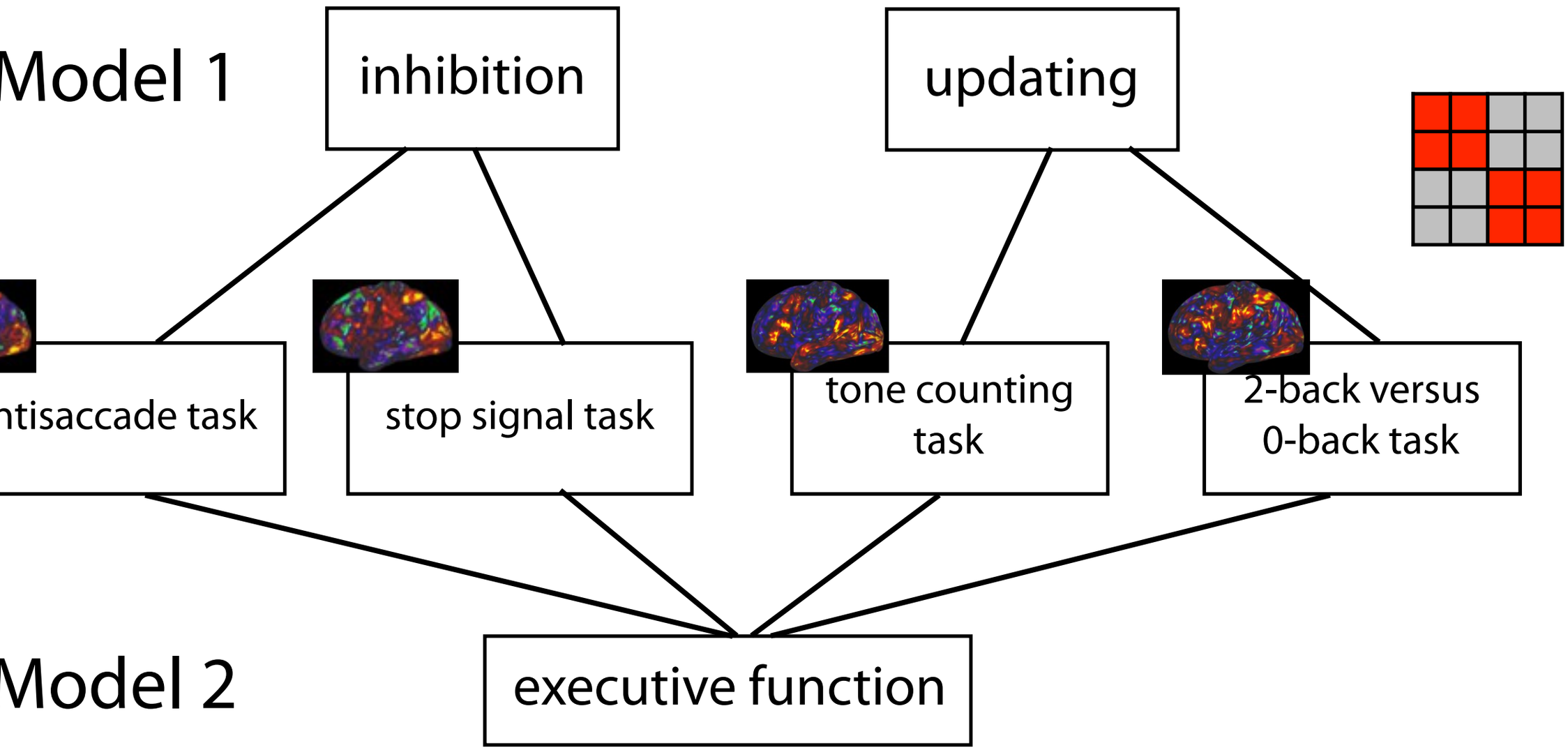
Towards meta-analytic testing of cognitive ontologies

Model 1



Towards meta-analytic testing of cognitive ontologies

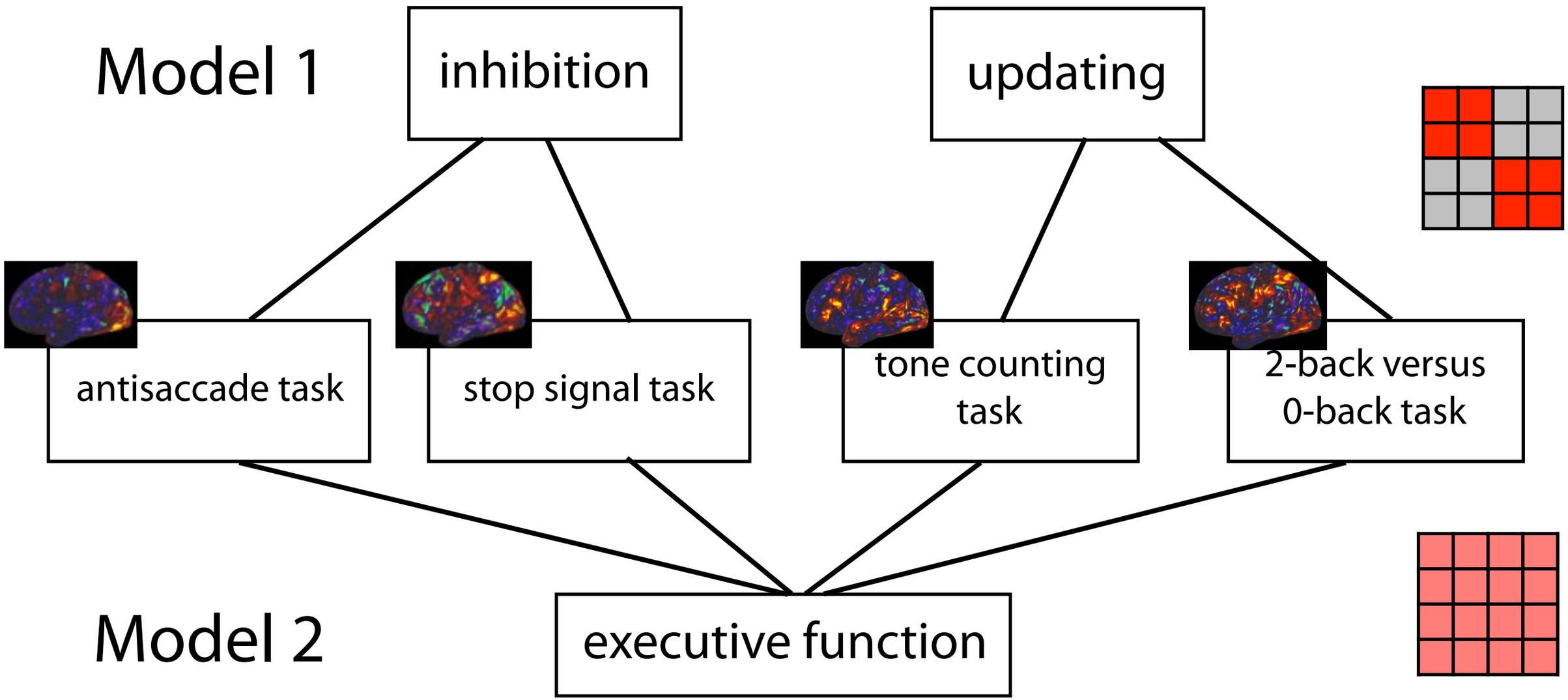
Model 1



Model 2

Towards meta-analytic testing of cognitive ontologies

Model 1



Model 2

Towards meta-analytic testing of cognitive ontologies

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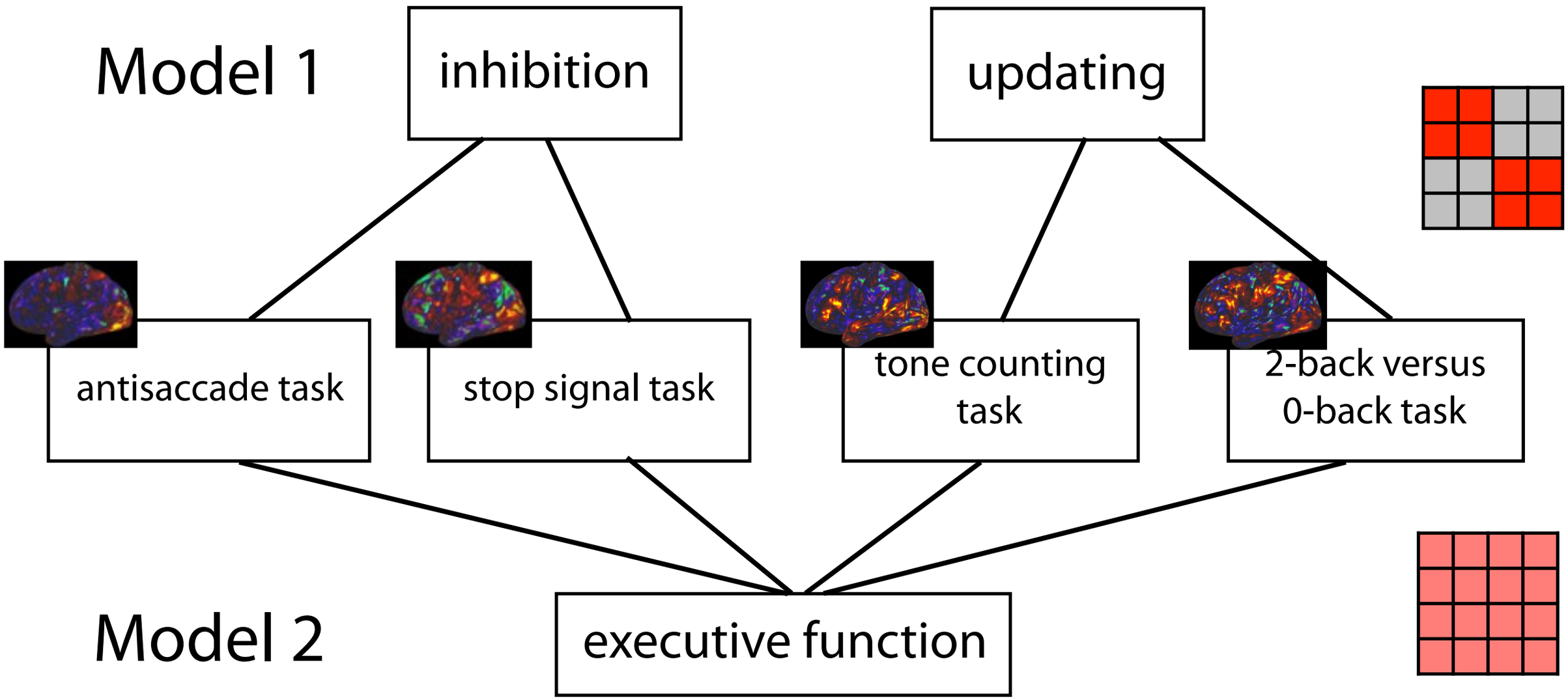
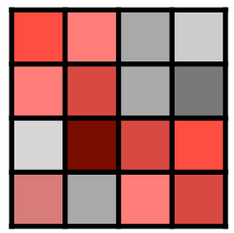


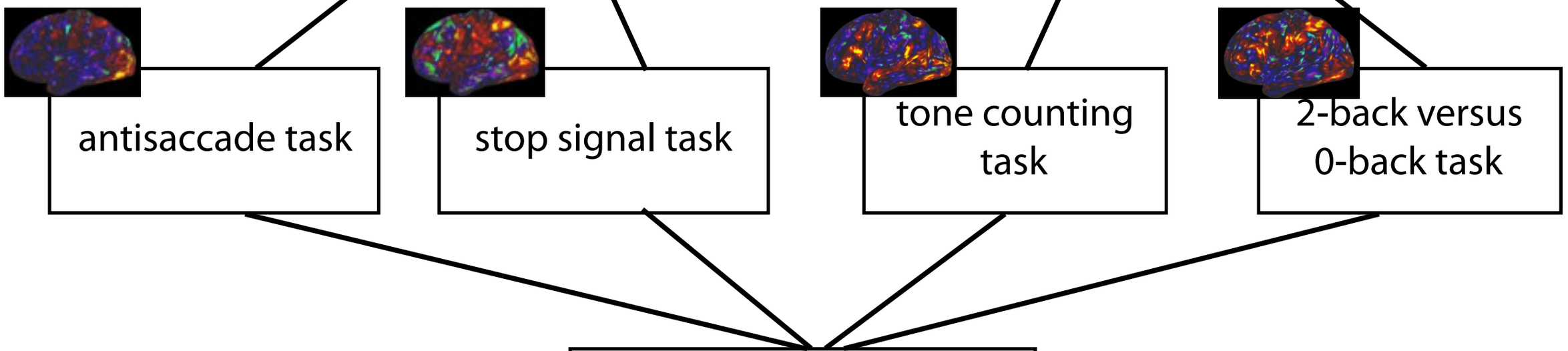
Model 2

Observed covariance



Towards meta-analytic testing of cognitive ontologies

Model 1



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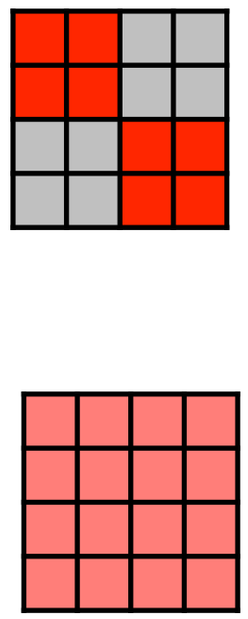
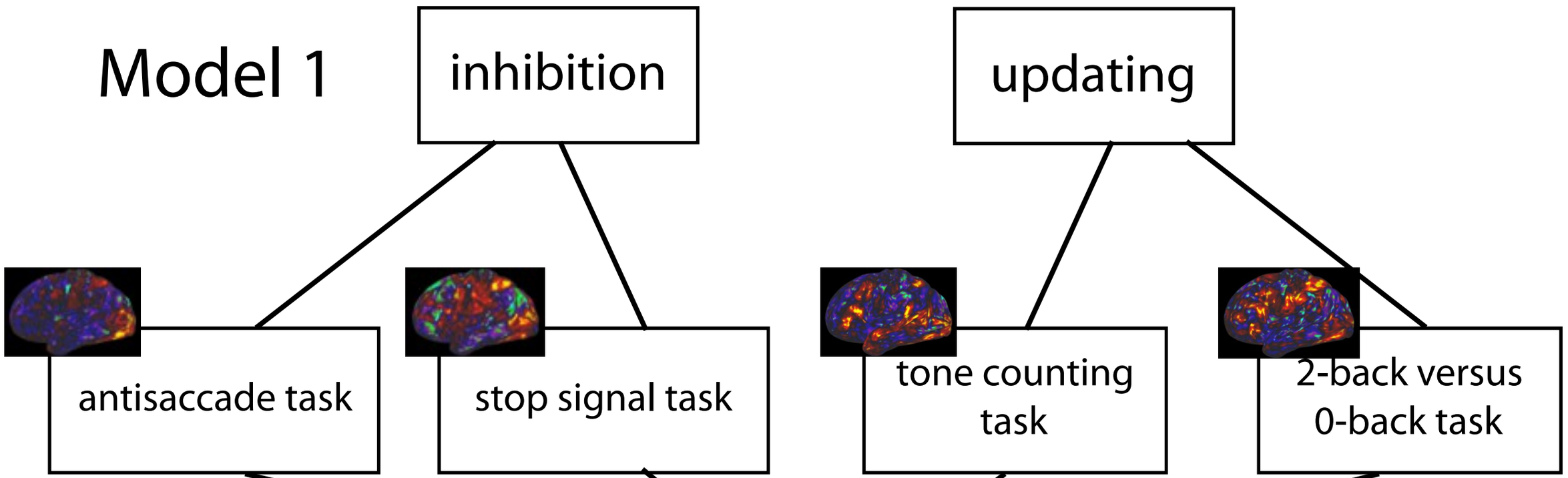


Towards meta-analytic testing of cognitive ontologies

Model 1



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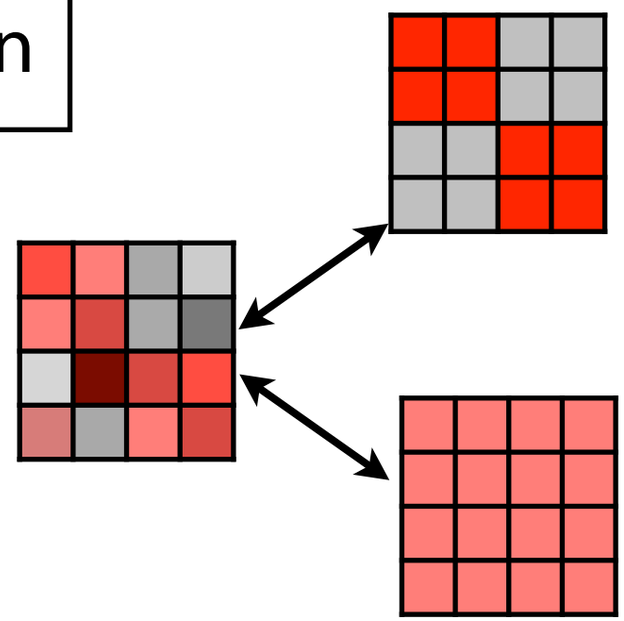
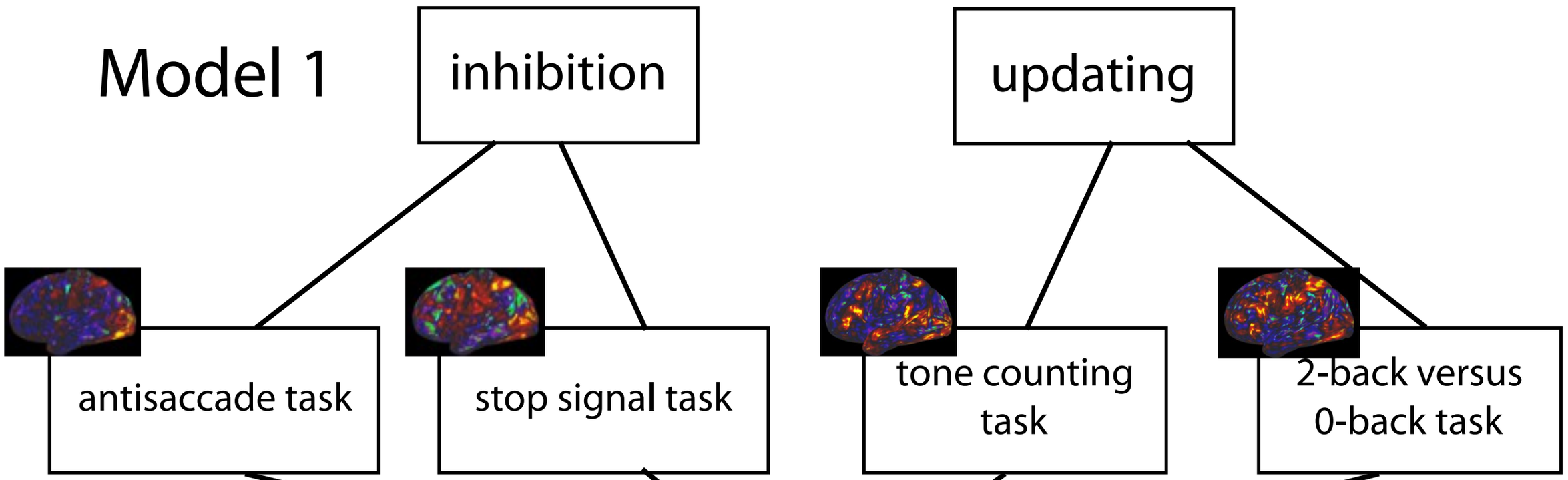


Towards meta-analytic testing of cognitive ontologies

Model 1



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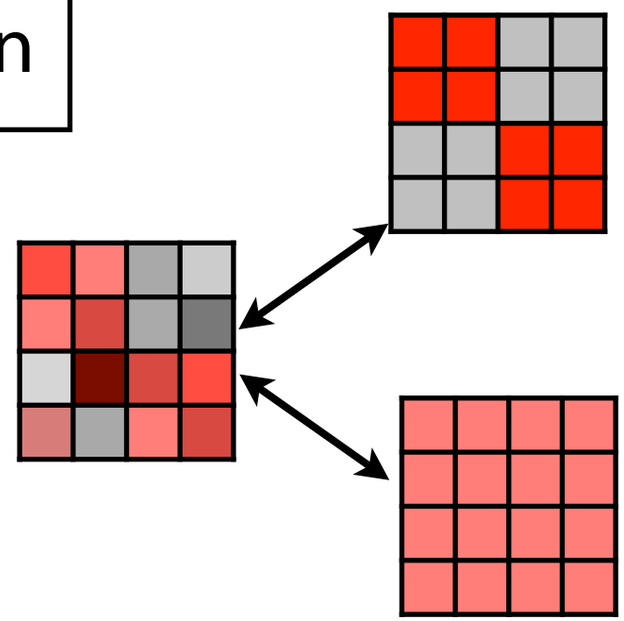
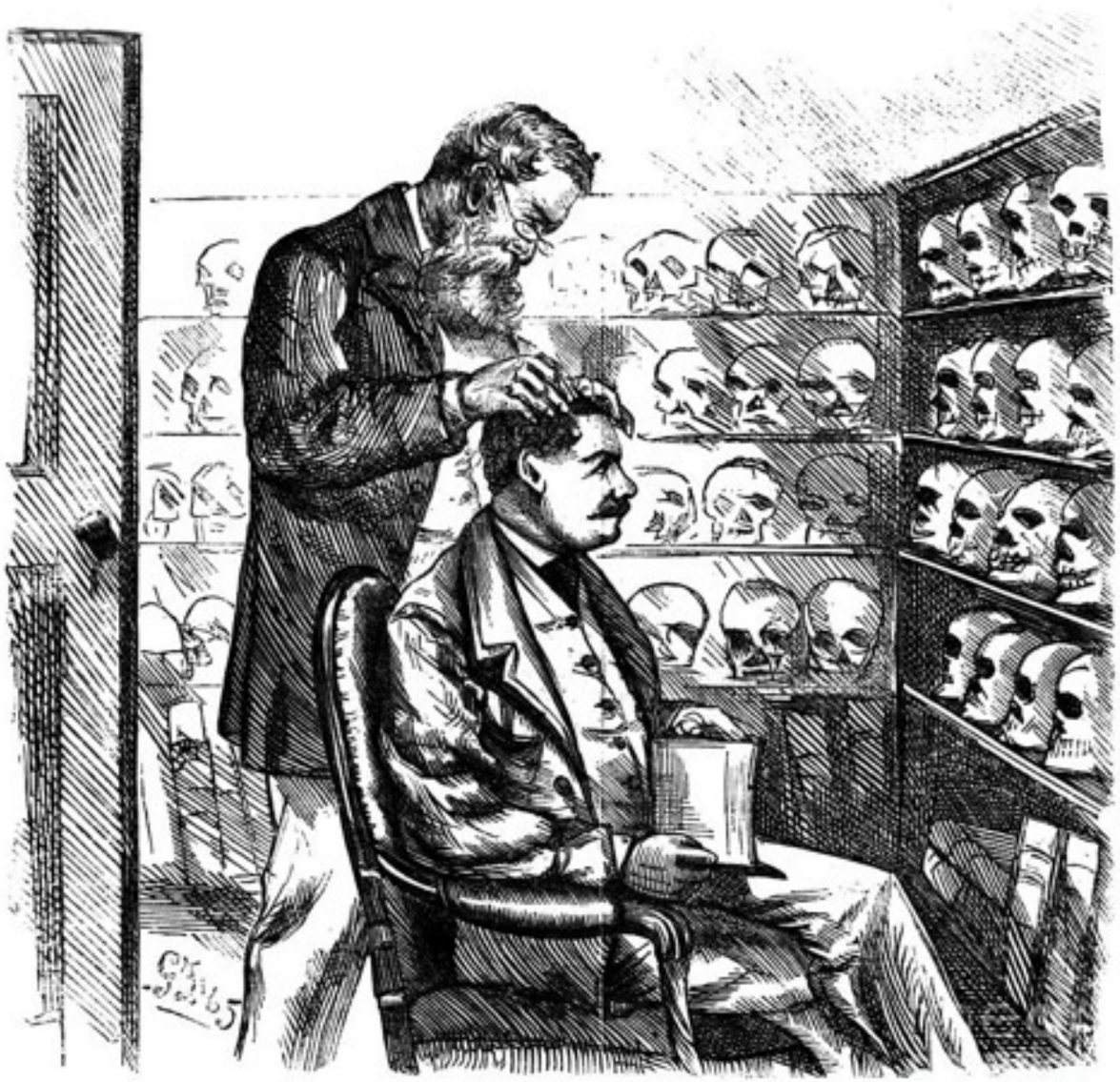
Observed covariance

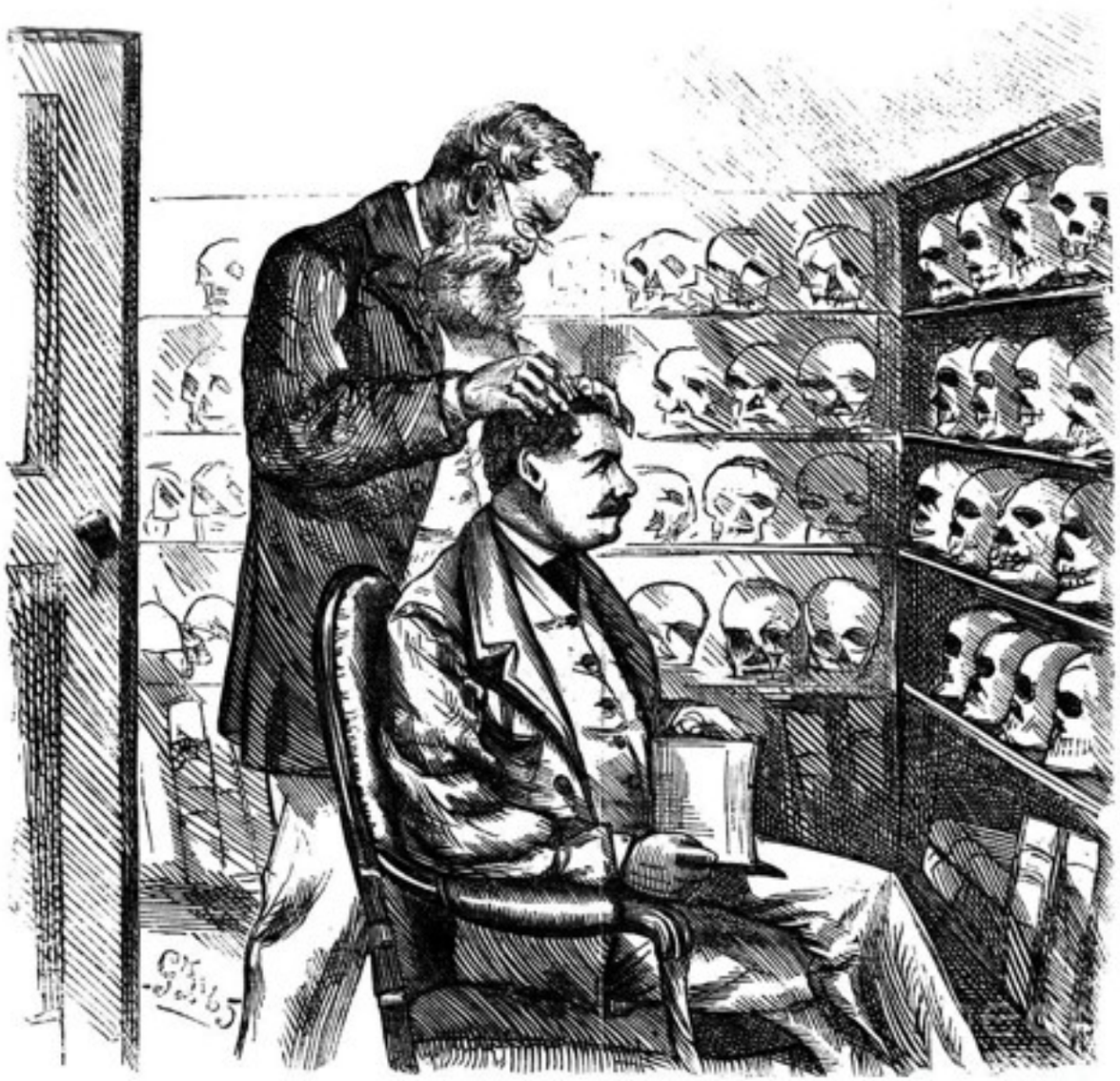


How confident are we in our scientific approach?



A HINT TO PHRENOLOGISTS; or, "September 20, 1876."

How confident are we in our scientific approach?

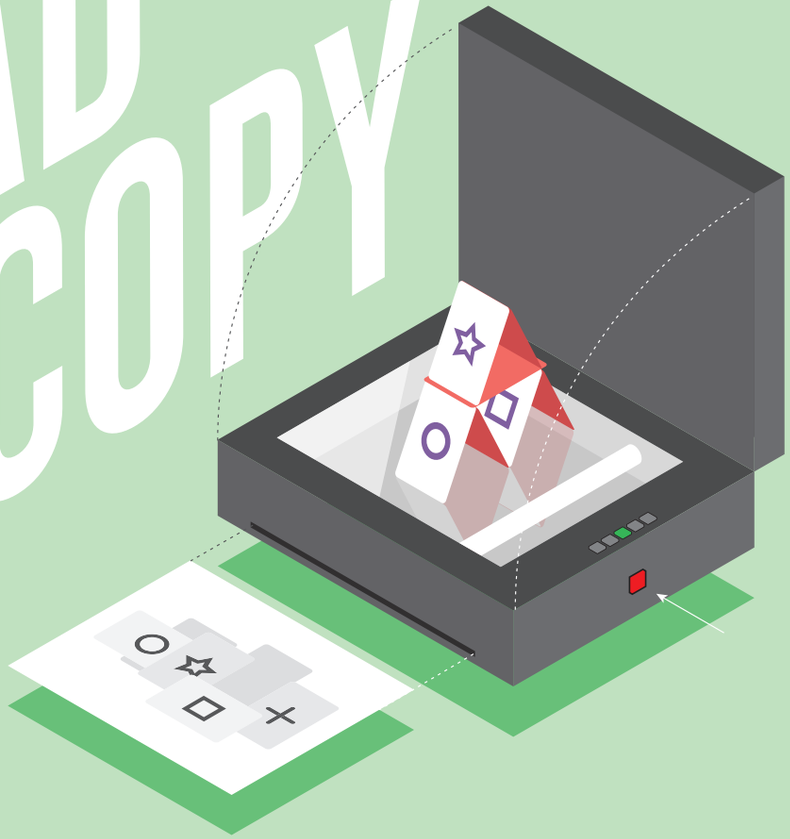


A HINT TO PHRENOLOGISTS; or, "September 20, 1876."

Science in crisis (?)

298 | NATURE | VOL 485 | 17 MAY 2012

BAD COPY



IN THE WAKE OF HIGH-PROFILE CONTROVERSIES, PSYCHOLOGISTS ARE FACING UP TO PROBLEMS WITH REPLICATION.

BY ED YONG

Open access, freely available online

Essay

Why Most Published Research Findings Are False

John P. A. Ioannidis

PLoS Medicine | www.plosmedicine.org 0696 August 2005 | Volume 2 | Issue 8 | e124

Raise standards for preclinical cancer research

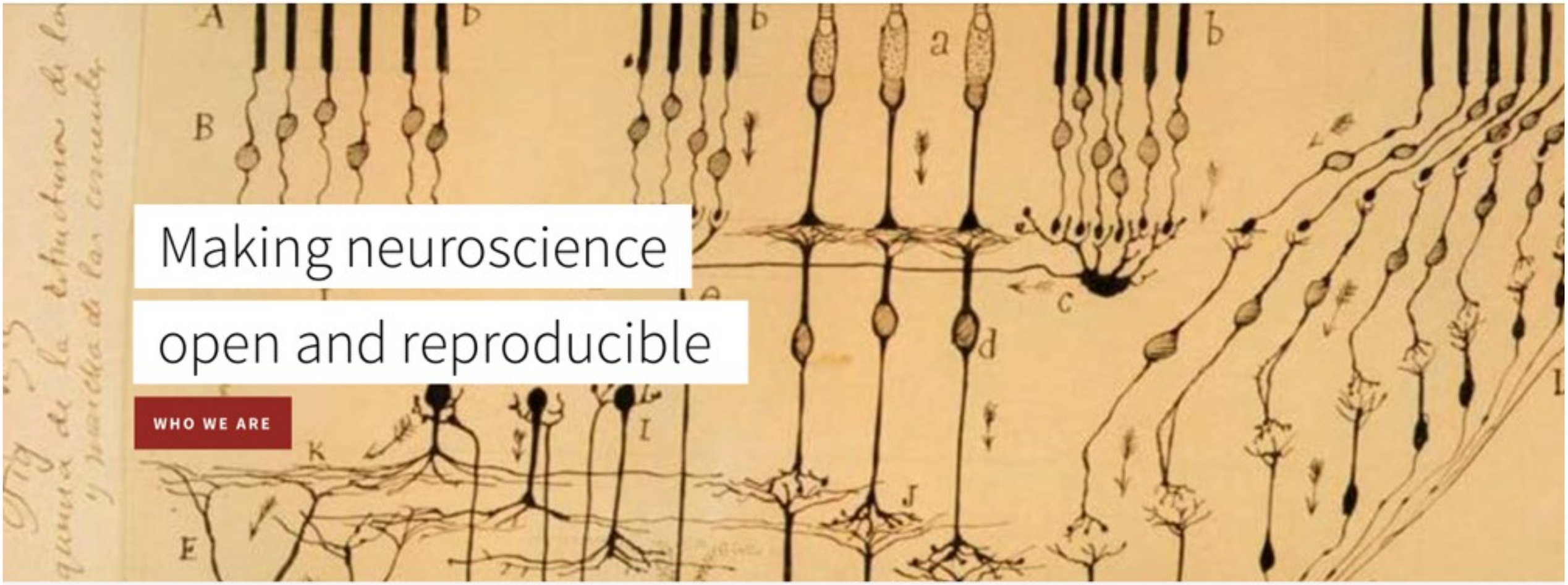
C. Glenn Begley and **Lee M. Ellis** propose how methods, publications and incentives must change if patients are to benefit.

29 MARCH 2012 | VOL 483 | NATURE | 531

Neuroimaging: a perfect storm for irreproducibility

Stanford Center For
Reproducible Neuroscience

HOME ABOUT THE CENTER WHO WE ARE RESOURCES BLOG



Making neuroscience open and reproducible

WHO WE ARE

Reproducibility matters

Neuroscience research is the basis for critical decisions about health and society. Our first goal as researchers is to ensure that the results of our research will stand the test of time.

Enabling better research

We are expanding the OpenfMRI project into a free and open platform that will enable the analysis and sharing of neuroimaging data, harnessing the power of high-performance computing to improve the quality of research.

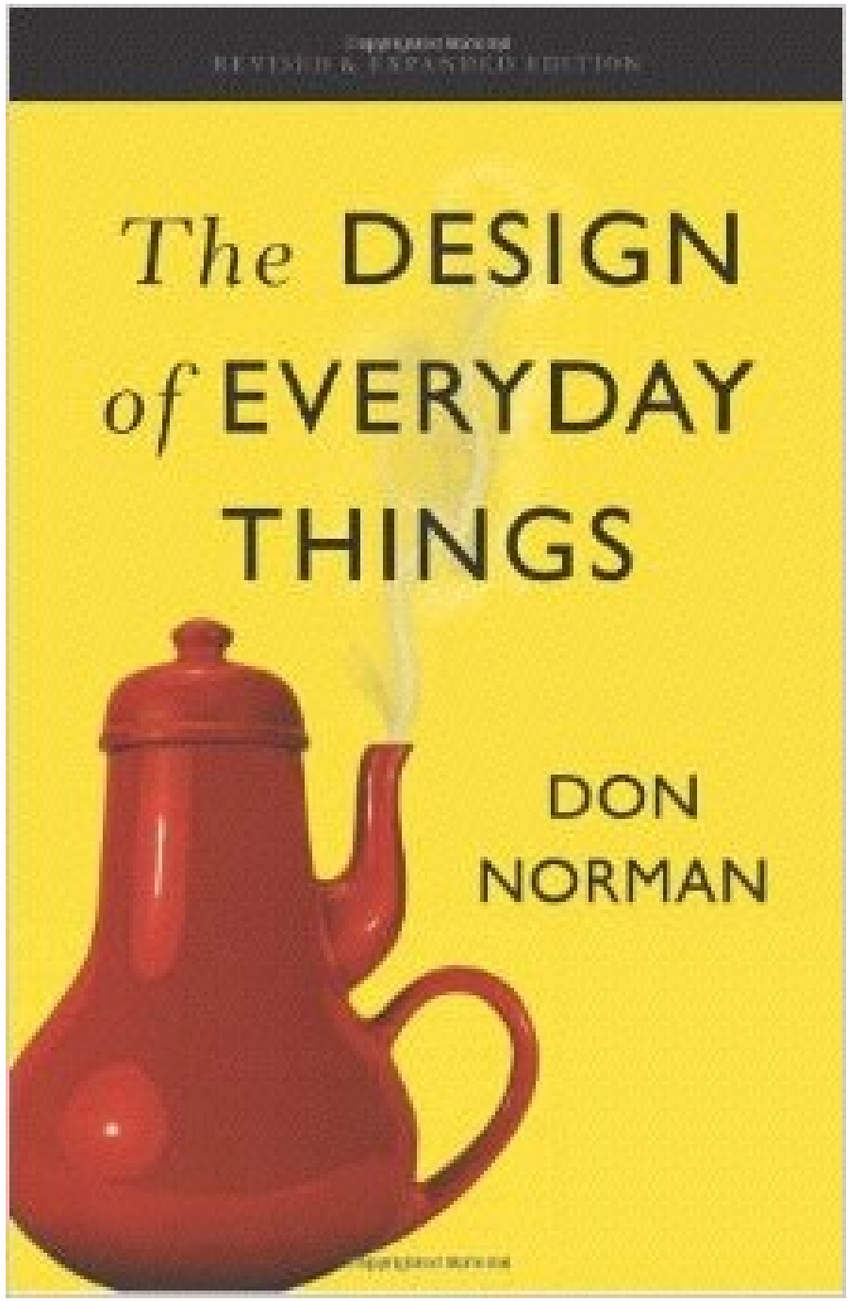
From data to discovery

Our platform will provide neuroimaging researchers with leading-edge tools to analyze and share large datasets, with a focus on quantifying the reproducibility of the results.

http://reproducibility.stanford.edu

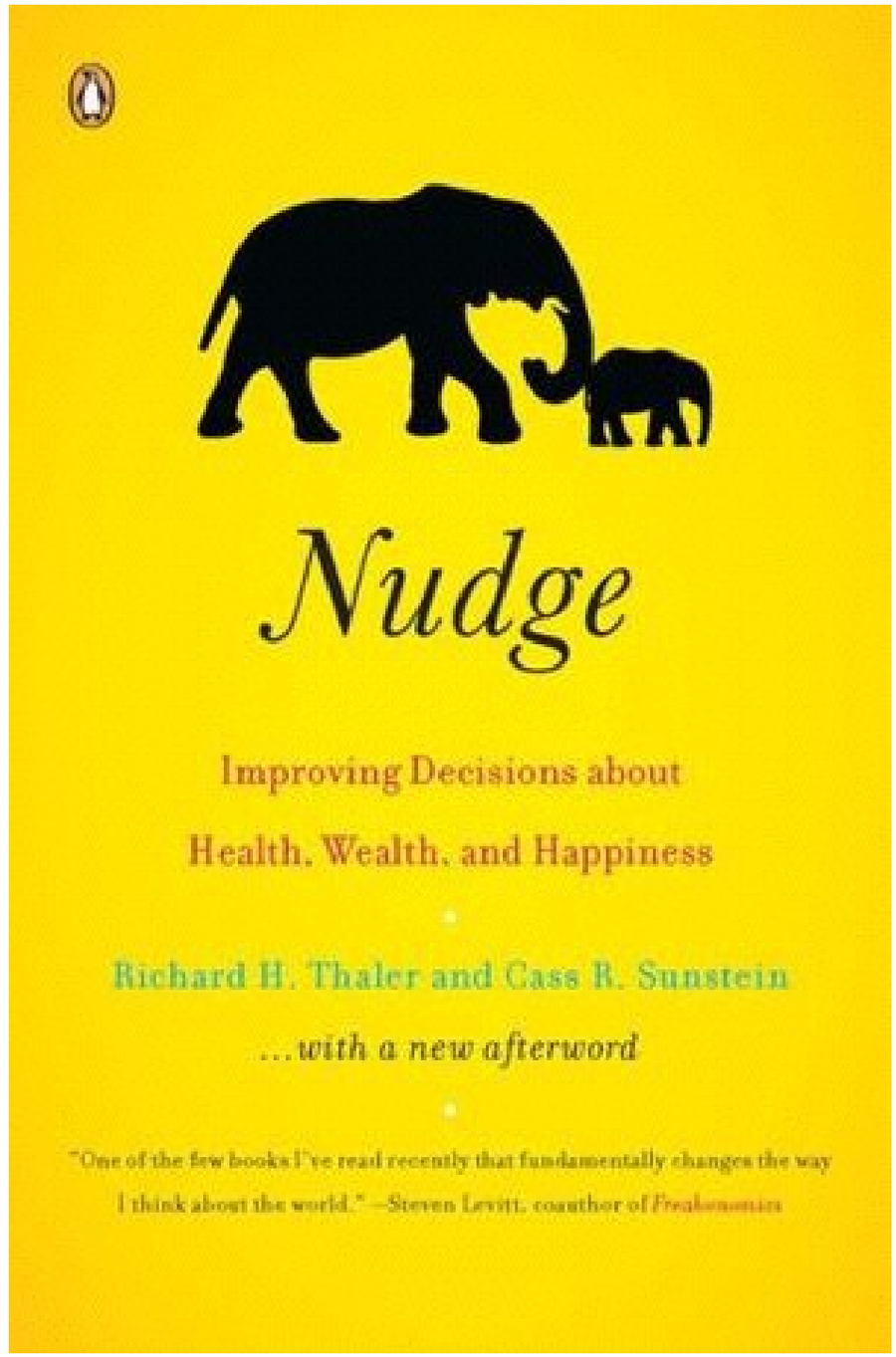
Designing a more reproducible scientific enterprise

Designing a more reproducible scientific enterprise



Improving the choice architecture of science

- Choice architecture
  - particular set of features that drive people toward or away from particular choices
- Nudges
  - Improving incentives
  - Using the power of defaults
  - Providing feedback
  - Expecting and prevent errors

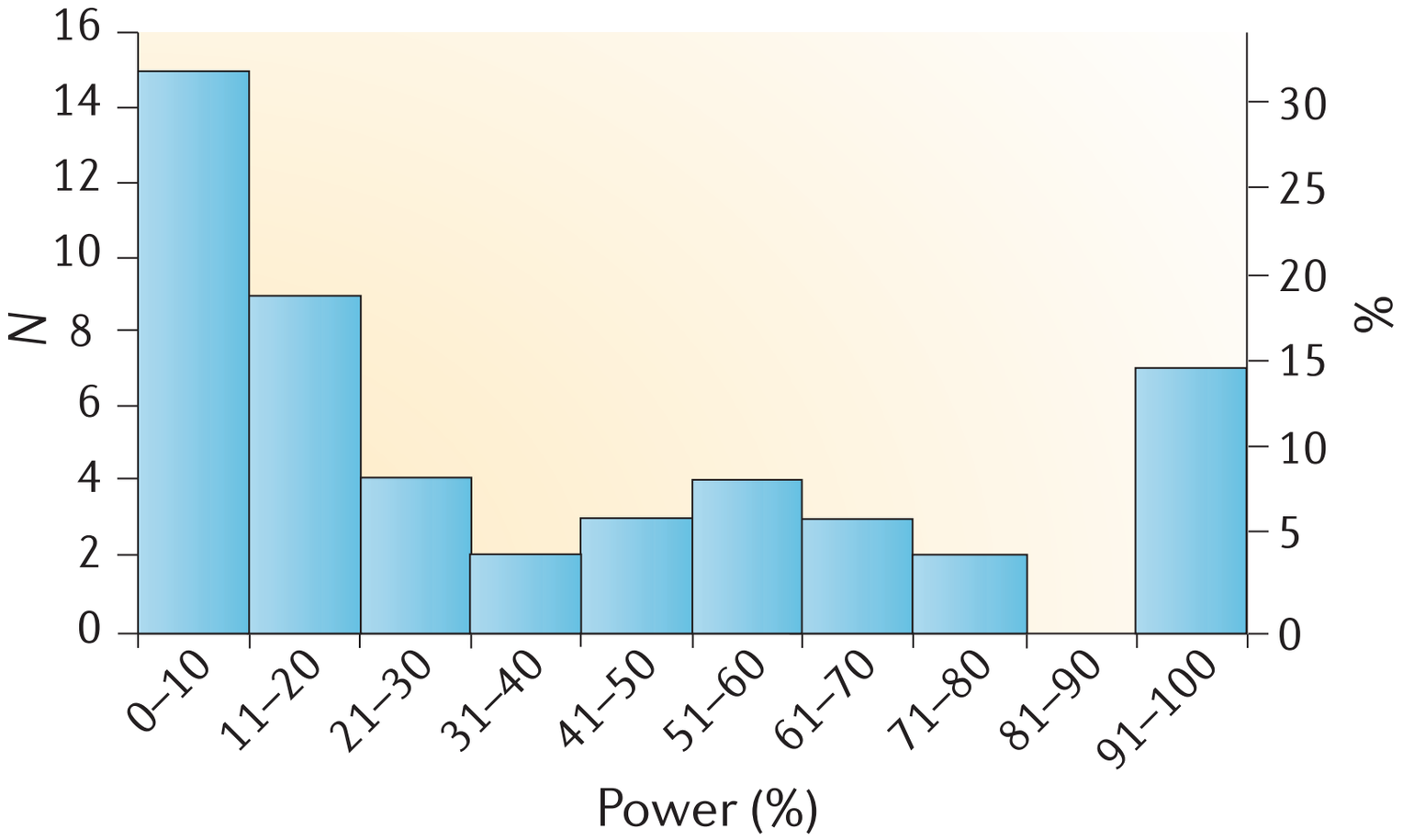


Threats to reproducibility: Low power

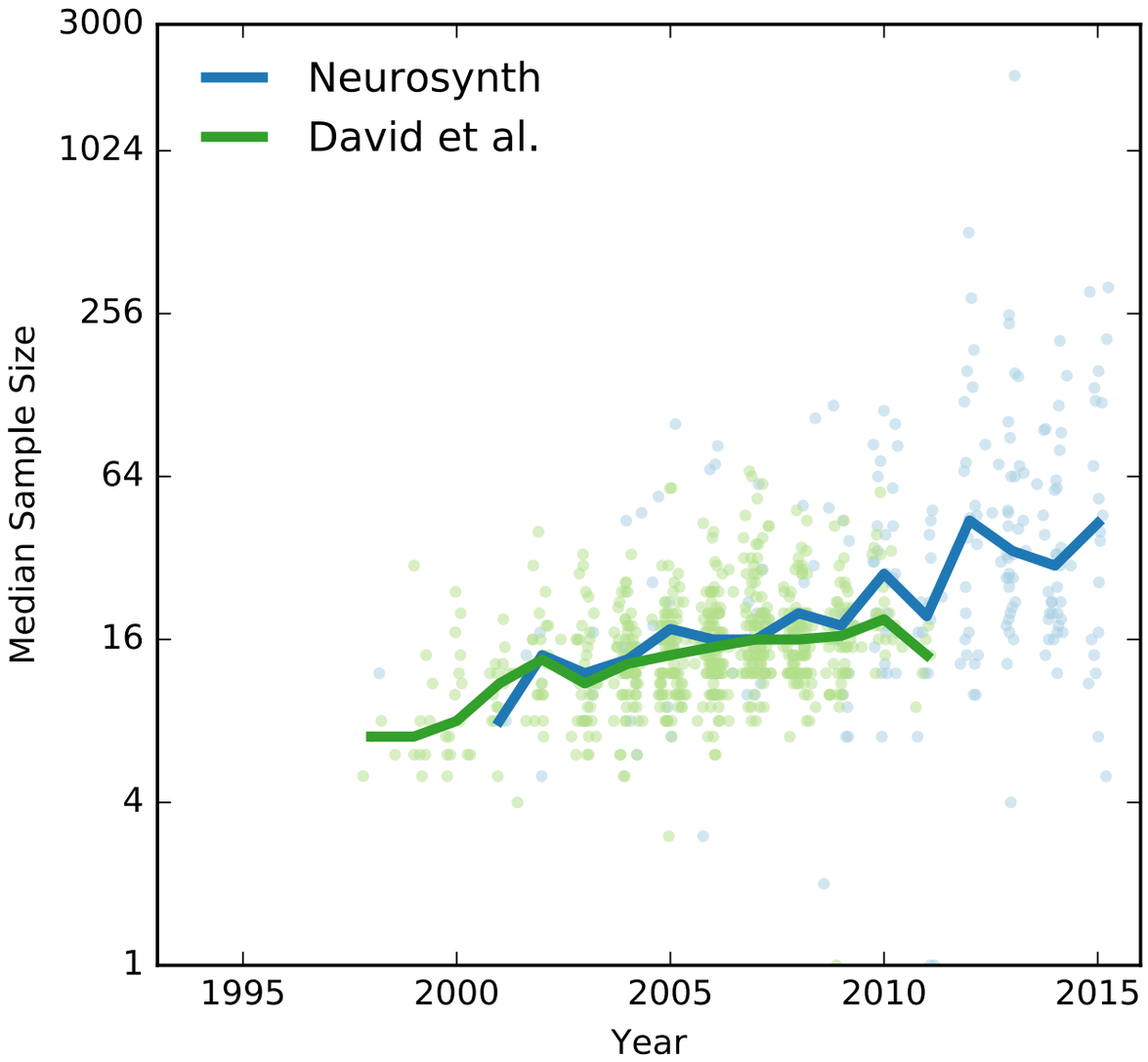
Power failure: why small sample size undermines the reliability of neuroscience

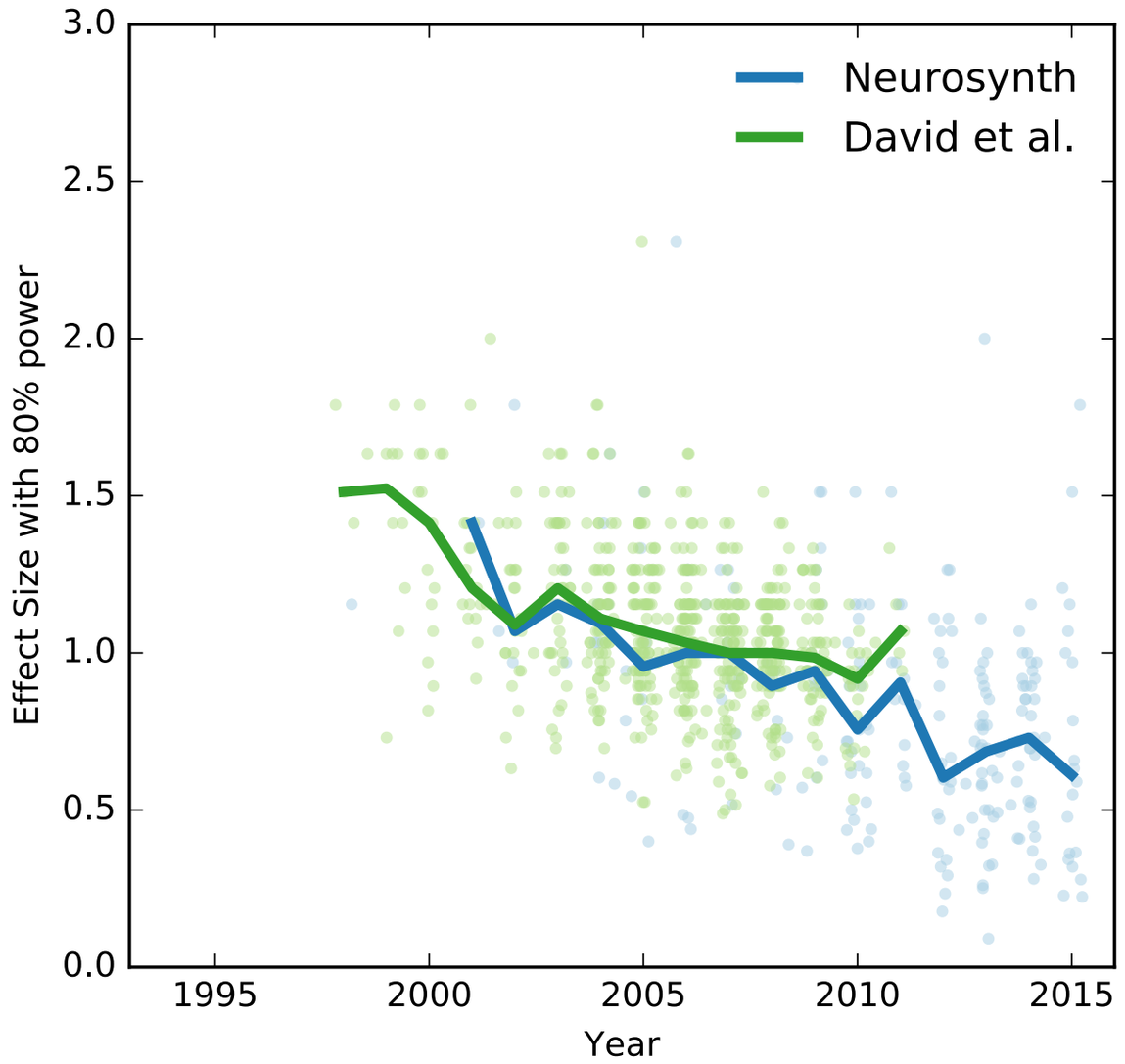
Katherine S. Button[1,2], John P. A. Ioannidis[3], Claire Mokrysz[1], Brian A. Nosek[4], Jonathan Flint[5], Emma S. J. Robinson[6] and Marcus R. Munafò[1]

NATURE REVIEWS | NEUROSCIENCE VOLUME 14 | MAY 2013 | 365



Sample size and power in fMRI studies





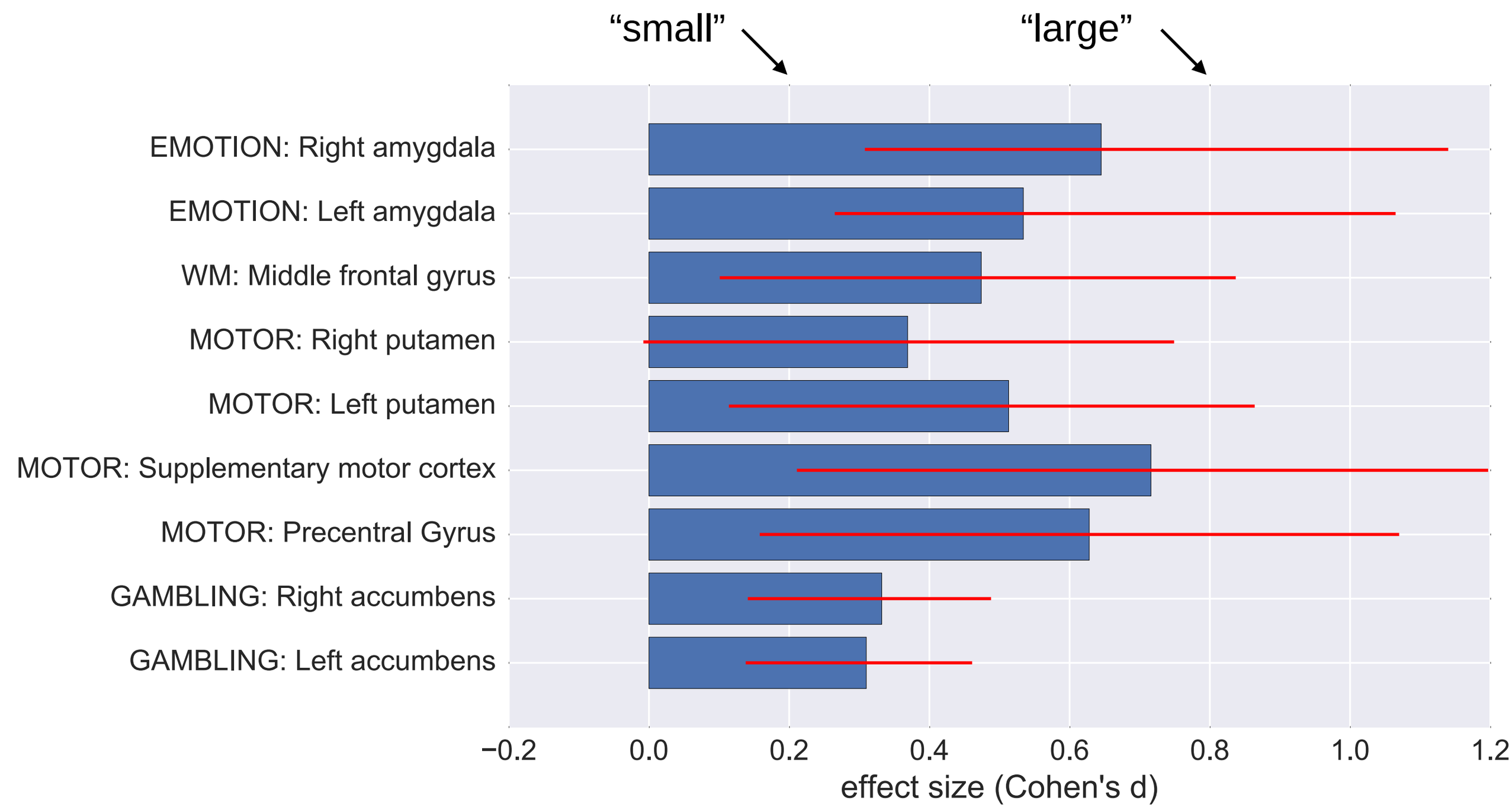
Median estimated sample size in 2015 = 43

Median effect size with 80% power = 0.61

Thanks to Sean David and Tal Yarkoni
for sample size data

Poldrack et al, submitted

What are realistic effect sizes for fMRI?



Estimated from HCP task data
using combined anatomical + neurosynth ROIs

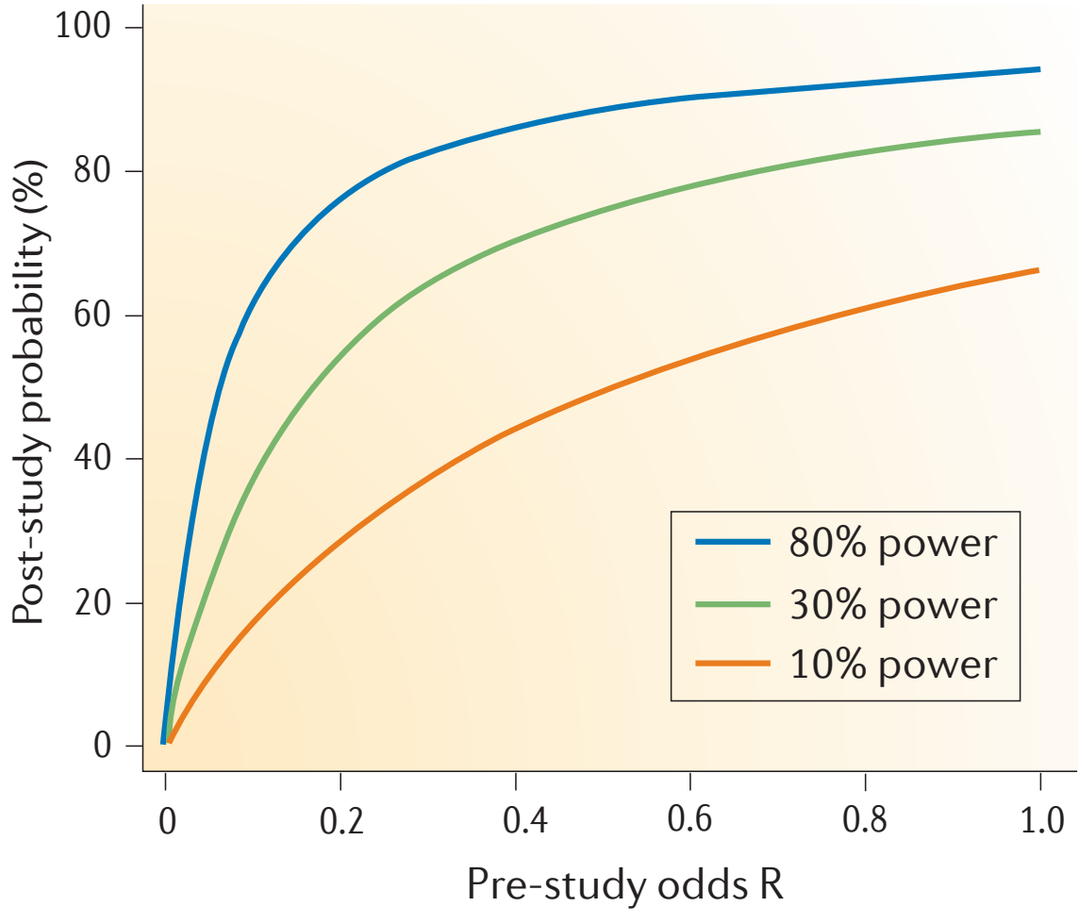
Poldrack et al, submitted

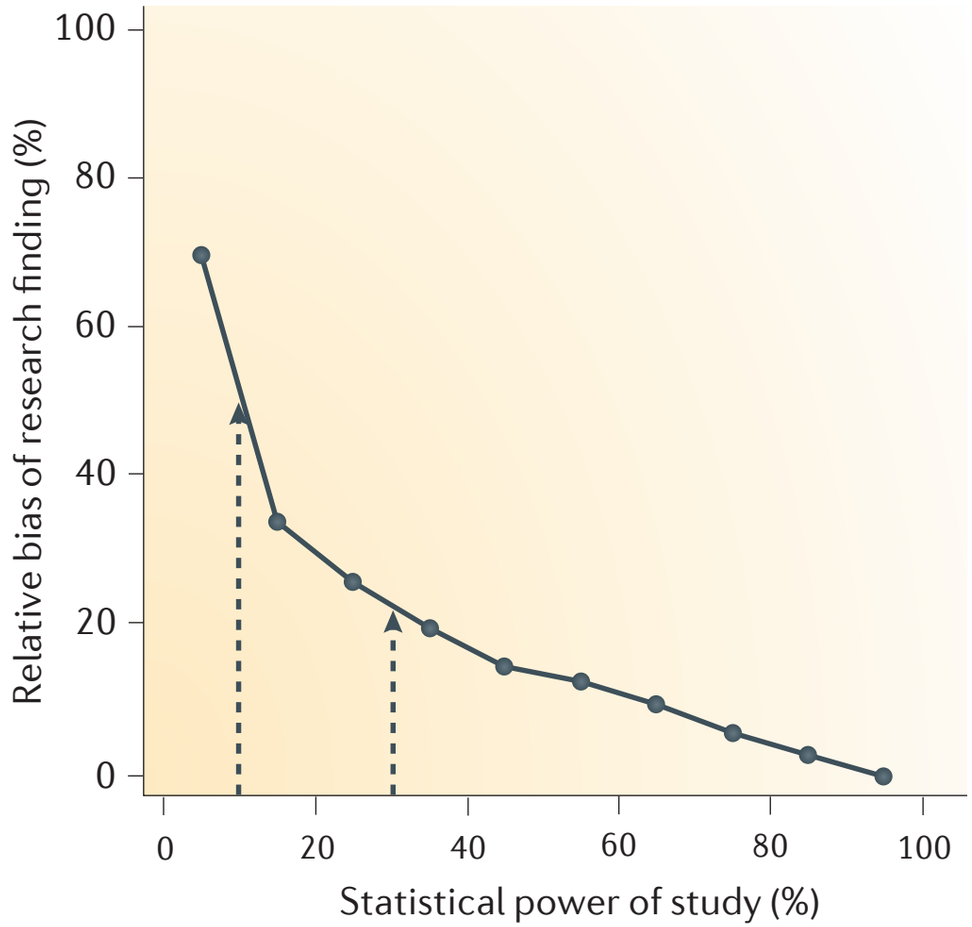
Low power -> unreliable science

Positive Predictive Value (PPV): The probability that a positive result is true

Winner's Curse: overestimation of effect sizes for significant results

$$PPV = ([1 - \beta] \times R) / ([1 - \beta] \times R + \alpha)$$





Button et al., 2013

- "My result isn't significant, so I need to add more subjects…"

Sample size flexibility

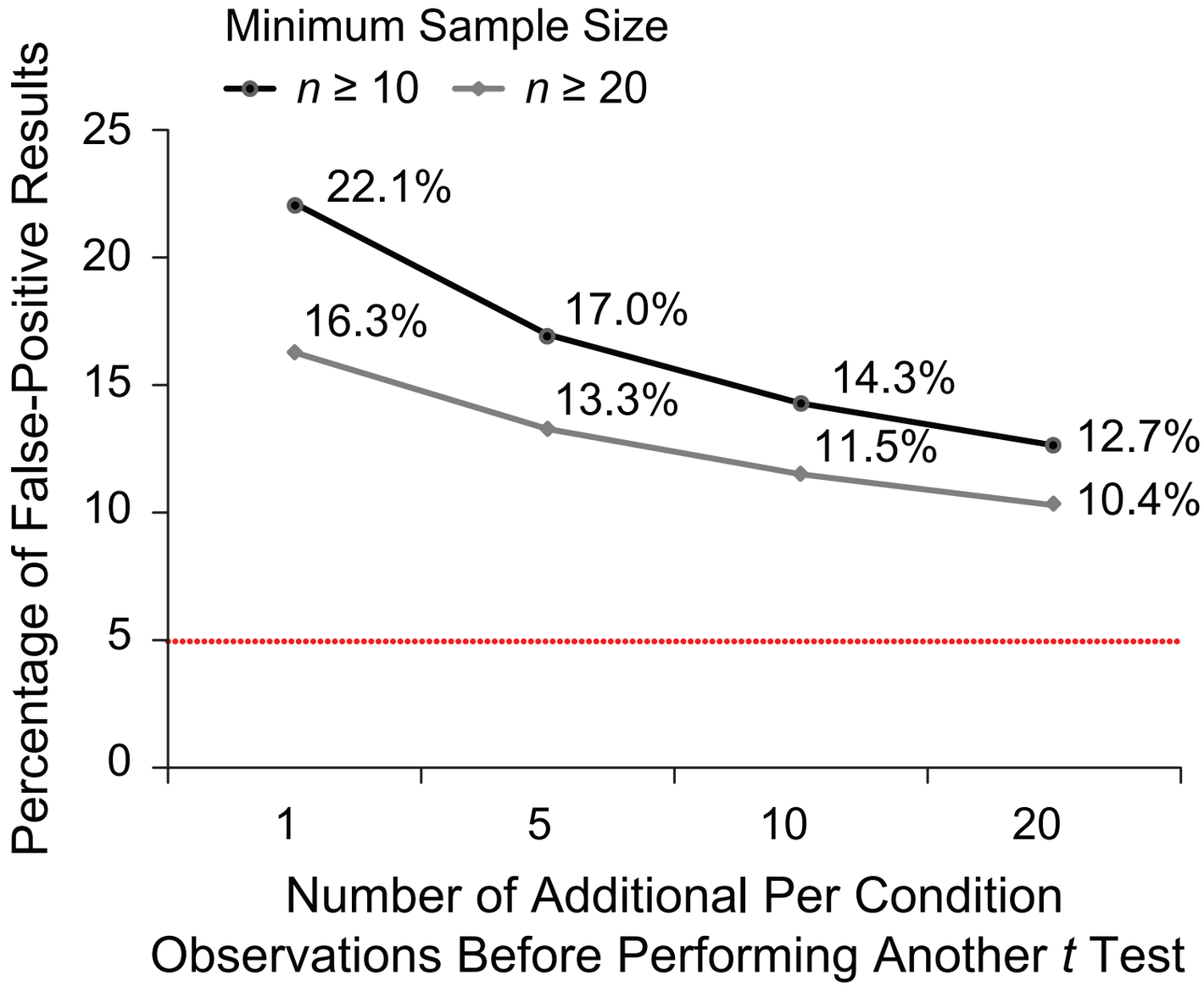


Fig. 1. Likelihood of obtaining a false-positive result when data collection ends upon obtaining significance ($p \leq .05$, highlighted by the dotted line). The figure depicts likelihoods for two minimum sample sizes, as a function of the frequency with which significance tests are performed.

-Simmons et al., 2011, Psychological Science

Improvement: always predetermine sample size

neuropowertools.org

NeuroPower

1. Load data | 2. Estimate model | 3. Power

Select your statistical parametric map for a certain contrast (T or Z) in nifti format (.nii, NOT .nii.gz).

Bladeren... spmT_0001.nii

Upload complete

Are the values Z- or T-values?

T

What is your peakforming threshold?

units = p-value

0.01

How many subjects?

18

Is the study a one- or two-sample test?

One-sample

How do you want the smoothness to be defined?

- (•) Estimate from the data
- ( ) Manual input

If manually: what is the FWHM in mm? (eg. '[8,8,8]')

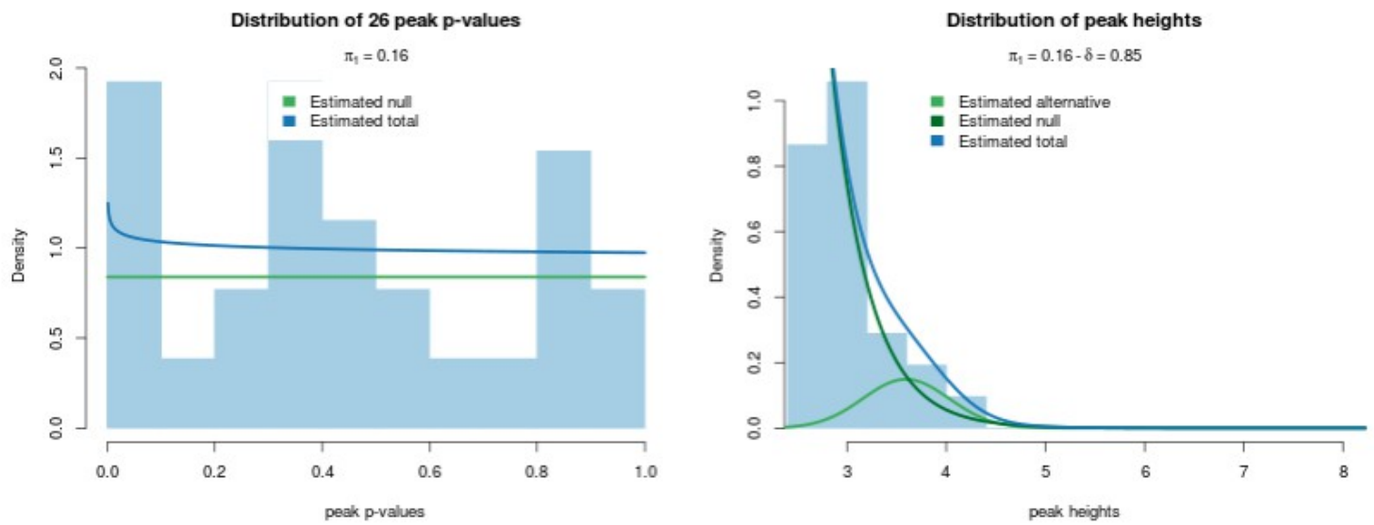
[8,8,8]

If manually: What is the voxelsize? (eg. '[2,2,2.3]')

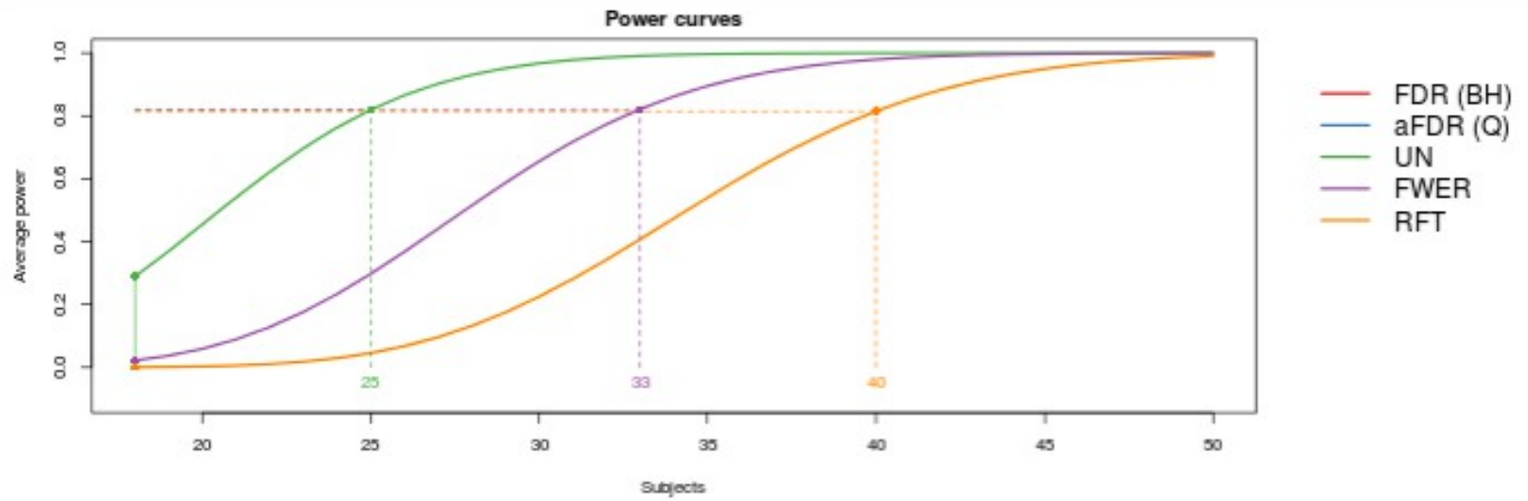
[3.9,3.9.4]

Extract peaks

Welcome | Peaks | Model fit | Post-hoc | Power



Welcome | Peaks | Model fit | Post-hoc | Power



To obtain a power level of 0.8 with RFT control at level 0.05 , the minimal sample size is 40 .

Joke Durnez

Threats to reproducibility: Methodological flexibility

- Using standard FSL analysis options
  - 69,120 possible analysis workflows

Processing step	Reason	Options	Number of plausible options
Motion correction	Correct for head motion during scanning	Interpolation [linear vs. sinc] Reference volume [single vs. mean]	4
Slice timing correction	Correct for differences in acquisition timing of different slices	No/before motion correction/after motion correction	3
Field map correction	Correct for distortion due to magnetic susceptibility	Yes/No	2
Spatial smoothing	Increase SNR for larger activations and ensure assumptions of Gaussian random field theory	FWHM [4/6/8 mm]	3
Spatial normalization	Warp individual brain to match a group template	Method [linear/nonlinear]	2
High pass filter	Remove low-frequency nuisance signals from data	Frequency cutoff [100, 120]	2
Head motion regressors	Remove remaining signals due to head motion via statistical model	Yes/No If Yes: 6/12/24 parameters or single timepoint “scrubbing” regressors	5
Hemodynamic response	Account for delayed nature of hemodynamic response to neuronal activity	Basis function [single-gamma, double-gamma] Derivatives [none/shift/dispersion]	6
Temporal autocorrelation model	Model for the temporal autocorrelation inherent in fMRI signals.	Yes/no	2
Multiple comparison correction	Correct for large number of comparisons across the brain	Voxel-based GRF, Cluster-based GRF, FDR, nonparameteric	4
Total possible workflows			**69,120**

Poldrack et al., submitted

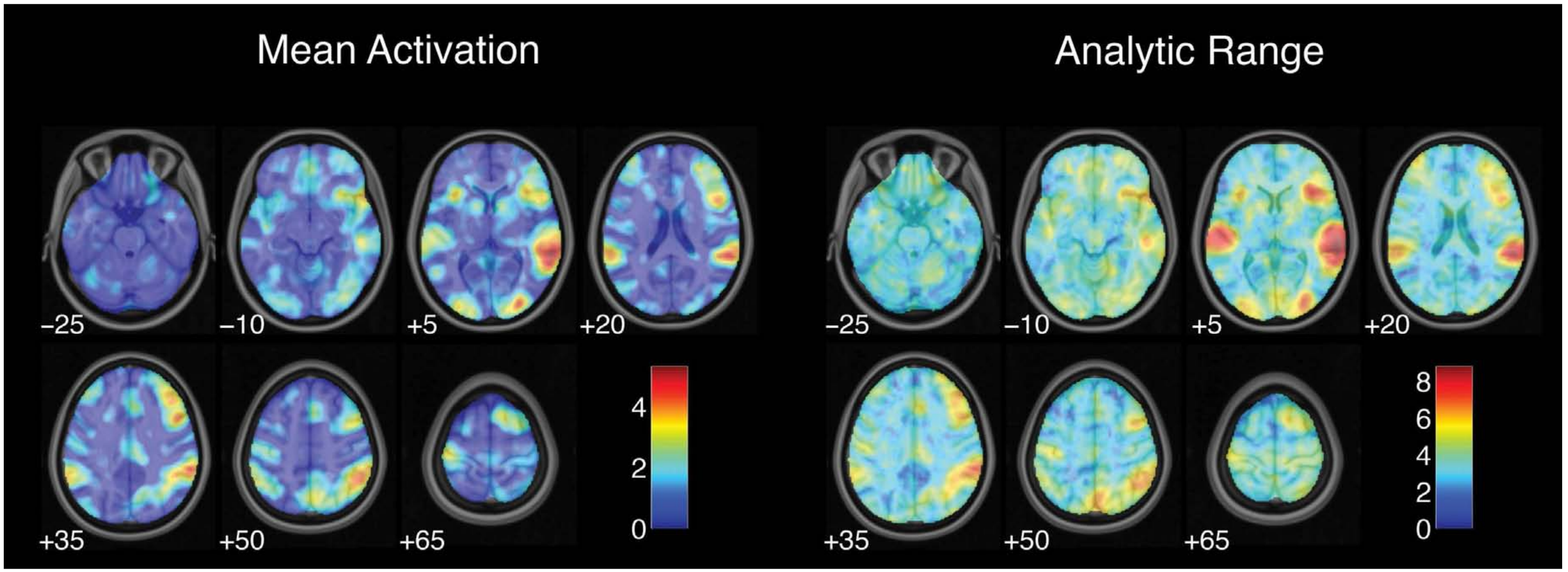
frontiers in
NEUROSCIENCE

ORIGINAL RESEARCH ARTICLE
published: 11 October 2012
doi: 10.3389/fnins.2012.00149

On the plurality of (methodological) worlds: estimating the analytic flexibility of fMRI experiments

Joshua Carp*

6,912 pipelines



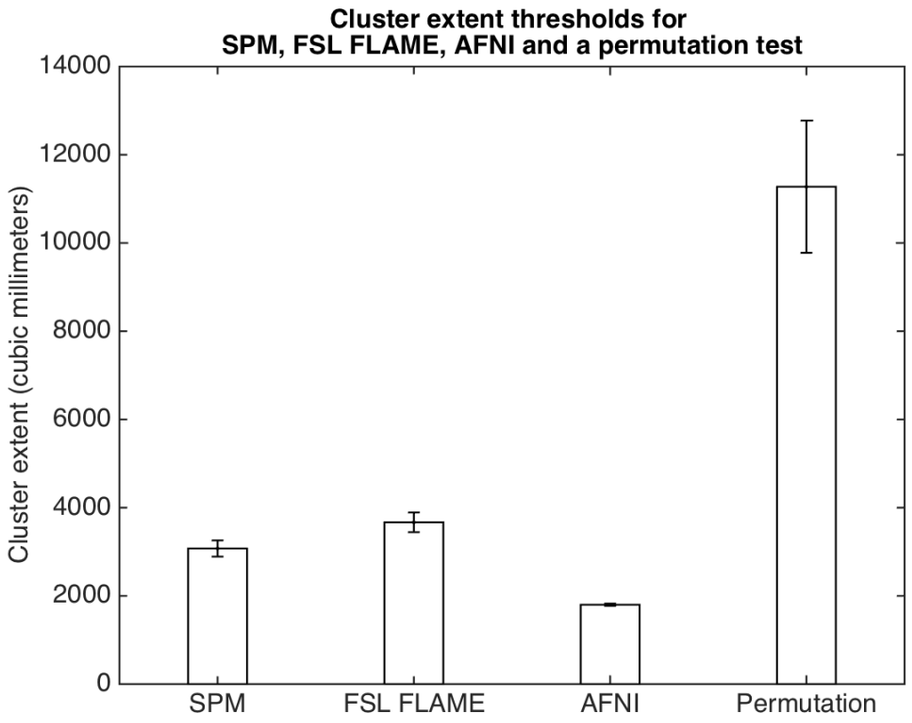
Multiple comparison correction

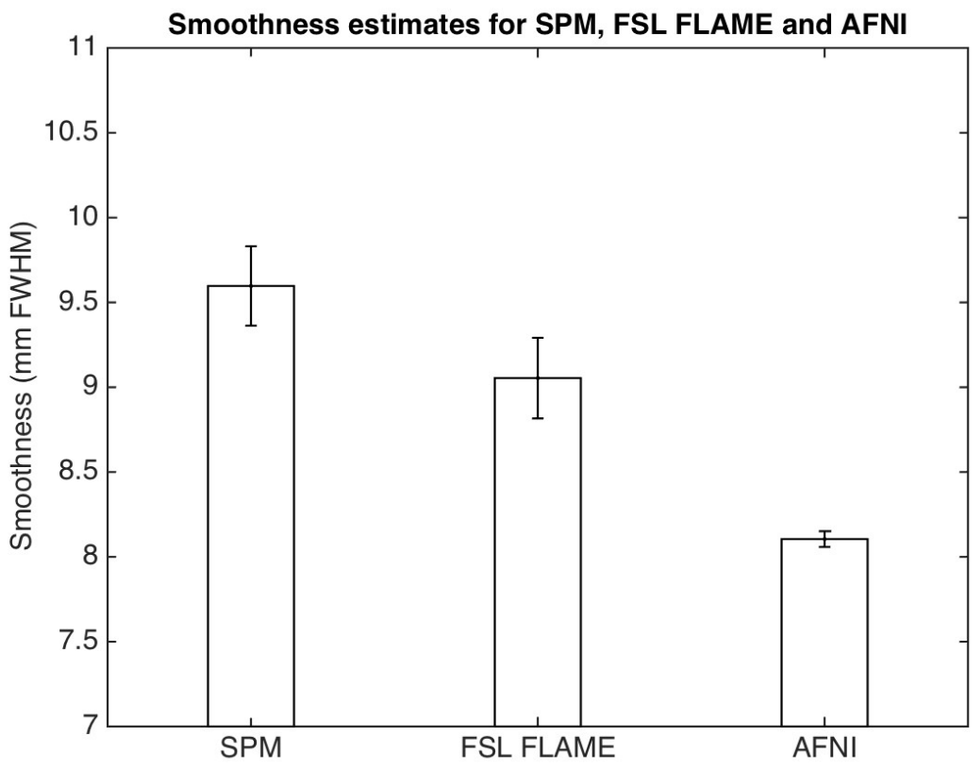
- Assessed latest 100 papers matching query for fMRI activation studies
  - 65 reported whole-brain activation data
  - Good news
    - only 3 papers reported uncorrected results
  - Bad news
    - 11% of papers analyzed data using SPM/FSL but then corrected for multiple comparisons using AFNI's alphasim/3dclustsim
  - Why is this a problem?

Poldrack et al., submitted

Communal p-hacking?

- Eklund et al. (2016, PNAS)
  - "a 15 year old bug was found in 3dClustSim while testing the three software packages (the bug was fixed by the AFNI group as of May 2015, during preparation of this manuscript). The effect of the bug was an underestimation of how likely it is to find a cluster of a certain size (in other words, the p-values reported by 3dClustSim were too low)."
  - AFNI also underestimated smoothness



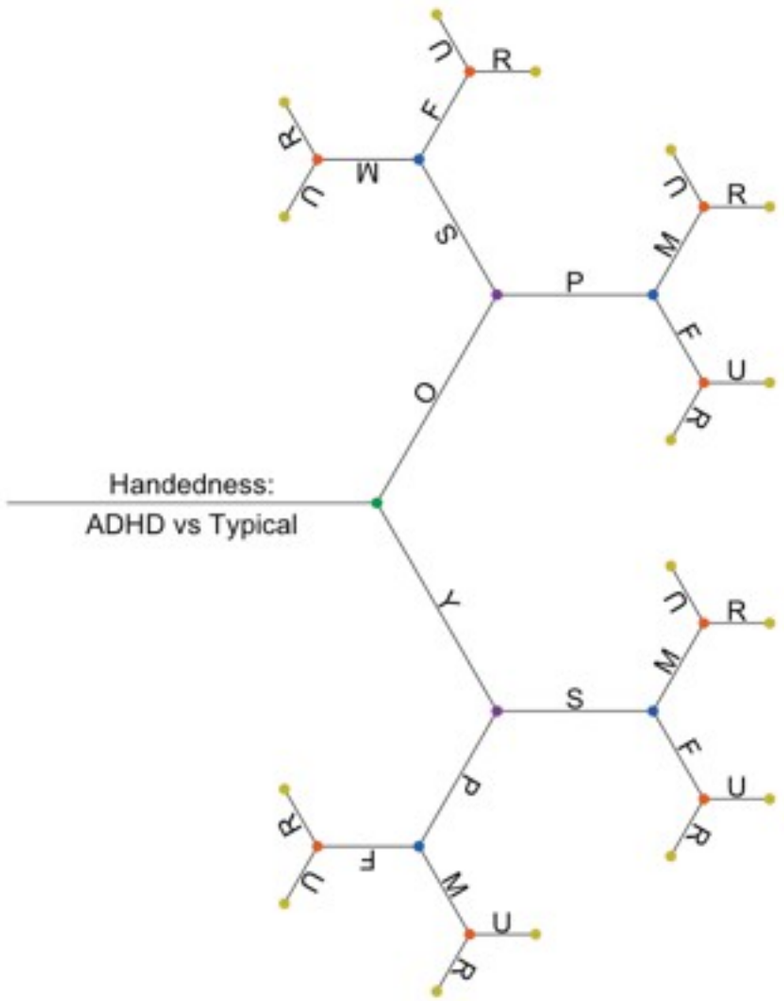


The garden of forking paths

The garden of forking paths: Why multiple comparisons can be a problem, even when there is no "fishing expedition" or "p-hacking" and the research hypothesis was posited ahead of time*

Andrew Gelman† and Eric Loken‡

14 Nov 2013



Bishop, 2016

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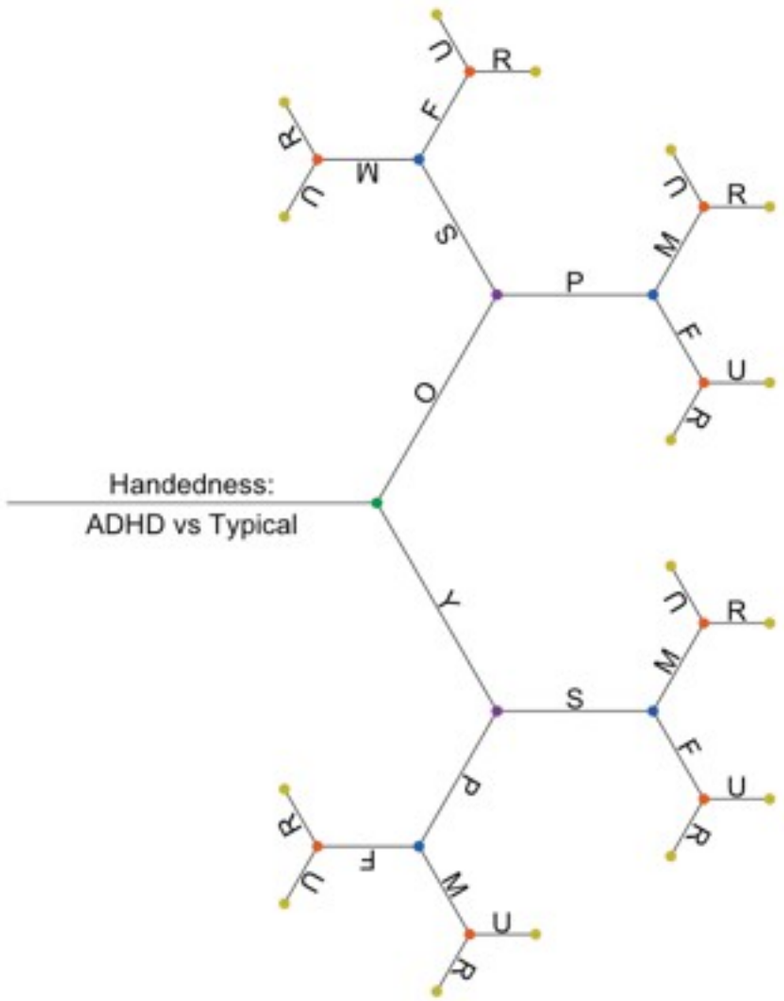


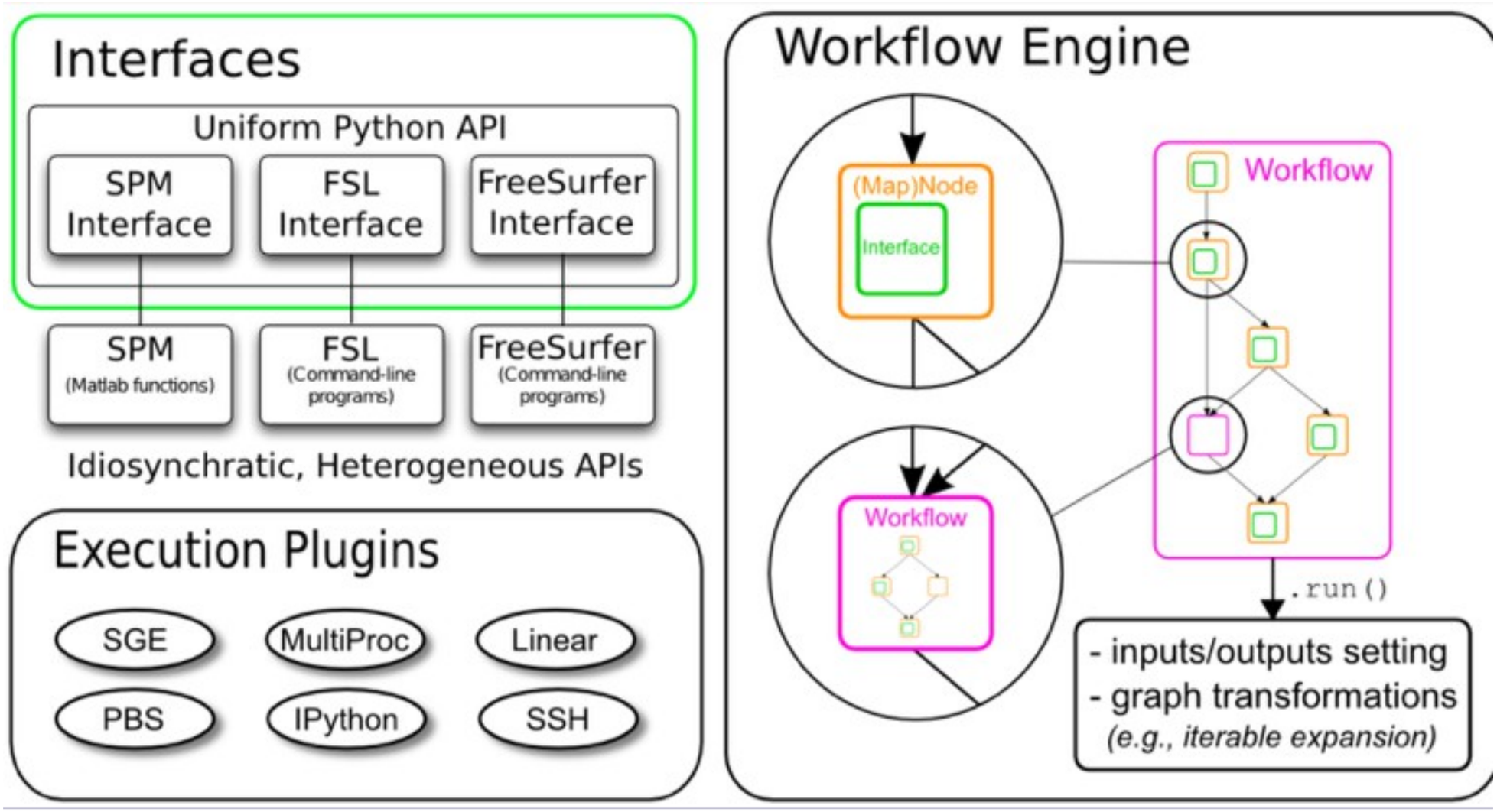
Bishop, 2016

Improvement: Study pre-registration

- Register sample size and analysis plan up front
- This does not prevent exploratory analysis
  - But planned and exploratory analyses must be clearly delineated in the paper

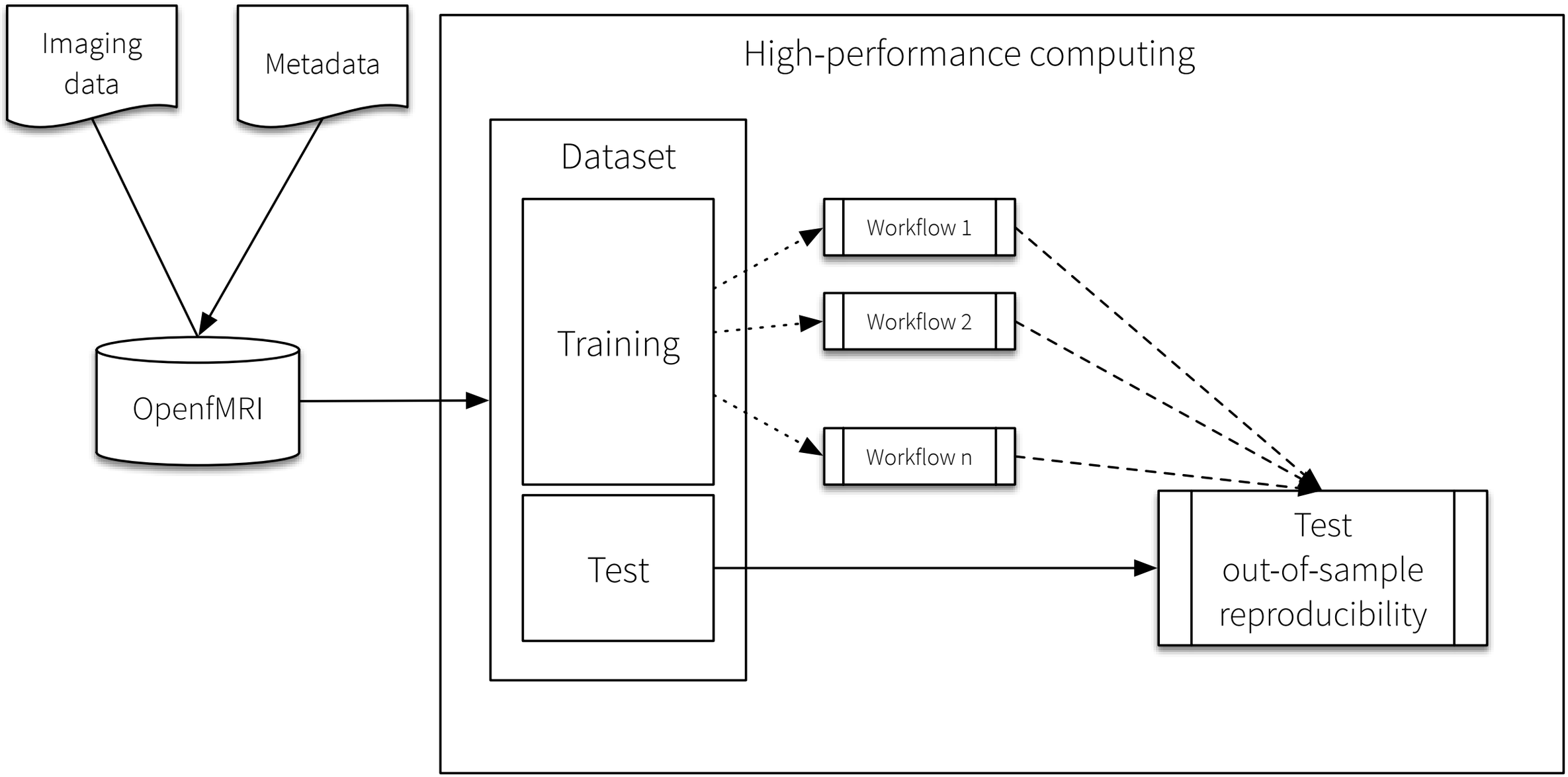
Improvement: Mapping the garden

nipype.org



Tracking every analysis
allows a full characterization of exploration

Improvement: Quantifying "vibration of effects"



Focusing on finding generalizable results,
rather than hitting the $p<0.05$ jackpot

Study reporting and transparency

- In 22 of the 65 papers we analyzed for multiple comparison procedures, it was impossible to identify precisely which correction technique was used
- beyond generic terms such as “cluster based correction”

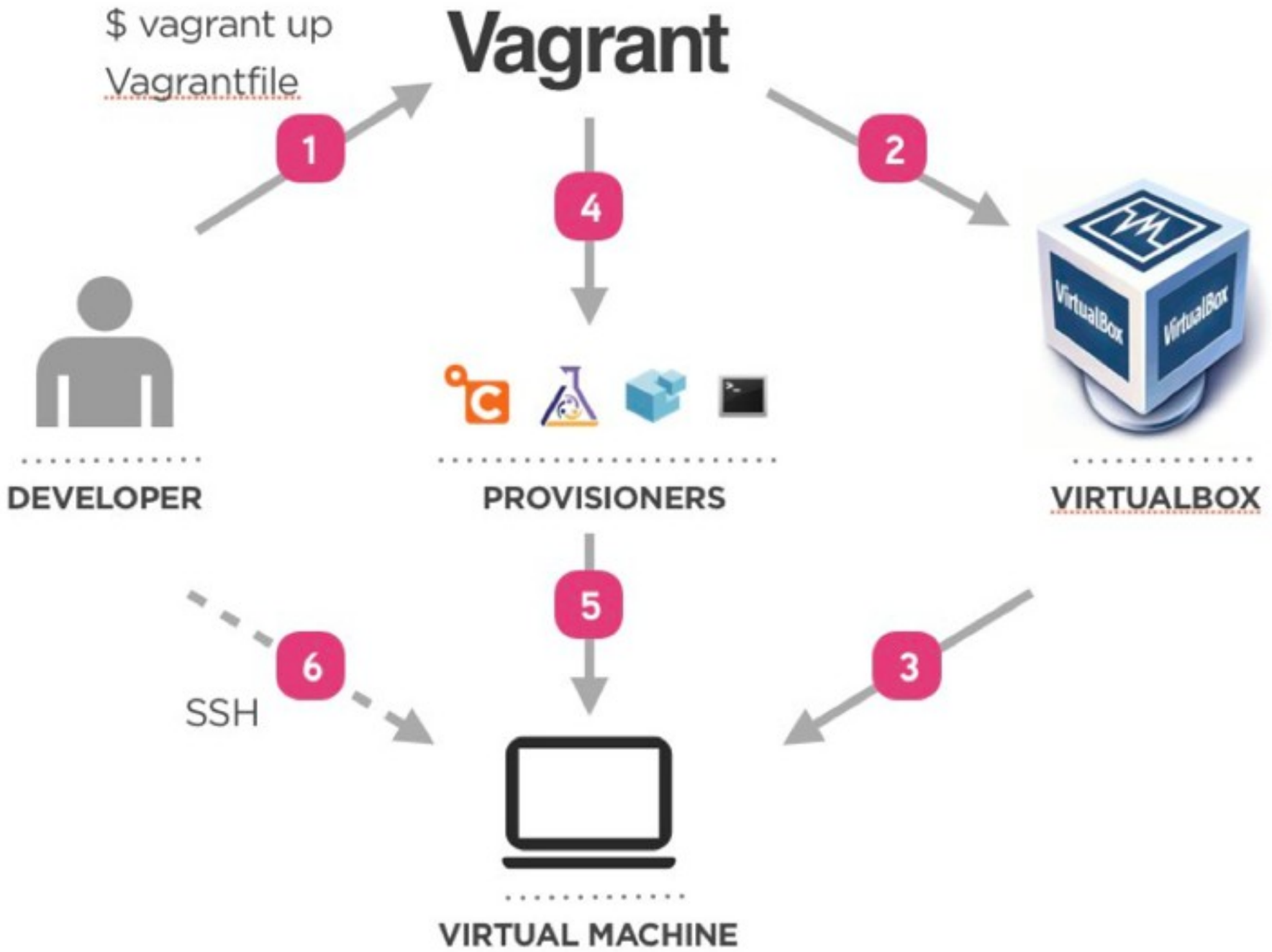
Improvement: Better study description

- OHBM Committee on Best Practices in Data Analysis and Sharing (COBIDAS) report
  - www.humanbrainmapping.org/cobidas/
- In the future, tools may be able to automatically generate standards-compliant methods text from a nipype workflow

Improvement: Sharing of analysis platforms

- "an article about a computational result is advertising, not scholarship. The actual scholarship is the full software environment, code and data, that produced the result." - Buckheit & Donoho, 1995
- The tale of myconnectome

Virtual machines as tools for reproducible science



Google Cal | https://ww | https://twitt | https://app | Nature | Shared with | Handling M | poldrack/my | Russ

GitHub, Inc. [US] https://github.com/poldrack/myconnectome-vm

Apps | Google Calendar - W | SERA | Axess | PubMed | sklearn | nipype

This repository Search | Pull requests | Issues | Gist

poldrack / myconnectome-vm

Unwatch 2 | Star 0 | Fork 1

Virtual machine setup for MyConnectome data analysis — Edit

86 commits | **1** branch | **0** releases | **3** contributors

Branch: **master** | **myconnectome-vm** / +

Merge pull request #14 from vsoch/master ···

poldrack authored 23 days ago — latest commit 3b45da4ddb

LICENSE	Initial commit	2 months ago
README.md	Update README.md	24 days ago
Vagrantfile	removing supervisor controller from application - will be run with st…	23 days ago

README.md

MyConnectome-VM: A virtual machine to implement MyConnectome analyses.

The MyConnectome project is a project meant to investigate the relations between mind, brain, and body across an extended period of time in a single individual. One of the major goals of the project is to serve as a testbed for reproducible analysis practices. For this reason, we have released the data and as much code as possible for the processing and analyses.

Code

Issues 0

Pull requests 0

Wiki

Pulse

Graphs

Settings

SSH clone URL

git@github.com:poldr

You can clone with HTTPS, SSH, or Subversion.

Clone in Desktop

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nihms-470697.pdf | yoi140096.pdf | Show All

Conclusions

- fMRI has come a long way in 20 years, but we have a long way to go
- We need to move towards approaches that will give us greater insight into selective mind-brain mappings
- "The first principle is that you must not fool yourself and you are the easiest person to fool"
  - R. Feynman
  - We need to redesign the choice architecture of fMRI methods so that it prevents rather than affords fooling ourselves

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The Poldrack Lab @ Stanford

http://reproducibility.stanford.edu

NSF

Data sets and code will be made available at www.openfmri.org