



# Toward an Open Science Ecosystem in Neuroimaging

Russ Poldrack  
Stanford University

# Conflicts of interest

- I have research grants from the US National Institutes of Health
- I am a paid consultant for the US National Institute of Mental Health

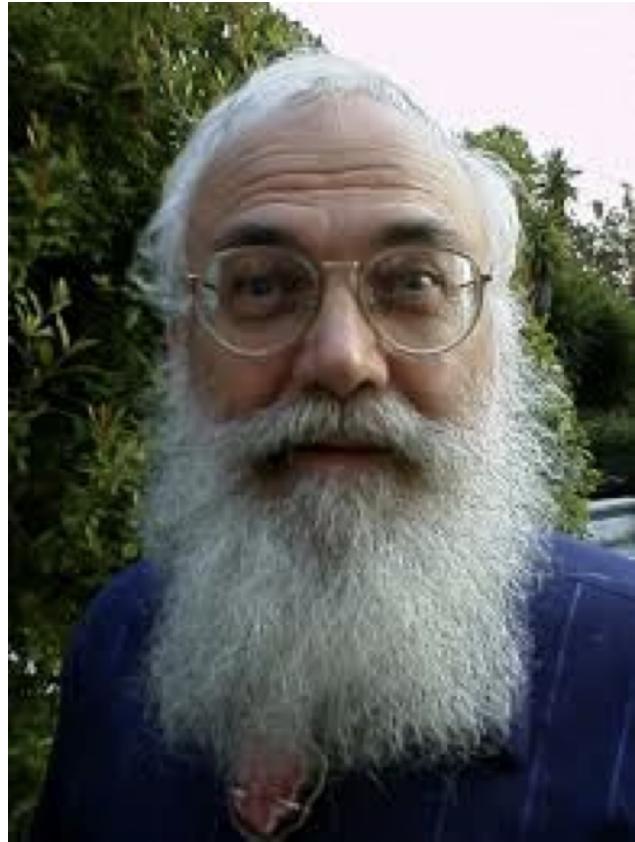
# Transparency is essential for reproducibility

		Data	
		Same	Different
Analysis	Same	Reproducible	Replicable
	Different	Robust	Generalisable

“we can distill Claerbout’s insight into a slogan:

An article about computational science in a scientific publication is not the scholarship itself, it is merely advertising of the scholarship. The actual scholarship is the complete software development environment and the complete set of instructions which generated the figures..”

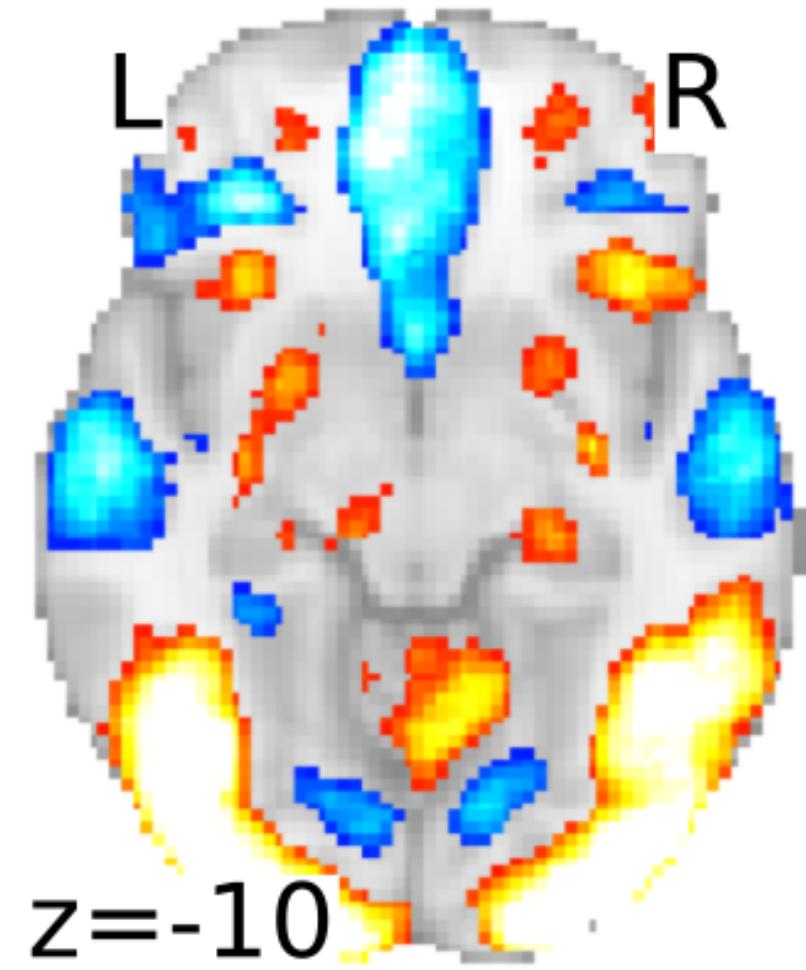
- Buckheit & Donoho, 1995



- Jon Claerbout

# Why neuroimaging is a best-case scenario for open science

- Magnetic resonance imaging (MRI) is the primary tool for studying human brain structure and function
- MRI data are digital end-to-end
  - From MRI scanner to automated analysis
  - Usually zero/few manual analysis steps
- The field has largely converged on:
  - a standardized image format (NiFTI)
  - a ~common spatial coordinate system



# A false start for fMRI data sharing

The fMRI Data Center  
**fMRI**DC

SEARCH fMRI<sup>100</sup>DC Database FOR  SUBMIT

▶ HOME  
DATABASE  
SUBMISSIONS  
RESOURCES  
DATA MANAGEMENT TOOL  
HELP  
ABOUT US

[Sitemap](#)   
[Contact Us](#)



A public repository of peer-reviewed fMRI studies and their underlying data.  
Funded By  
The National Science Foundation  
The W. M. Keck Foundation  
The National Institutes of Mental Health  
A Sun Center of Excellence for Neuroscience

**PROJECT STATISTICS**

Registered users: 1912  
Datasets available: 110  
Dataset requests: 1789  
[More database statistics...](#)

Updated November 18, 2005

**INFORMATION**

[How do I get started?](#)  
Answers to questions commonly posed by first-time visitors.

[Q&A about fMRI<sup>100</sup>DC](#)  
A comprehensive list of frequently asked questions about the fMRI<sup>100</sup>DC.

[Available Datasets](#)  
A list of datasets currently available.

[Information for Authors](#)  
How to submit your imaging data to the Data Center.

[fMRI Data Management Tool](#)  
A tool to aid in the tracking, sharing, and searching of data from neuroimaging experiments.

**fMRI<sup>100</sup>DC NEWS**

[fMRI<sup>100</sup>DC Releases DCSearch \(beta\)](#)  
November 10, 2005 - Now Search the fMRI Data Center archive by anatomical region, Brodmann area, talairach/MNI coordinates, and other fields.

[Michael Gazzaniga Elected to Institute of Medicine](#)  
October 24, 2005 - fMRI<sup>100</sup>DC PI Receives Honor

[The PALS Brain Atlas from WUSTL](#)  
October 17, 2005 - As seen in Science NetWatch, 7 Oct 2005

[Computer Generated Phantoms for Use in Evaluating fMRI Methods](#)  
October 6, 2005 - Free test images for use in assessing data processing routines

[More news items...](#)

**Special Collections**  
Data from special or rare populations of subjects.

**Summer Workshops**

**The New Perspectives in fMRI Research Award**

**fMRI<sup>100</sup>DC Data Management Tool**  
Written in Java.™

**Our computing power. Your analysis.**  
High-performance servers and databases available to researchers.

Maintained at [Dartmouth College](#), [Disclaimer](#) and [Privacy Statement](#)  
©1999-2005, The fMRI Data Center. All rights reserved.

[Web site design and development by Paradigm Consulting Co.](#)

# A false start for fMRI data sharing

**nature  
neuroscience**

## A debate over fMRI data sharing

**nature**

3 August 2000 Volume 406 Issue no 6795

## Whose scans are they, anyway?

This letter comes from a group of scientists who are publishing papers using fMRI to understand the links between brain and behavior. We are writing in reaction to the recent announcement of the creation of the National fMRI Data Center ([www.fmridc.org](http://www.fmridc.org)). In the letter announcing the creation of the center, it was also implied that leading journals in our field may require authors of all fMRI related papers accepted for publication to submit all experimental data pertaining to their paper to the Data Center. ... We are particularly concerned with any journal's decision to require all authors of all fMRI related papers accepted for publication to submit all experimental data pertaining to their paper to the Data Center.

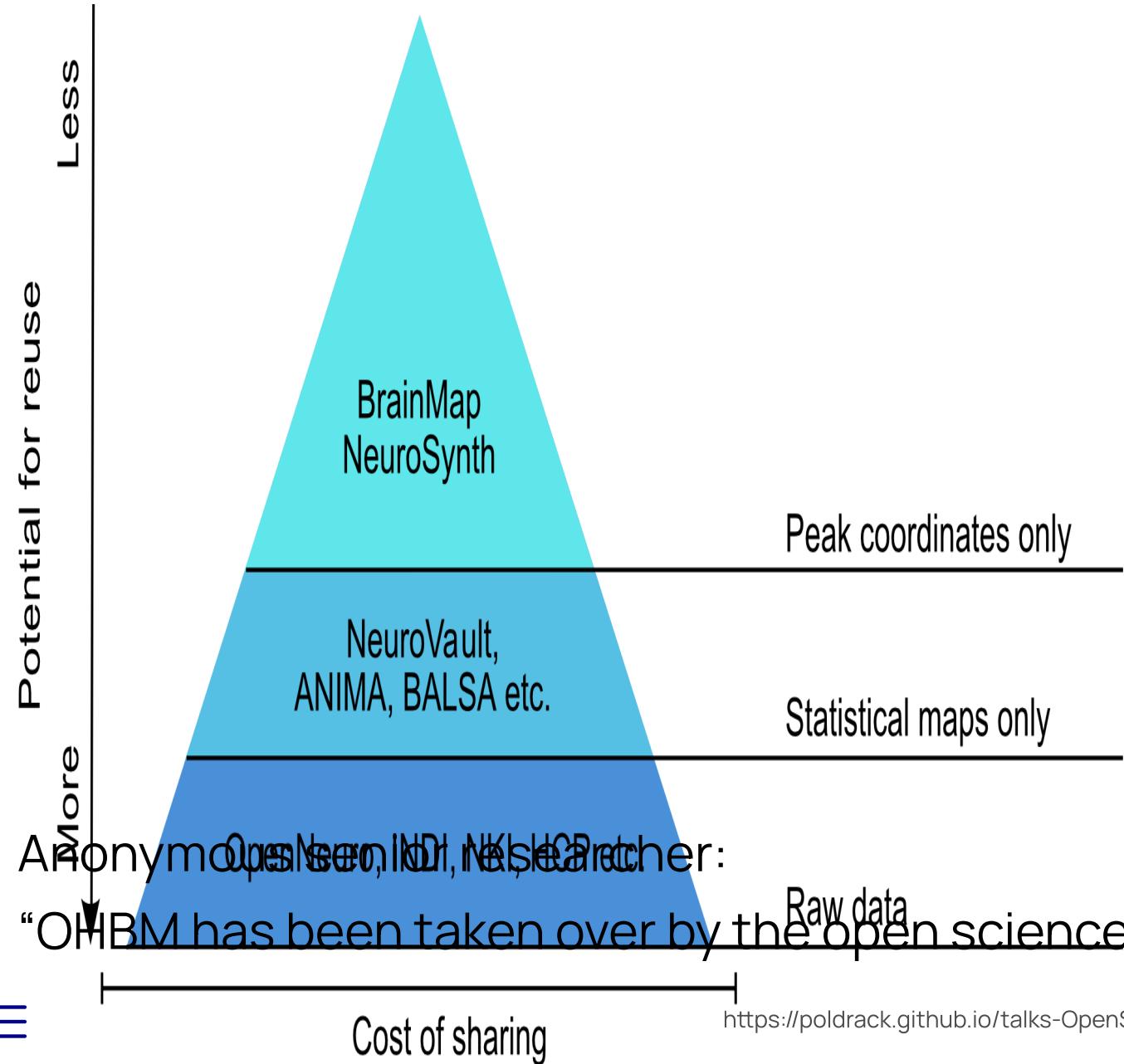
# 2010: The year data sharing broke in neuroimaging

## Toward discovery science of human brain function

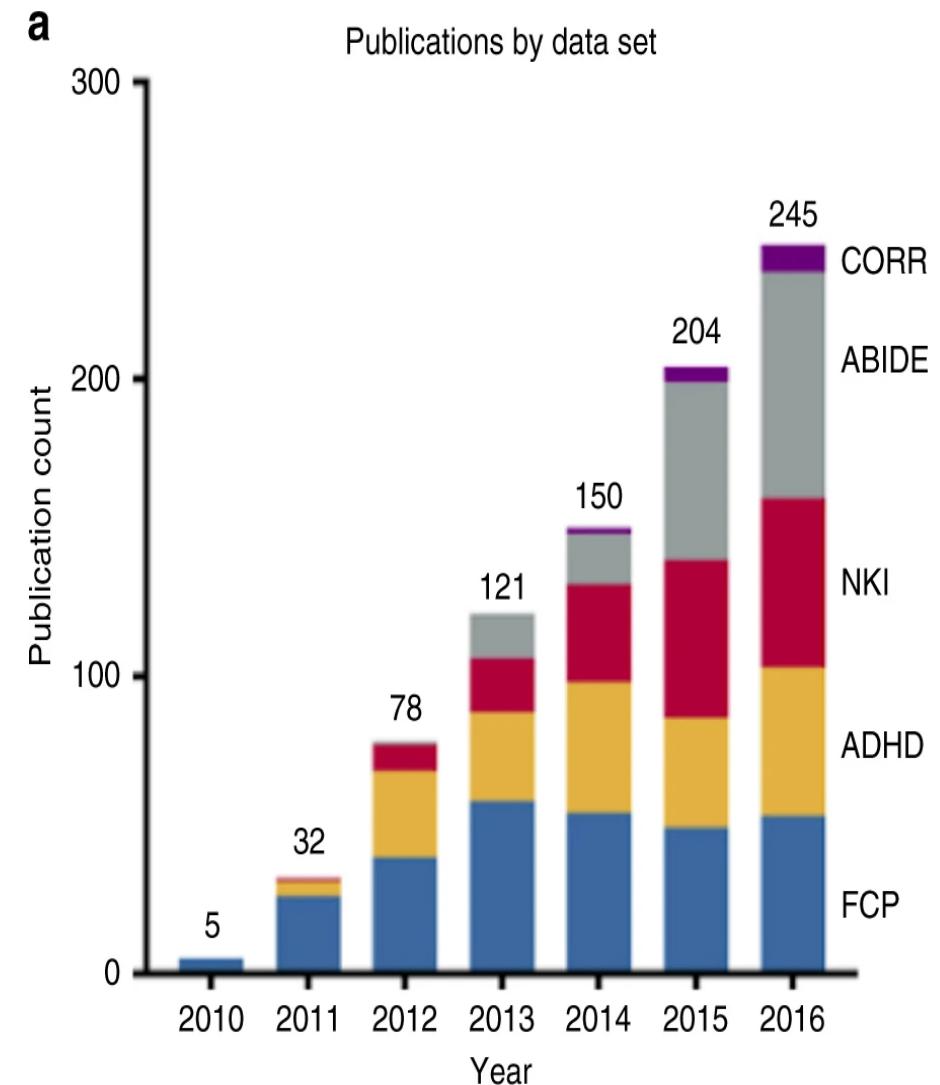
Bharat B. Biswal<sup>a</sup>, Maarten Mennes<sup>b</sup>, Xi-Nian Zuo<sup>b</sup>, Suril Gohel<sup>a</sup>, Clare Kelly<sup>b</sup>, Steve M. Smith<sup>c</sup>, Christian F. Beckmann<sup>c</sup>, Jonathan S. Adelstein<sup>b</sup>, Randy L. Buckner<sup>d</sup>, Stan Colcombe<sup>e</sup>, Anne-Marie Dogonowski<sup>f</sup>, Monique Ernst<sup>g</sup>, Damien Fair<sup>h</sup>, Michelle Hampson<sup>i</sup>, Matthew J. Hoptman<sup>j</sup>, James S. Hyde<sup>k</sup>, Vesa J. Kiviniemi<sup>l</sup>, Rolf Kötter<sup>m</sup>, Shi-Jiang Li<sup>n</sup>, Ching-Po Lin<sup>o</sup>, Mark J. Lowe<sup>p</sup>, Clare Mackay<sup>c</sup>, David J. Madden<sup>q</sup>, Kristoffer H. Madsen<sup>f</sup>, Daniel S. Margulies<sup>r</sup>, Helen S. Mayberg<sup>s</sup>, Katie McMahon<sup>t</sup>, Christopher S. Monk<sup>u</sup>, Stewart H. Mostofsky<sup>v</sup>, Bonnie J. Nagel<sup>w</sup>, James J. Pekar<sup>x</sup>, Scott J. Peltier<sup>y</sup>, Steven E. Petersen<sup>z</sup>, Valentin Riedl<sup>aa</sup>, Serge A. R. B. Rombouts<sup>bb</sup>, Bart Rypma<sup>cc</sup>, Bradley L. Schlaggar<sup>dd</sup>, Sein Schmidt<sup>ee</sup>, Rachael D. Seidler<sup>ff,u</sup>, Greg J. Siegle<sup>gg</sup>, Christian Sorg<sup>hh</sup>, Gao-Jun Teng<sup>ii</sup>, Juha Veijola<sup>jj</sup>, Arno Villringer<sup>ee,kk</sup>, Martin Walter<sup>ll</sup>, Lihong Wang<sup>q</sup>, Xu-Chu Weng<sup>mm</sup>, Susan Whitfield-Gabrieli<sup>nn</sup>, Peter Williamson<sup>oo</sup>, Christian Windischberger<sup>pp</sup>, Yu-Feng Zang<sup>qq</sup>, Hong-Ying Zhang<sup>ii</sup>, F. Xavier Castellanos<sup>b,j</sup>, and Michael P. Milham<sup>b,1</sup>

4734–4739 | PNAS | March 9, 2010 | vol. 107 | no. 10

# Data sharing is becoming the norm in neuroimaging



<https://poldrack.github.io/talks-OpenScienceEcosystem/>



Milham et al., *Nature Communications*, 2018

# An open ecosystem for retrospective data sharing

Breadth

The screenshot shows the Neurosynth.org homepage. At the top, there is a navigation bar with links to Neurosynth.org (Beta), Home, Meta-analyses, Studies, Locations, Decoder, Code, FAQs, and Sign in. Below the navigation bar, the text "neurosynth.org" is displayed, followed by a subtitle: "Neurosynth is a platform for large-scale, automated synthesis of functional magnetic resonance imaging (fMRI) data. It takes thousands of published articles reporting the results of fMRI studies, chews on them for a bit, and then spits out images that look like this." Below this text are three brain maps labeled y=0, x=0, and z=0, showing red clusters of activity. A caption below the maps reads "An automated meta-analysis of 790 studies of emotion". Below these images is the NeuroVault logo, which features a stylized brain icon above the word "NEUROVAULT". At the bottom of the screenshot is the OpenNEURO logo, which consists of a 3D cube icon with blue dots and the text "OpenNEURO" in white and blue.

Depth

- Neurosynth.org: Open database of published neuroimaging coordinates
- Neurovault.org: Open archive for neuroimaging results
- OpenNeuro.org: Open archive for raw/processed neuroimaging data

# Maximally open sharing

- Data shared under maximally permissive data use agreements:
  - Neurosynth: Open Data Commons Open Database License v1.0
  - Neurovault: CC0
  - OpenNeuro: CC0
- All data available programmatically via web API as well as web page



- CC0 enables scientists, educators, artists and other creators and owners of copyright- or database-protected content to waive those interests in their works and thereby place them as completely as possible in the public domain, so that others may freely build upon, enhance and reuse the works for any purposes without restriction under copyright or database law.
  - <https://creativecommons.org/share-your-work/public-domain/cc0/>

# Neurosynth: Sharing activation coordinates

- Brain activity is reported in a (somewhat) standardized coordinate system

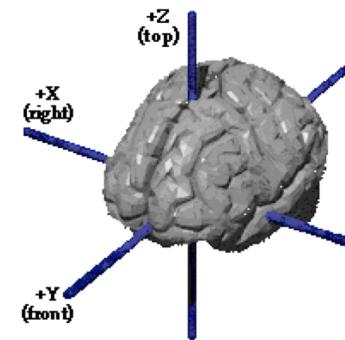


Table 1

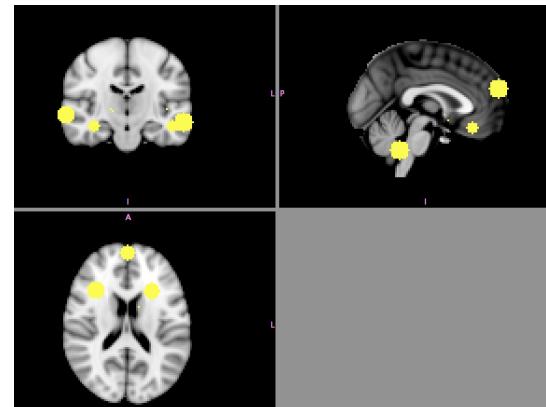
Regions that showed a condition × time interaction in the ANOVA analysis

No.	Region	Hemisphere	BA	x	y	z	mm <sup>3</sup>
1	Middle/superior temporal gyrus	L	21/22/37	-52	-54	9	13257
2	Inferior frontal gyrus	L	45/46/9	-49	26	6	2781
3	Posterior cerebellum	L		-19	-79	-38	2214
4	Dorsomedial PFC	L	9/8	-11	42	47	3051
5	Left anterior PFC	L	10	-37	49	15	2025
6	Inferior parietal cortex	L	40/7	-42	-58	47	3132
7	Dorsal premotor cortex	L	6	-43	0	50	1485
8	Lingual gyrus	L	17	-10	-95	-2	378
9	Middle /superior temporal gyrus	R	21/22/37	52	-40	5	16470
10	Inferior frontal gyrus	R	45/46	51	28	6	2241
11	Posterior cerebellum	R		23	-78	-34	2808
12	Dorsomedial PFC	R	9	5	53	29	405
13	Right anterior PFC	R	10	38	42	21	5022
14	Inferior parietal cortex	R	40/7	42	-53	48	9963
15	Superior frontal gyrus	R	6/8	10	28	60	297
16	Anterior cingulate cortex	M	32	0	26	35	5076
17	Posterior cingulate cortex	M	23/31/7	0	-35	31	9612
18	Precuneus	M	7/19	1	-76	36	10044

# Creating meta-analytic maps

- Automated Coordinate Extraction
  - Automatically extracts activation tables from fMRI papers for 17 journals
  - Current database has 14,371 papers (with full text)
  - 84% sensitivity, 97% specificity against manual database (SumsDB)
- Meta-analytic maps created for each paper
  - 10mm sphere placed at each focus

X	Y	Z
12	57	-6
33	21	15
24	-6	51
28	10	18



Yarkoni et al, 2011, *Nature Methods*

# working memory

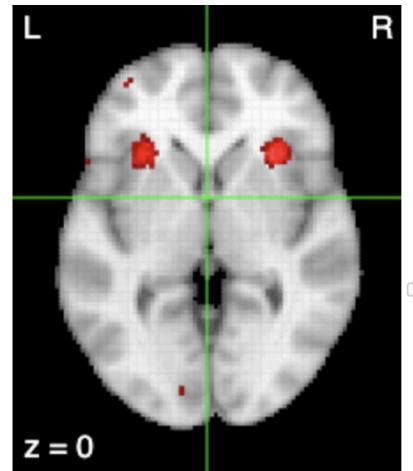
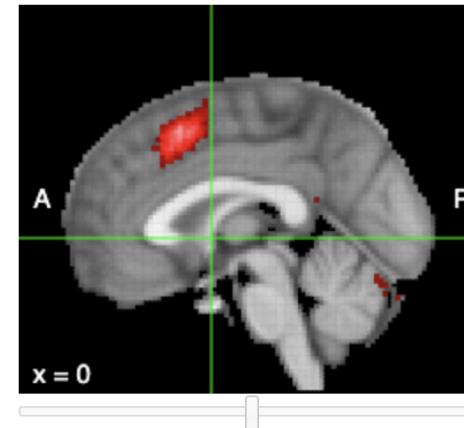
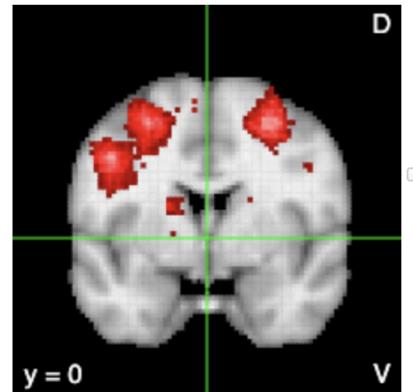
An automated meta-analysis of 1091 studies

Search for another term:

Maps

Studies

FAQs



z-score: 0 What's here?

X: 0 Y: 0 Z: 0

Layers

<input checked="" type="checkbox"/> eye	working memory: association test	<input type="button" value="Delete"/>	<input type="button" value="Download"/>
<input checked="" type="checkbox"/> eye	working memory: uniformity test	<input type="button" value="Delete"/>	<input type="button" value="Download"/>
<input checked="" type="checkbox"/> eye	anatomical	<input type="button" value="Delete"/>	<input type="button" value="Download"/>

Color palette:

red ▼

Crosshairs

Positive/Negative:

positive ▼

Pan/zoom

Labels

Thresholds:

0 ▼ 0

Opacity:

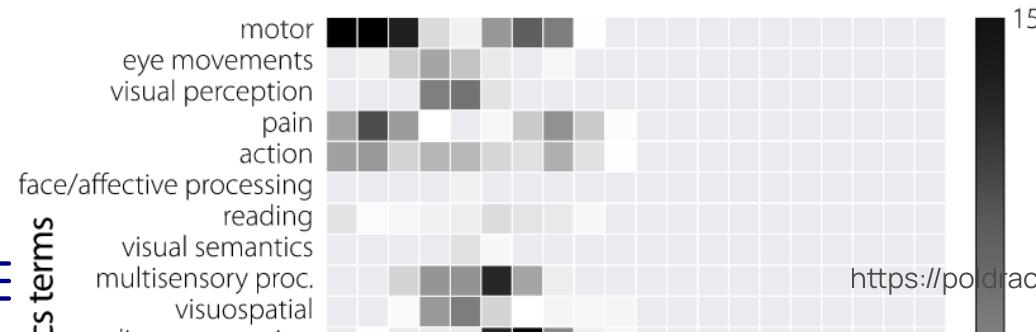
1 ▼

# Example of Neurosynth usage

## Situating the default-mode network along a principal gradient of macroscale cortical organization

Daniel S. Margulies<sup>a,1</sup>, Satrajit S. Ghosh<sup>b,c</sup>, Alexandros Goulas<sup>d</sup>, Marcel Falkiewicz<sup>a</sup>, Julia M. Huntenburg<sup>a,e</sup>, Georg Langs<sup>f,g</sup>, Gleb Bezgin<sup>h</sup>, Simon B. Eickhoff<sup>i,j</sup>, F. Xavier Castellanos<sup>k,l</sup>, Michael Petrides<sup>m</sup>, Elizabeth Jefferies<sup>n,o</sup>, and Jonathan Smallwood<sup>n,o</sup>

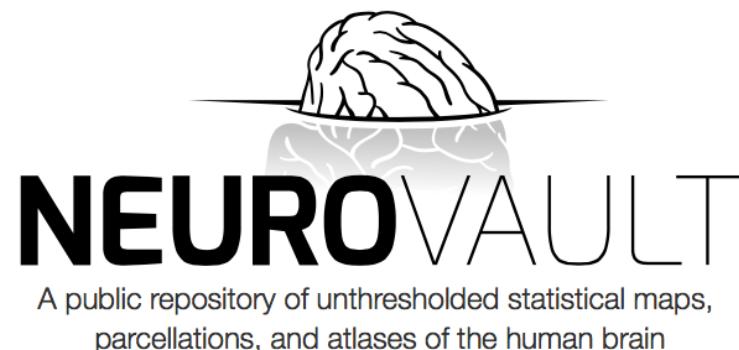
12574–12579 | PNAS | November 1, 2016 | vol. 113 | no. 44



- Identified gradients of functional organization across the cortex
- Used Neurosynth to identify the most common terms associated with each

# Neurovault: Sharing neuroimaging results

- The results of most neuroimaging studies are images with statistical estimates at each voxel
- Neurovault.org is an open archive for these results



## 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



Get started and upload an image!

- Collections

- A set of images (such as all images from a particular paper) can be uploaded as a collection
- Each collection receives a persistent identifier

NeuroVault Collections Metaanalyses About RussPoldrack Search

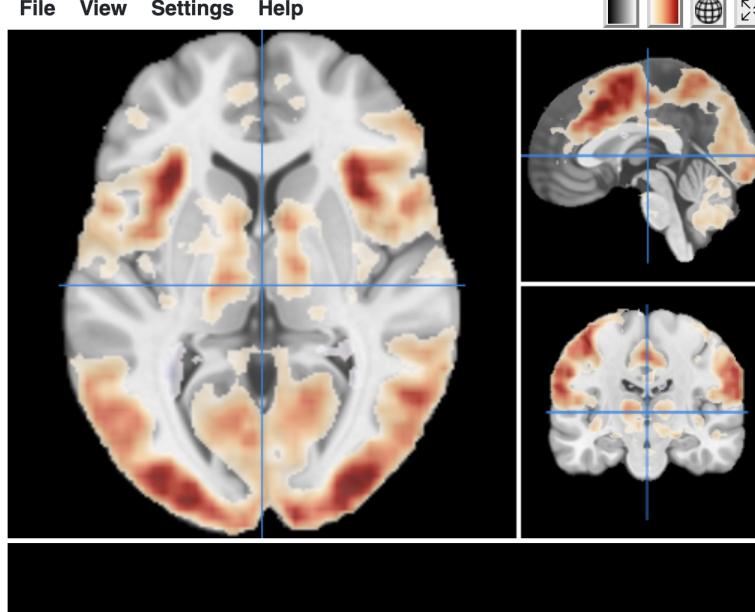
## Preprocessed Consortium for Neuropsychiatric Phenomics dataset

Related article: <http://doi.org/10.12688/f1000research.11964.2>

Source data:

3D View Download

File View Settings Help



Group Metadata

Show 7 entries Search:

View	ID	Name	Type
	49974	BART Accept	T map
	49975	BART AcceptParam - ExplodeParam	T map
	49976	BART AcceptParam - RejectParam	T map
	49977	BART AcceptParametric	T map
	49978	BART Accept_RT	T map
	49979	BART Control	T map
	49980	BART Explode - Reject	T map

Showing 1 to 7 of 178 entries First Previous Next Last

Citation guidelines

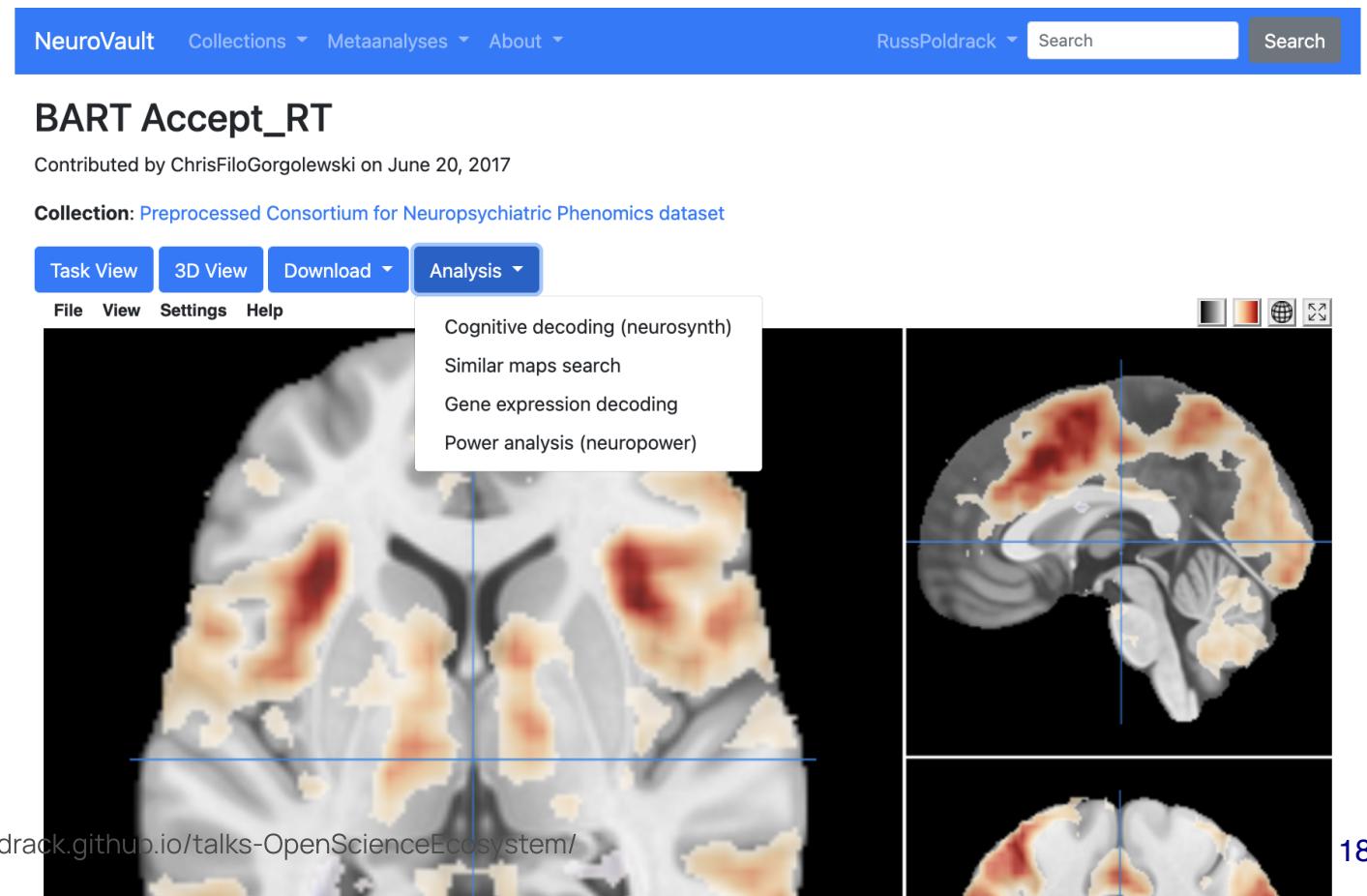
If you use the data from this collection please include the following persistent identifier in the text of your manuscript:

<https://identifiers.org/neurovault:collection:2606> <https://poldrack.github.io/talks/OpenScienceEcosystem/>

This will help to track the use of this data in the literature. In addition, consider also citing the paper related to this collection.

- **Image browser**

- Individual images can be browsed and downloaded
- A number of analysis tools can also be applied
- Each image also receives a persistent identifier



# Example of Neurovault usage

## Comprehensive decoding mental processes from Web repositories of functional brain images

Romuald Menuet<sup>5,6</sup>, Raphael Meudec<sup>1,2,3,6</sup>, Jérôme Dockès<sup>4</sup>, Gael Varoquaux<sup>1,2,3</sup> & Bertrand Thirion<sup>1,2,3</sup>✉

Scientific Reports | (2022) 12:7050



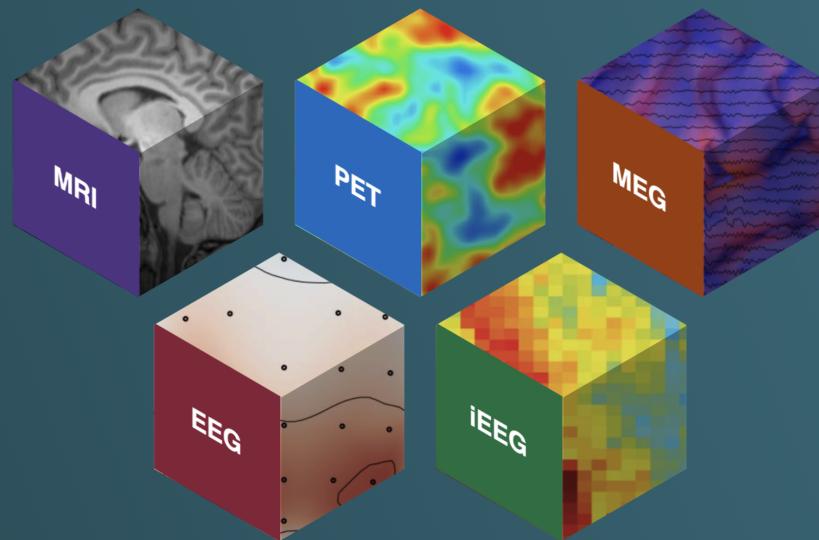
# OpenNEURO

[SEARCH](#) [SUPPORT](#) [FAQ](#)[Sign in](#)

A free and open platform for validating and sharing BIDS-compliant [MRI](#), [PET](#), [MEG](#), [EEG](#), and [iEEG](#) data

**29,064** Participants

**761** Public Datasets



Browse by Modalities

Or

Search



[SIGN IN](#)

[Google](#)

[ORCID](#)



## Validation Using BIDS

The [Brain Imaging Data Structure](#) (BIDS) is an emerging standard for the organization of neuroimaging data.

Want to contribute to BIDS?

Visit the [Google discussion group](#) to contribute.



## OpenNeuro Runs on DataLad

Want to access OpenNeuro datasets with DataLad? Visit the [dataset collection on GitHub](#).

A data management solution built on [Git](#) and [Git annex](#). Read more about [DataLad](#).



Simply sharing data is not sufficient  
It must be shared in a way that makes it useful!

# It's easy to share data badly

## Data Sharing and Management Snafu in 3 Short Acts

- <https://www.youtube.com/watch?v=N2zK3sAtr-4>



- I received the data, but when I opened it up it was in hexadecimal
  - Yes, that is right
  - I cannot read hexadecimal
  - You asked for my data and I gave it to you. I have done what you asked.
- ...
- Is there a guide to the data anywhere?
  - Yes, of course, it is the article that is published in Science.

# Brain Imaging Data Structure (BIDS)

- A community-based open standard for neuroimaging data



SCIENTIFIC DATA

## OPEN

### SUBJECT CATEGORIES

- » Data publication and archiving
- » Research data

The brain imaging data structure, a format for organizing and describing outputs of neuroimaging experiments

Received: 18 December 2015

Accepted: 19 May 2016

Published: 21 June 2016

Krzysztof J. Gorgolewski<sup>1</sup>, Tibor Auer<sup>2</sup>, Vince D. Calhoun<sup>3,4</sup>, R. Cameron Craddock<sup>5,6</sup>, Samir Das<sup>7</sup>, Eugene P. Duff<sup>8</sup>, Guillaume Flandin<sup>9</sup>, Satrajit S. Ghosh<sup>10,11</sup>, Tristan Glatard<sup>7,12</sup>, Yaroslav O. Halchenko<sup>13</sup>, Daniel A. Handwerker<sup>14</sup>, Michael Hanke<sup>15,16</sup>, David Keator<sup>17</sup>, Xiangrui Li<sup>18</sup>, Zachary Michael<sup>19</sup>, Camille Maumet<sup>20</sup>, B. Nolan Nichols<sup>21,22</sup>, Thomas E. Nichols<sup>20,23</sup>, John Pellman<sup>6</sup>, Jean-Baptiste Poline<sup>24</sup>, Ariel Rokem<sup>25</sup>, Gunnar Schaefer<sup>1,26</sup>, Vanessa Sochat<sup>27</sup>, William Triplett<sup>1</sup>, Jessica A. Turner<sup>3,28</sup>, Gaël Varoquaux<sup>29</sup> & Russell A. Poldrack<sup>1</sup>

# The development of BIDS

- January 2015
  - Initial stakeholder meeting at Stanford (funded by INCF)
  - Initiated development of a draft standard
- September 2015
  - Draft standard posted to BIDS web site with 22 example datasets
  - Solicited feedback from community
- June 2016
  - Published paper
- September 2018
  - BIDS-standard Github organization started

# BIDS Principles

- *Adoption is crucial*
  - Keep it as similar to existing practices as possible
    - Don't let technology override usability!
  - Focus on engaging the community
- *Don't reinvent the wheel*
  - Use existing standards when possible
- *80/20 rule*
  - Focus on the most common use cases
  - Don't let the perfect be the enemy of the good!

# From DICOM to BIDS

dicomdir/

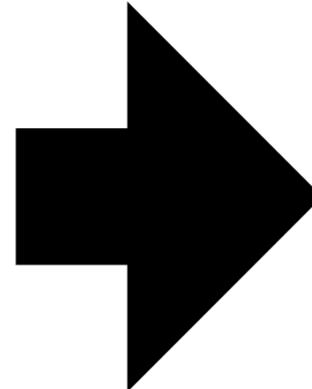
1208200617178\_22/

- 1208200617178\_22\_8973.dcm
- 1208200617178\_22\_8943.dcm
- 1208200617178\_22\_2973.dcm
- 1208200617178\_22\_8923.dcm
- 1208200617178\_22\_4473.dcm
- 1208200617178\_22\_8783.dcm
- 1208200617178\_22\_7328.dcm
- 1208200617178\_22\_9264.dcm
- 1208200617178\_22\_9967.dcm
- 1208200617178\_22\_3894.dcm
- 1208200617178\_22\_3899.dcm

1208200617178\_23/

1208200617178\_24/

1208200617178\_25/



my\_dataset/

participants.tsv

sub-01/

anat/

sub-01\_T1w.nii.gz

func/

sub-01\_task-rest\_bold.nii.gz

sub-01\_task-rest\_bold.json

dwi/

sub-01\_dwi.nii.gz

sub-01\_dwi.json

sub-01\_dwi.bval

sub-01\_dwi.bvec

sub-02/

sub-03/

sub-04/

# The importance of automated validation

## Summary

- 40 Files, 18.42kB
- 13 - Subjects
- 1 - Session

## Available Tasks

- rhyme judgment

## Available Modalities

- bold
- T1w

Your dataset is not a valid BIDS dataset.

[view 1 error in 23 files](#)

[view 1 warning in 4 files](#)

<https://bids-standard.github.io/bids-validator/>

<https://poldrack.github.io/talks-OpenScienceEcosystem/>

# BIDS Extensions

- BIDS was originally focused on structural/functional MRI data
- BIDS extension process allows extension of the standard through BIDS Extension Proposals (BEPS) initiated by the community
  - Patterned after the Python Enhancement Proposal (PEP) process

## 11 Completed BEPs:

BEP #	Title
-------	-------

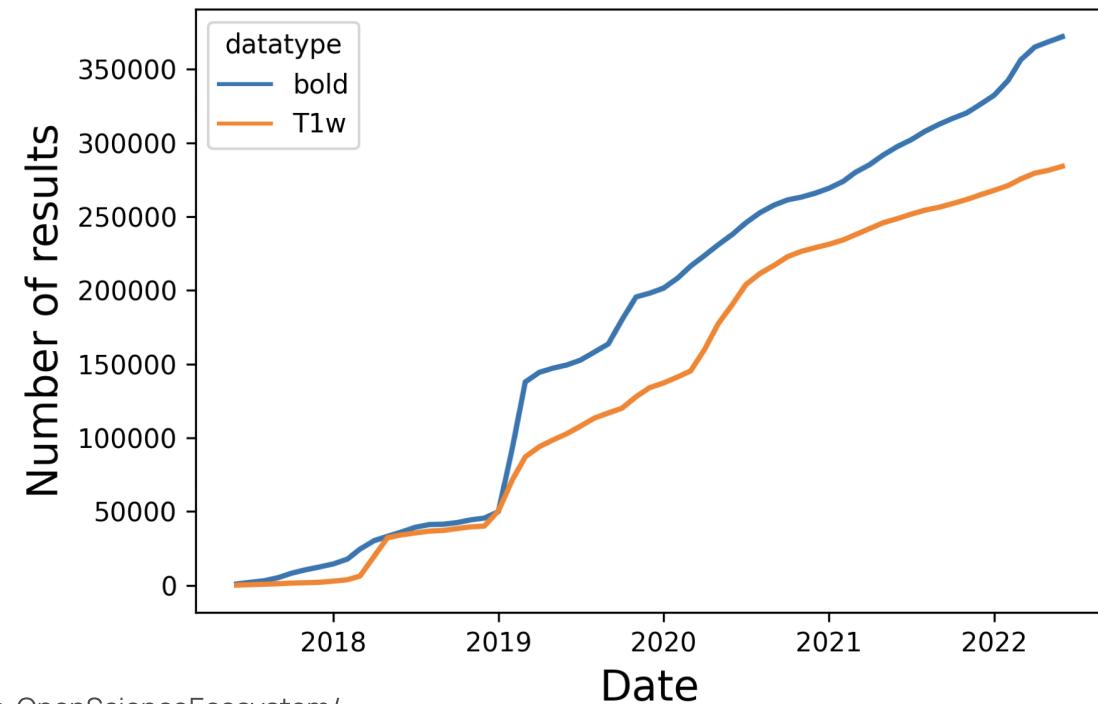
BEP001	Quantitative MRI (qMRI)
BEP003	Common Derivatives
BEP005	Arterial Spin Labeling (ASL)
BEP006	Electroencephalography (EEG)
BEP007	Hierarchical Event Descriptor (HED) Tags
BEP008	Magnetoencephalography (MEG)
BEP009	Positron Emission Tomography (PET)
BEP010	intracranial Electroencephalography (iEEG)
BEP018	Genetic information
BEP030	Near Infrared Spectroscopy (NIRS)
BEP031	Microscopy

# The growing usage of BIDS: An example

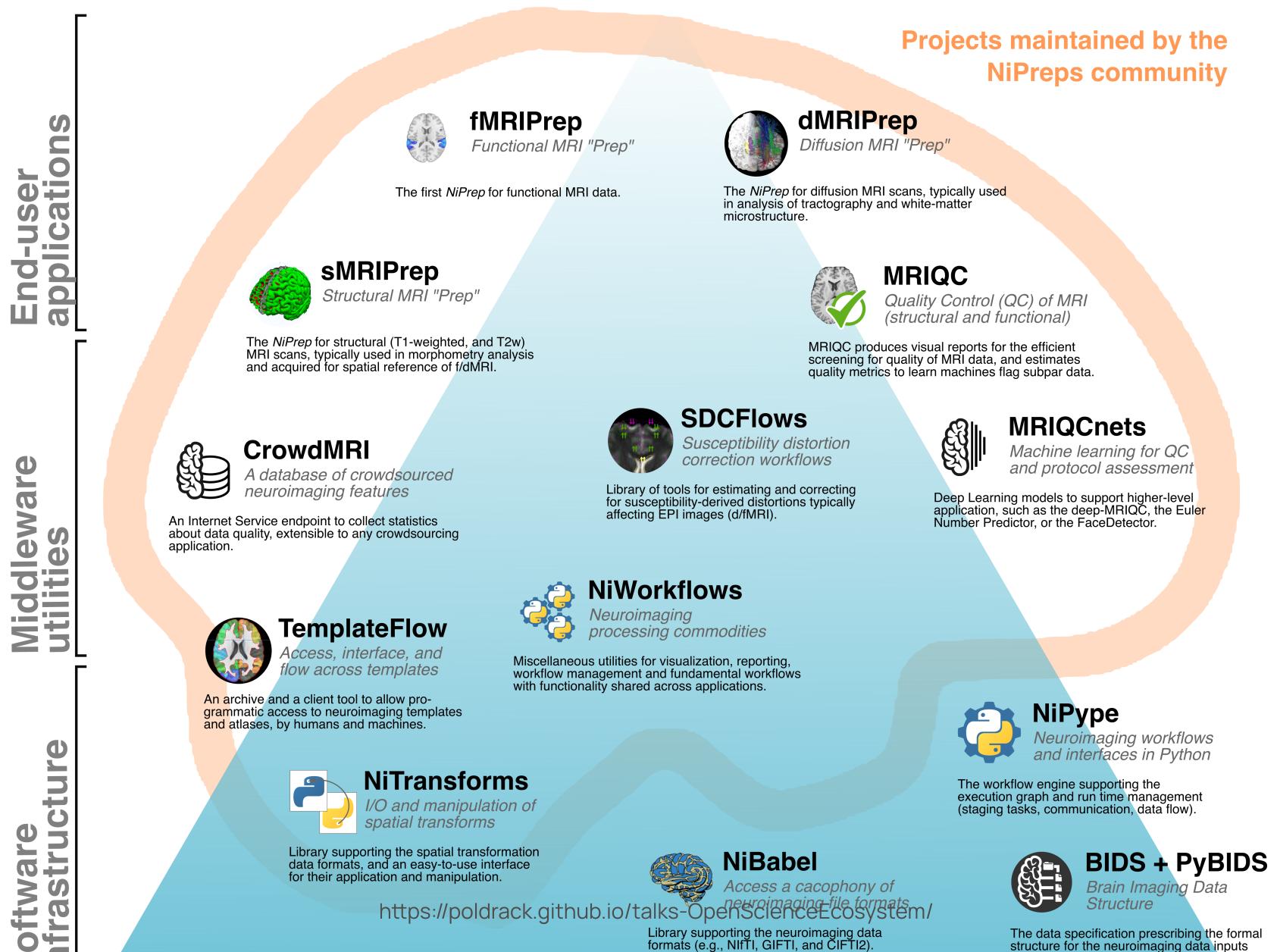
- MRIQC Web API
  - Crowdsourced database of MR QC metrics
  - QC metrics from ~375K unique BOLD scans and ~280K T1w scans as of June 2022
  - Publicly available:  
<https://mriqc.nimh.nih.gov/>

SCIENTIFIC DATA  
110110  
0111101  
11011110  
011101101

OPEN  
DATA DESCRIPTOR  
Received: 19 September 2018  
Accepted: 12 March 2019  
Crowdsourced MRI quality metrics and expert quality annotations for training of humans and machines  
Oscar Esteban<sup>1</sup>, Ross W. Blair<sup>1</sup>, Dylan M. Nielson<sup>2</sup>, Jan C. Varada<sup>3</sup>, Sean Marrett<sup>3</sup>, Adam G. Thomas<sup>1</sup>, Russell A. Poldrack<sup>1</sup> & Krzysztof J. Gorgolewski<sup>1</sup>



# BIDS enables a growing open-source software ecosystem



A free and open platform for validating and sharing BIDS-compliant [MRI](#), [PET](#), [MEG](#), [EEG](#), and [iEEG](#) data

29,064 Participants    761 Public Datasets

Browse by Modalities

Or

reading

SIGN IN    G Google    ORCID

- A BRAIN Initiative archive for neuroimaging data
- Supports sharing of any validated BIDS dataset



#### Validation Using BIDS

The [Brain Imaging Data Structure](#) (BIDS) is an emerging standard for the organization of neuroimaging data.

Want to contribute to BIDS?

Visit the [Google discussion group](#) to contribute.



#### OpenNeuro Runs on DataLad

Want to access OpenNeuro datasets with DataLad? Visit the [dataset collection on GitHub](#).

A data management solution built on [Git](#) and [Git annex](#). Read more about [DataLad](#).

## Search All Datasets

Keywords ?

Enter Keyword(s) to Search



reading X

These filters return **194** datasets:

CLEAR ALL

KEYWORD:

reading X

## Modalities

MRI

PET

EEG

iEEG

MEG

Age of Participants

Number of Participants

Diagnosis

Task

Authors / PI

Sex

Publication Date

Species

Study Type

Study Domain

Radiotracers

[The Reading Brain Project L1 Adults](#)

Uploaded by: Chanyuan Gu on 2022-01-07 - 10 months ago | Updated: 2022-01-05 - 10 months ago

MODALITY:

MRI

TASKS:

read task rest

OPENNEURO ACCESSION NUMBER: ds003974

SESSIONS: 1

PARTICIPANTS: 52

PARTICIPANTS' AGES: N/A

SIZE: 46.67GB

FILES: 893

[The Reading Brain Project L2 Adults](#)

Uploaded by: Chanyuan Gu on 2022-01-11 - 10 months ago | Updated: 2022-02-01 - 10 months ago

MODALITY:

MRI

TASKS:

read task rest

OPENNEURO ACCESSION NUMBER: ds003988

SESSIONS: 1

PARTICIPANTS: 56

PARTICIPANTS' AGES: N/A

SIZE: 63.82GB

FILES: 960

[The Reading Brain Project L2 Adults](#)

Uploaded by: Friederike Seyfried on 2021-11-08 - about 1 year ago | Updated: 2021-11-08 - about 1 year ago

MODALITY:

MRI

TASKS:

rest read task

OPENNEURO ACCESSION NUMBER: ds003872

SESSIONS: 1

PARTICIPANTS: 56

PARTICIPANTS' AGES: N/A

SIZE: 63.79GB

FILES: 960



MRI **The Reading Brain Project L2 Adults**
★ Follow 2 Bookmark 2
**BIDS Validation**

4 WARNINGS

Valid

brainlife.io

Clone

Files

Download

Metadata

**README**

OpenNeuro curator note: This dataset was previously accessible at ds002317. The dataset was reuploaded due to privacy considerations.

This dataset contains the bilingual (L2) adult subset of the Reading Brain Project (RBP) data, focusing on 56 participants who underwent two sessions of testing: MRI scanning and behavioral tests tests; collected 2-3 days apart. During the first session, following the scanning of structural (T1-weighted) and resting-state data, participants performed a reading task with simultaneous eye-tracking and fMRI scanning, and the session ended with a diffusion tensor imaging (DTI) scan. The second session consisted of only behavioral tests, including five standardized tests: the Attention Network Test (ANT), Gray's Silent Reading Test (GSRT), Letter-Number Sequencing (LNS), Peabody Picture Vocabulary Test (PPVT-4), and Tower of Hanoi (ToH), followed by a survey: Reading Background Questionnaire (RBQ), which includes familiarity rating for the topics of our five reading texts. The raw data are all provided here. The first 28 subjects (sub-01 to sub-28) were native speakers of Mandarin Chinese living in the United States. Their data was collected in Hershey, PA. The second 28 subjects (sub-29 to sub-56) were native speakers of Mandarin Chinese who lived in China. Their data was collected in Beijing, China.

An updated version of the methodology document will be available at [http://blclab.org/reading\\_brain](http://blclab.org/reading_brain) under L2 Adult dataset/

## The Reading Brain Project L2 Adults

Files: 960 Size: 63.82GB

- CHANGES
- README
- dataset\_description.json
- .bidsignore
- L2\_Adult\_eyetracking.xlsx
- L2\_Adults\_LHQ.tsv
- L2\_Adults\_RBQ.tsv
- L2\_adults\_demographics.tsv
- T1w.json
- dir-AP\_epi.json
- dir-PA\_epi.json
- dwi.json
- task-read\_bold.json

**OpenNeuro Accession Number**

ds003988

**Authors**

Ping Li, Chun-Ting Hsu, Ben Schloss, Anya Yu, Lindsey Ma, Marissa Scotto, Friederike Seyfried, Chanyuan Gu

**Available Modalities**

MRI

**Versions**

1.0.0

Created: 2022-02-01

Versions

**Tasks**

read task, rest

**Uploaded by**

Chanyuan Gu on 2022-01-11 - 10 months ago

**Last Updated**

2022-02-01 - 10 months ago

**Sessions**

1

**Participants**

56

**Dataset DOI**[doi:10.18112/openneuro.ds003988.v1.0.0](https://doi.org/10.18112/openneuro.ds003988.v1.0.0)**License**

CC0

**How To Cite**
Text BibTeX Copy

Ping Li and Chun-Ting Hsu and Ben Schloss and Anya Yu and Lindsey Ma and Marissa Scotto and Friederike Seyfried and Chanyuan Gu (2022). The Reading Brain Project L2 Adults. OpenNeuro. [Dataset] doi: [doi:10.18112/openneuro.ds003988.v1.0.0](https://doi.org/10.18112/openneuro.ds003988.v1.0.0)

# Each shared dataset is versioned and receives a persistent identifier (DOI)

# Any valid BIDS dataset can be shared via OpenNeuro



# OpenNEURO

SEARCH SUPPORT FAQ

Sign in

A free and open platform for validating and sharing BIDS-compliant [MRI](#), [PET](#), [MEG](#), [EEG](#), and [iEEG](#) data

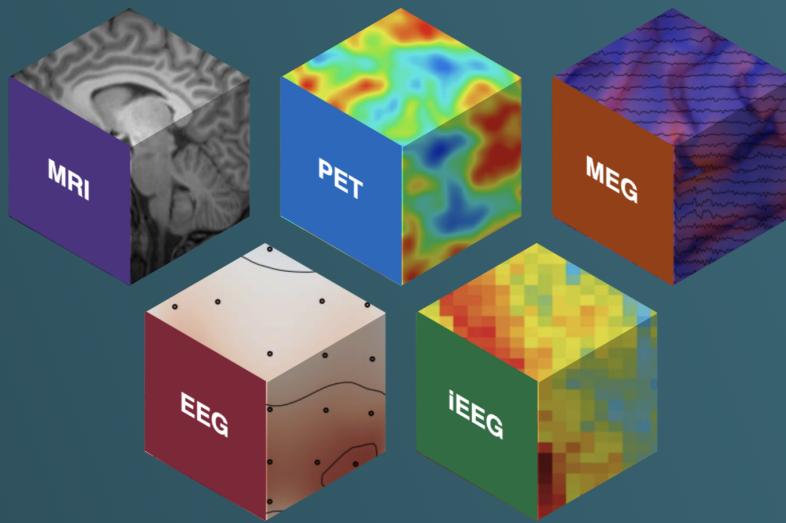
29,064 Participants

761 Public Datasets

Browse by Modalities

Or

Search



SIGN IN

G Google

ORCID



### Validation Using BIDS

The [Brain Imaging Data Structure](#) (BIDS) is an emerging standard for the organization of neuroimaging data.

Want to contribute to BIDS?

Visit the [Google discussion group](#) to contribute.



### OpenNeuro Runs on DataLad

Want to access OpenNeuro datasets with DataLad? Visit the [dataset collection on GitHub](#).

A data management solution built on [Git](#) and [Git-annex](#). Read more about [DataLad](#)

A free and open platform for validating and sharing compliant [MRI](#), [PET](#), [MEG](#), [EEG](#), and [iEEG](#) data.

29,064 Participants    761 Public Datasets

Browse by Modalities ▾

Or

Search

SIGN IN [Google](#) [ORCID](#)

**BIDS**  
BRAIN IMAGING DATA STRUCTURE

**Validation Using BIDS**

The [Brain Imaging Data Structure](#) (BIDS) is an emerging standard for the organization of neuroimaging data.

Want to contribute to BIDS?  
Visit the [Google discussion group](#) to contribute.

**DataLad**

**OpenNeuro Runs on DataLad**

Want to access OpenNeuro datasets with DataLad? Visit the [dataset collection on GitHub](#).

A data management solution built on [Git](#) and [Git-annex](#). Read more about [DataLad](#).



SEARCH SUPPORT FAQ UPLOAD

My Account

A free and open platform for validating and sharing BIDS-compliant [MRI](#), [PET](#), [MEG](#), [EEG](#), and [iEEG](#) data

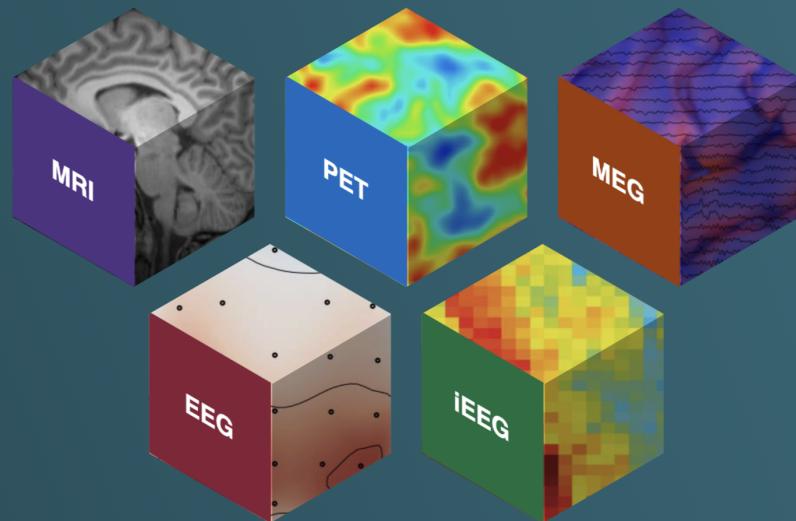
29,064 Participants

761 Public Datasets

Browse by Modalities

Or

Search



#### Validation Using BIDS

The [Brain Imaging Data Structure](#) (BIDS) is an emerging standard for the organization of neuroimaging data.

Want to contribute to BIDS?

Visit the [Google discussion group](#) to contribute.



#### OpenNeuro Runs on DataLad

Want to access OpenNeuro datasets with DataLad? Visit the [dataset collection on GitHub](#).

A data management solution built on [Git](#) and [Git annex](#). Read more about [DataLad](#).



A free and open platform for validating  
compliant **MRI**, **PET**, **MEG**, **EEG**, and  
**29,064 Participants**

Browse by Modalities

Or

Search



## Upload Dataset

Step 1: Select Files

Step 2: Validation

Step 3: Metadata

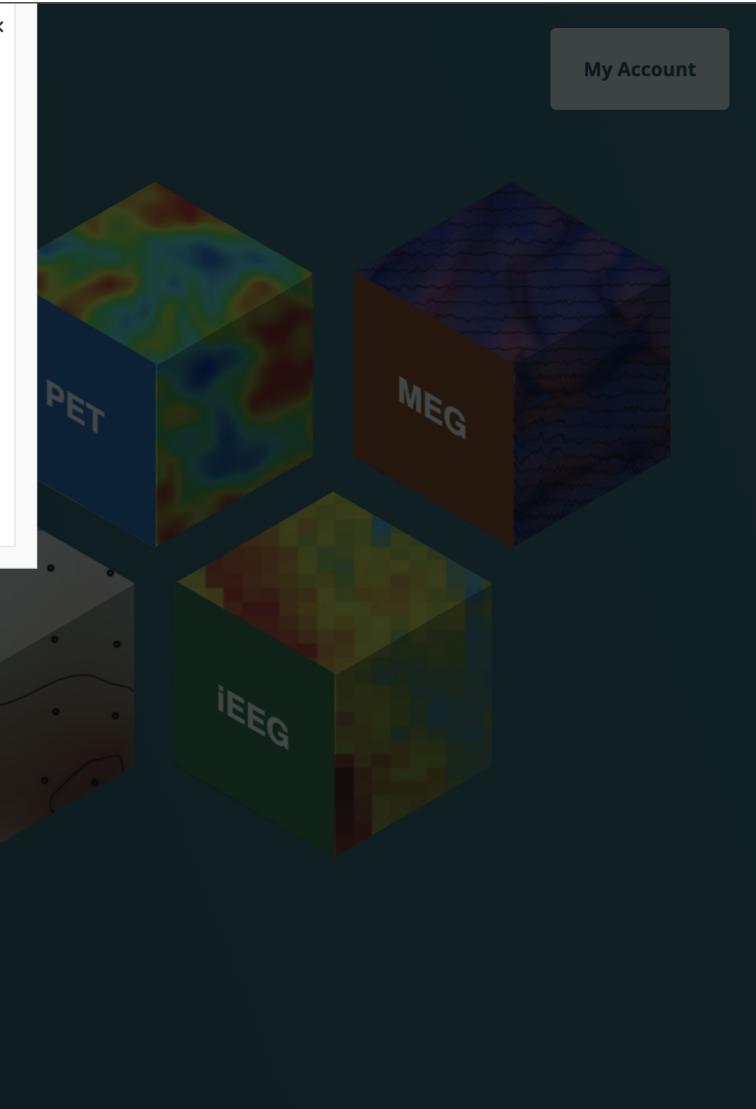
Step 4: Accept Terms

To protect the privacy of the individuals who have been scanned, we require that all scan data be defaced before publishing a dataset.

Select a BIDS dataset to upload

Select folder

close





## MRI Rhyme judgment

My Account

This dataset is public

### BIDS Validation

Files Share Versioning Admin

### How to Download

#### Download with your browser

This method is convenient and allows you to select a local directory.

#### Steps

1. Select a local directory to save the dataset and grant permission.
2. Download will run in the background, please leave the page open.
3. A notification will appear when complete.

Download

#### Download from S3

The most recently published snapshot can be downloaded from S3. This method is best for larger datasets or unstable connections. This example uses [AWS CLI](#).

## Upload Dataset

Step 1: Select Files

Step 2: Validation

Step 3: Metadata

Step 4: Accept Terms

We found 3 warnings in your dataset. You are not required to fix warnings, but doing so will make your dataset more BIDS compliant. Continue or fix the issues and select folder again.

Continue

**VIEW 3 WARNINGS IN 15 FILES**

#### Warning: 1

[VIEW 13 FILES](#)

You should define 'SliceTiming' for this file. If you don't provide this information slice time correction will not be possible. 'Slice Timing' is the time at which each slice was acquired within each volume (frame) of the acquisition. Slice timing is not slice order -- rather, it is a list of times containing the time (in seconds) of each slice acquisition in relation to the beginning of volume acquisition.

#### Warning: 2

[VIEW 1 FILE](#)

Not all subjects/sessions/runs have the same scanning parameters.

#### Warning: 3

[VIEW 1 FILE](#)

Tabular file contains custom columns not described in a data dictionary

Click to view details on [BIDS specification](#)

close

Versions ▾

#### Uploaded by

Chris Gorgolewski on 2016-10-13 - about 6 years ago

The screenshot shows the OpenNEURO dataset page for 'Rhyme judgment'. At the top, there's a navigation bar with 'MRI' and 'Rhyme judgment' followed by 'Edit'. Below this is a green header bar with 'This dataset' and a dropdown menu for 'BIDS Validation'. Under 'BIDS Validation', there are links for 'Files', 'Share', 'Versioning', and 'Admin'. A 'How to Download' section follows, with 'Download with your browser' being the active tab. It contains steps 1-3 for saving the dataset to a local directory, a 'Download' button, and sections for 'Download from S3' and 'Download with Node.js'. The 'Download with Node.js' section includes a command-line example for AWS S3 sync.

A modal window titled 'Upload Dataset' is open, showing 'Step 3: Metadata' as the active step. It contains several input fields: 'DOI of papers from the source data lab' (with a note about papers from the source lab), 'Species', 'Study Type', 'Domain Studied', 'Number of Trials (if applicable)', 'Study Design', 'Papers published from this dataset', 'DX status(es)', 'Grant Funder Name', and 'Grant Identifier'. A 'Continue' button is at the bottom. The background of the page shows a dark header with 'My Account', 'Follow 1', 'Bookmark 2', and other dataset details like 'Accession Number ds000003', 'Created: 2020-05-14', and 'Last updated: 2016-10-13'.



# OpenNEURO

MRI Rhyme judgment Edit

This dataset is public.

## BIDS Validation

- Files
- Share
- Versioning
- Admin

### How to Download

#### Download with your browser

This method is convenient and allows you to select a local directory to save the dataset.

#### Steps

1. Select a local directory to save the dataset and grant permission to OpenNeuro to access it.
2. Download will run in the background, please leave the page open.
3. A notification will appear when complete.

Download

#### Download from S3

The most recently published snapshot can be downloaded from S3. For example, the command to download from S3 is:

```
aws s3 sync --no-sign-request s3://openneuro.org/datasets/rhyme-judgment/ /path/to/local/directory
```

To download unpublished datasets or older snapshots, see the [Download section](#).

## Upload Dataset

Step 1: Select Files Step 2: Validation Step 3: Metadata Step 4: Accept Terms

**By uploading this dataset to OpenNeuro I agree to the following conditions:**

I am the owner of this dataset and have any necessary ethics permissions to share the data publicly. This dataset does not include any identifiable personal health information as defined by the [Health Insurance Portability and Accountability Act of 1996](#) (including names, zip codes, dates of birth, acquisition dates, etc). I agree to destroy any key linking the personal identity of research participants to the subject codes used in the dataset.

I agree that this dataset will become publicly available under a [Creative Commons CC0](#) license after a grace period of 36 months counted from the date of the first snapshot creation for this dataset. You will be able to apply for up to two 6 month extensions to increase the grace period in case the publication of a corresponding paper takes longer than expected. See [FAQ](#) for details.

This dataset is not subject to GDPR protections.

Generally, data should only be uploaded to a single data archive. In the rare cases where it is necessary to upload the data to two databases (such as the NIMH Data Archive), I agree to ensure that the datasets are harmonized across archives.

Please affirm one of the following:

**All structural scans have been defaced, obscuring any tissue on or near the face that could potentially be used to reconstruct the facial structure.**

**I have explicit participant consent and ethical authorization to publish structural scans without defacing.**

I Agree close

My Account

Follow 1 Bookmark 2

them public.

uro Accession Number  
03

Russell A. Poldrack

lit

Modalities

Versions ▾  
ed: 2020-05-14

judgment

d by

orgolewski on 2016-10-13 - about 6 years ago

lated

5-14 - over 2 years ago

 Rhyme judgment [Edit](#)[Following 1](#) [Bookmark 0](#)

This dataset has not been published! Before it can be published, please [create a version](#)

## BIDS Validation ▾

2 WARNINGS

Valid

Clone ▾

[Files](#)[Publish](#)[Share](#)[Versioning](#)[Admin](#)[Download](#)[Metadata](#)[Delete](#)

## New Version

Create a new version of this dataset for download and public access. This will begin an export of this dataset to GitHub and S3 if it has been made public.

1.0.0

Major

Minor

Patch

## New Changelog

Add CHANGES file lines describing the new version.

[Add](#)

You must add at least one change message to create a new version

[Create Version](#)

## OpenNeuro Accession Number

ds004338

## Authors

Xue, G., Russell A. Poldrack

[Edit](#)

## Available Modalities

[MRI](#)

## Version

[Draft](#)

Updated: 2022-11-16

[Create Version](#)

## Tasks

rhyme judgment

## Uploaded by

Russ Poldrack on 2022-11-16 - 1 minute ago

## Sessions

1

## Participants

3

## Dataset DOI

[doi:10.18112/openneuro.ds000003.v1.0.0](#)



MRI Rhyme judgment

Follow 1 Bookmark 2

BIDS Validation ▾

1 ERROR

! Invalid

brainlife.io

Clone ▾

Files

View Draft

Download

Derivatives

Metadata

Deprecate Version

README

This dataset was obtained from the OpenfMRI project (<http://www.openfmri.org>). Accession #: ds003 Description: Rhyme judgment

Release history: 10/06/2011: initial release 3/21/2013: Updated release with QA information 2/18/2016: Updated orientation information in nifti headers for improved left-right determination

This dataset is made available under the Public Domain Dedication and License v1.0, whose full text can be found at <http://www.opendatacommons.org/licenses/pddl/1.0/>. We hope that all users will follow the ODC Attribution/Share-Alike Community Norms (<http://www.opendatacommons.org/norms/odc-by-sa/>); in particular, while not legally required, we hope that all users of the data will acknowledge the OpenfMRI project and NSF Grant OCI-1131441 (R. Poldrack, PI) in any publications.

Rhyme judgment ▾

CHANGES

README

dataset\_description.json

participants.tsv

task-rhymejudgment\_bold.json

derivatives ▾

sub-01 ▾

sub-02 ▾

sub-03 ▾

sub-04 ▾

sub-05 ▾

Files: 57 Size: 391.09MB



1.0.0  
Created: 2020-05-14

Versions ▾

Tasks

rhyme judgment

Uploaded by

Chris Gorgolewski on 2016-10-13 - about 6 years ago

Last Updated

2020-05-14 - over 2 years ago

Sessions

1

Participants

13

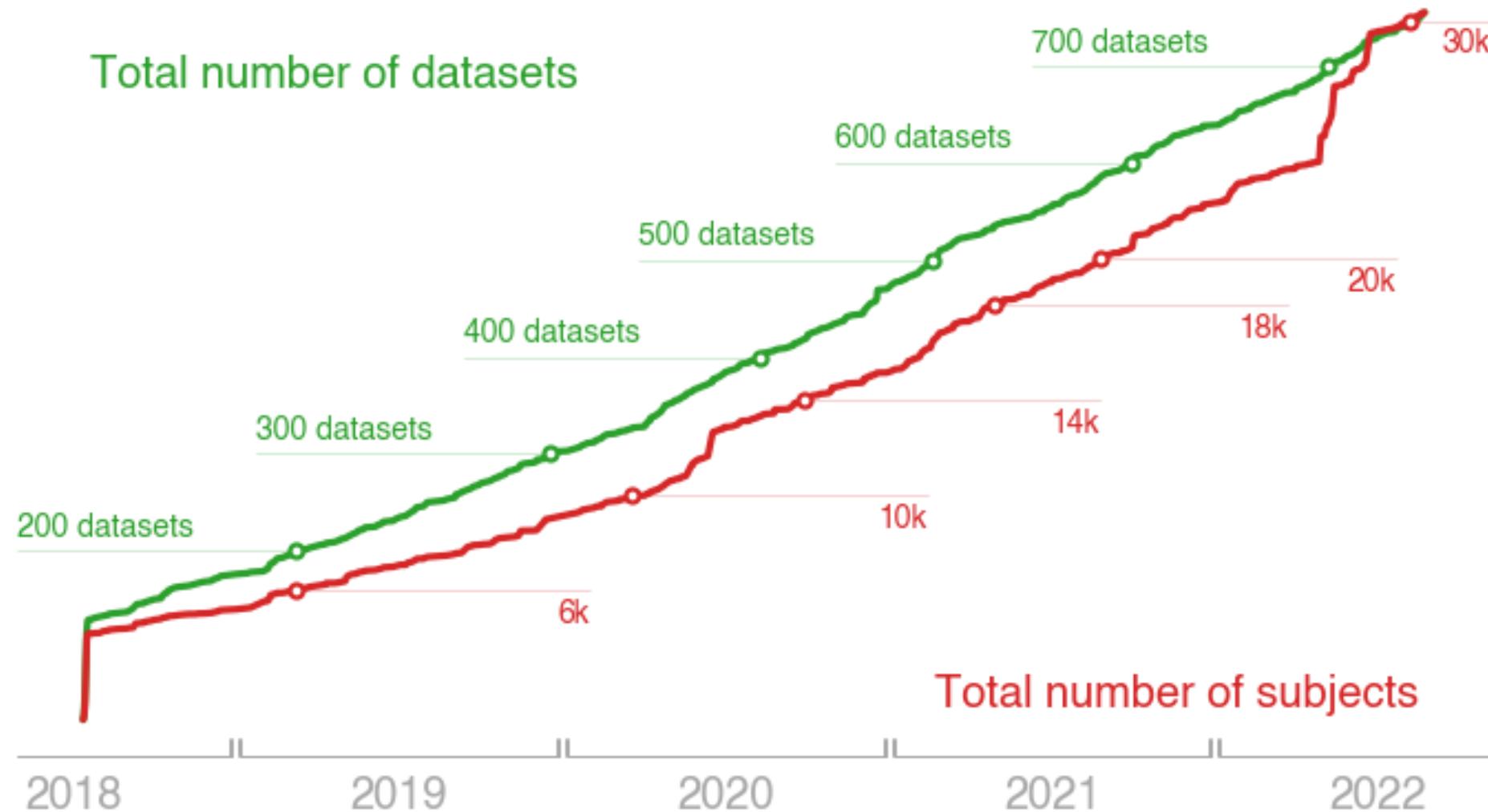
Dataset DOI

<doi:10.18112/openneuro.ds000003.v1.0.0>

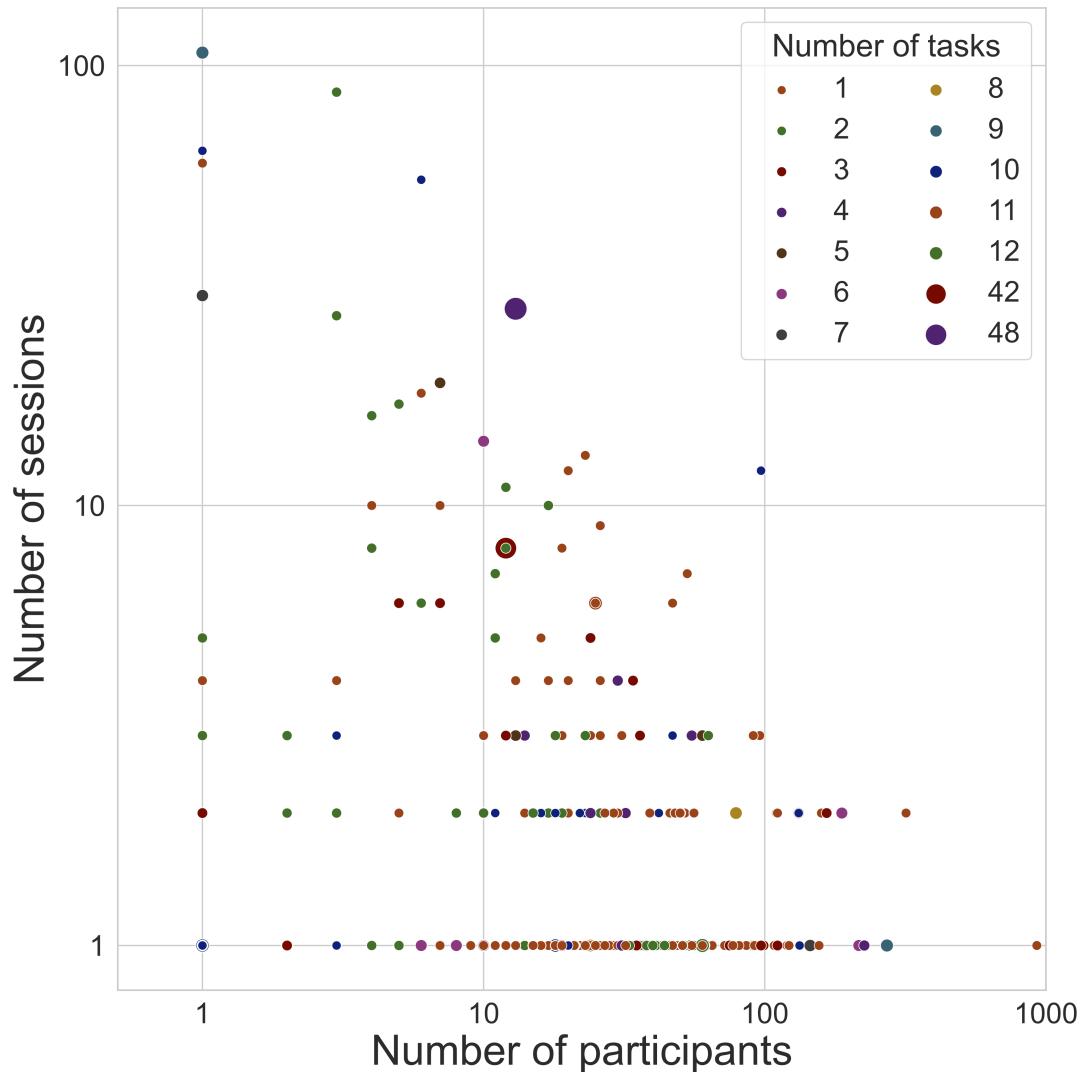
License

CC0

# The growth of OpenNeuro



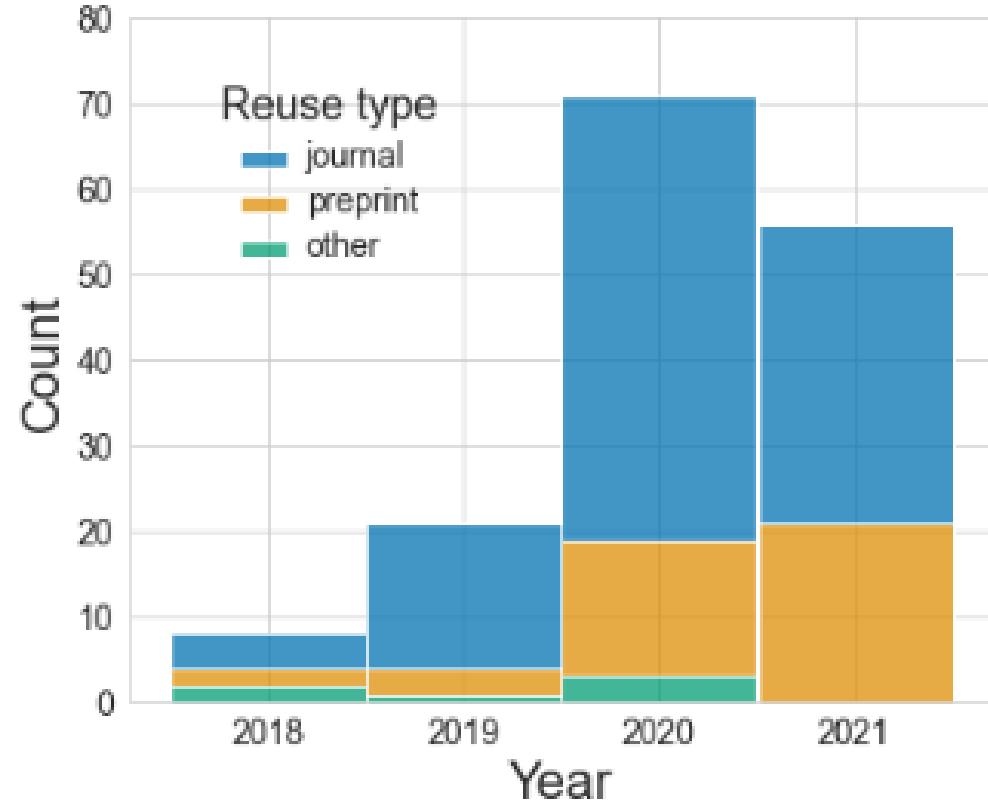
# The diversity of OpenNeuro datasets



Datatype	#
mri - anat	597
mri - func	521
eeg	120
mri - dwi	67
meg	30
ieeg	17
beh	13
pet	11

Species	#
Human	676
Mouse	20
Rat	12
NHP	2
phantoms	1
Juvenile pigs	1
Human, Mouse	1
Dog	1
Monkey	1
Sheep	1

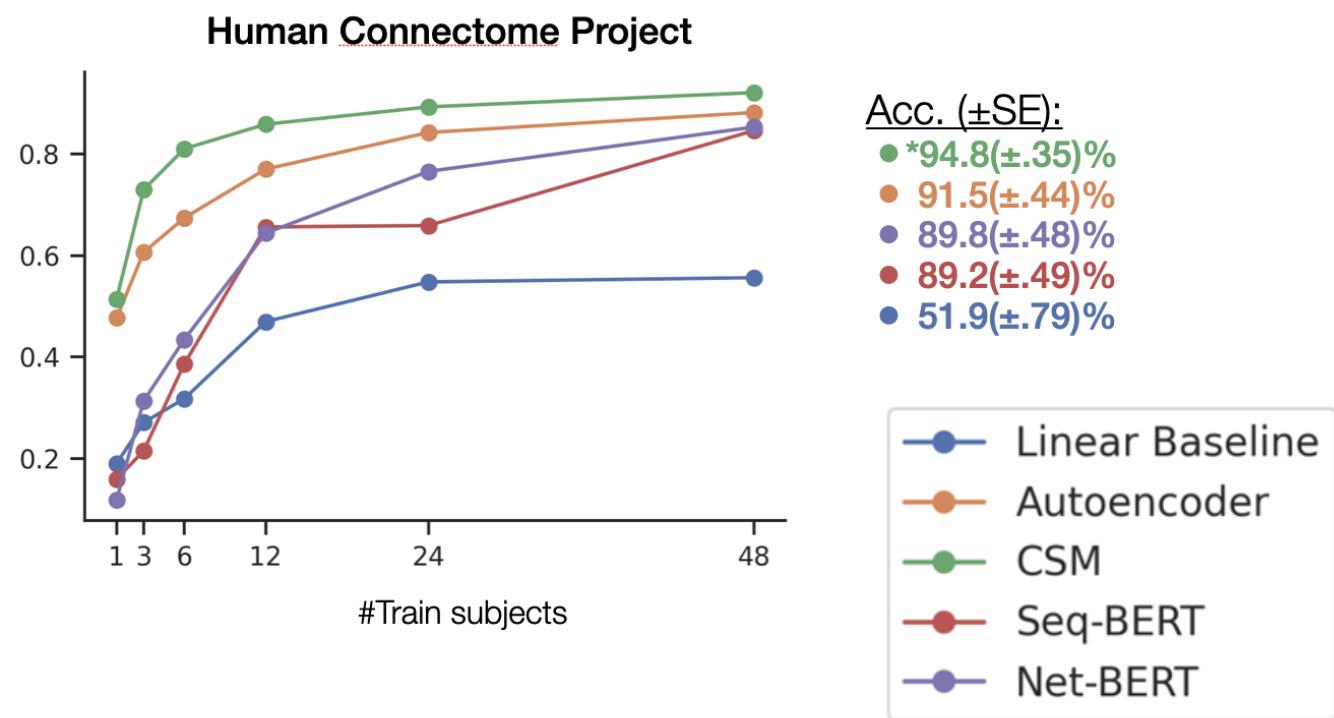
# Scholarly reuse of OpenNeuro datasets



*Figure 5. Published reuses of OpenNeuro datasets, split by the type of reuse. Note that the final bar includes only reuses identified through June 2021.*

# Example of OpenNeuro reuse

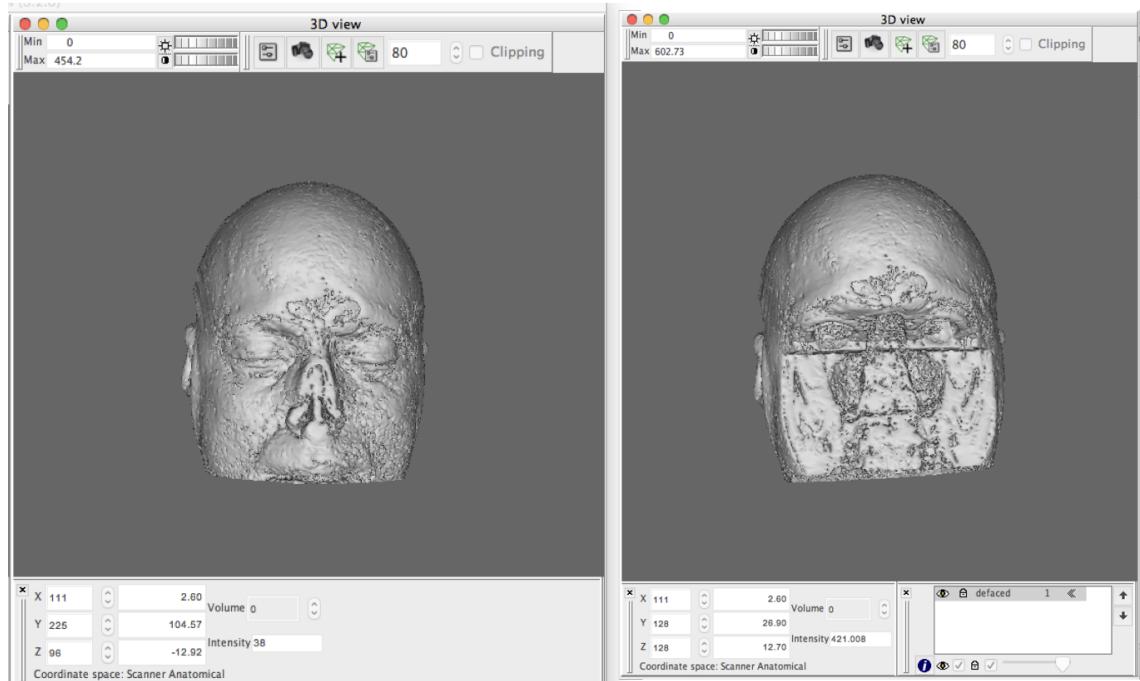
- A challenge for decoding brain activity from fMRI data is that most datasets are very small
- We used OpenNeuro to train a “foundation model”
  - A pre-trained model that can be used as a starting point for decoding models on smaller datasets
- We pre-train models on broad fMRI data from OpenNeuro: 11,980 experimental runs from 1,726 individuals across 34 datasets.



- This approach substantially increased decoding performance vs. a baseline model

# Challenges to open sharing

- All OpenNeuro MRI datasets must be *defaced*
  - To reduce risk of reidentification
- There is increasing risk that subjects might be reidentified even after defacing using advanced face recognition systems + face imputation tools (Schwartz et al., 2021)
- If the risk continues to rise, it may become necessary to move away from open sharing
  - This would be a huge loss for researchers, research participants, and the world
- We have proposed regulatory changes to protect subjects from misuse of neuroscience information in the US context (Jwa & Poldrack, 2022, *J. Law & Biosciences*)



# Keys to success in neuroimaging data sharing

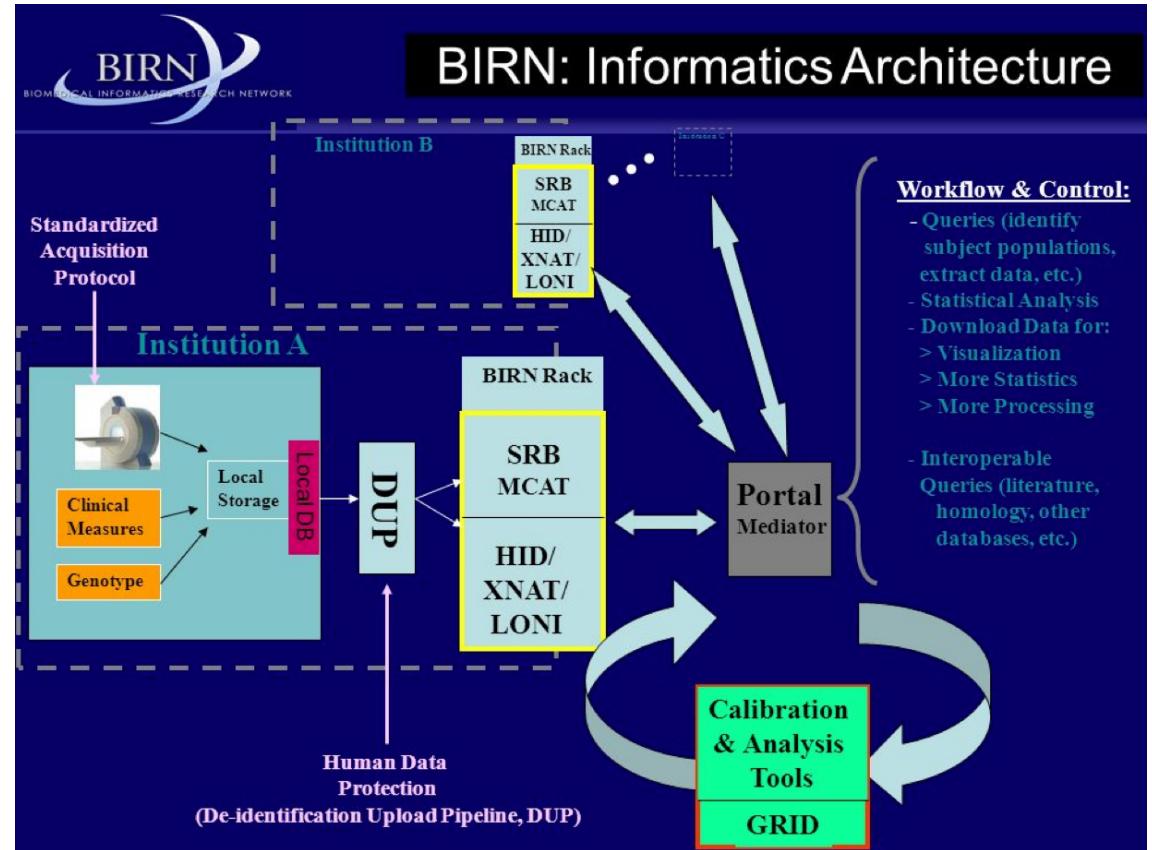
- *Data are digital end-to-end*
  - Minimizes manual steps in the process
- *Standardized file formats and data standards*
  - Makes data immediately usable by anyone
  - Reduces burden of curation and preparation
- *Demonstrated scientific utility*
- *Numerous success stories*

# Lessons learned

- Community buy-in is essential
  - Mandates put in place before the community is ready can backfire
    - Unless they have overwhelmingly powerful advocates, as in genomics
  - Important that sharing advocates are members of community and eat their own dog food

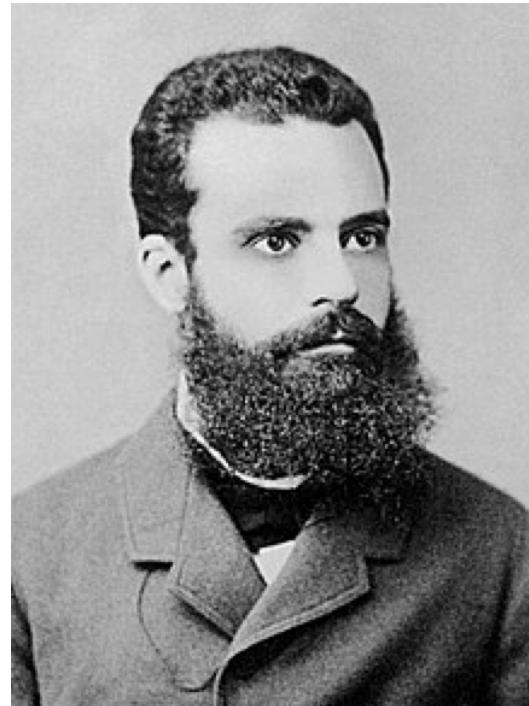
# Lessons learned

- Keep it simple and as close to standard practice as possible
  - Overengineered solutions have generally failed
  - If there are more than 2 acronyms...



# Lessons learned

- Don't let the perfect be the enemy of the good
  - 20% of the effort will cover 80% of the datasets - focus on these!
  - There is a long tail of edge cases with loud advocates



Vilfredo Pareto

# Conclusions

- The field of neuroimaging has built an model ecosystem for open science and data sharing
- Infrastructure is critical to ease friction
- Community engagement has been key to adoption
- Need to keep the tools as close as possible to current practice

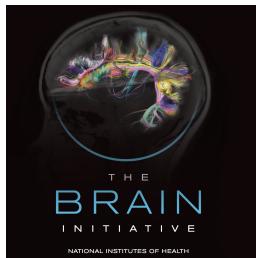
# The Poldrack Lab



# OpenNeuro Team



## Funding



## Collaborators



National Institute  
of Mental Health

<https://poldrack.github.io/talks-OpenScienceEcosystem/>





# Meta-analytic decoding using Neurosynth

- Given 2+ terms, can determine which is most likely given the data
- Naive Bayes classifier: assumes that all features (voxels) are independent; selects the most probable class
- Can apply this to any activation map—studies, individual subjects, etc.

Yarkoni et al, 2011, *Nature Methods*

- Cross-validated classification of all studies in database
- Select 25 high-frequency terms
- Pairwise classification: how well can we distinguish between the presence of each pair of terms?

