# Big Data for Reproducible Human Brain Mapping

Standard
Resources
Methodology

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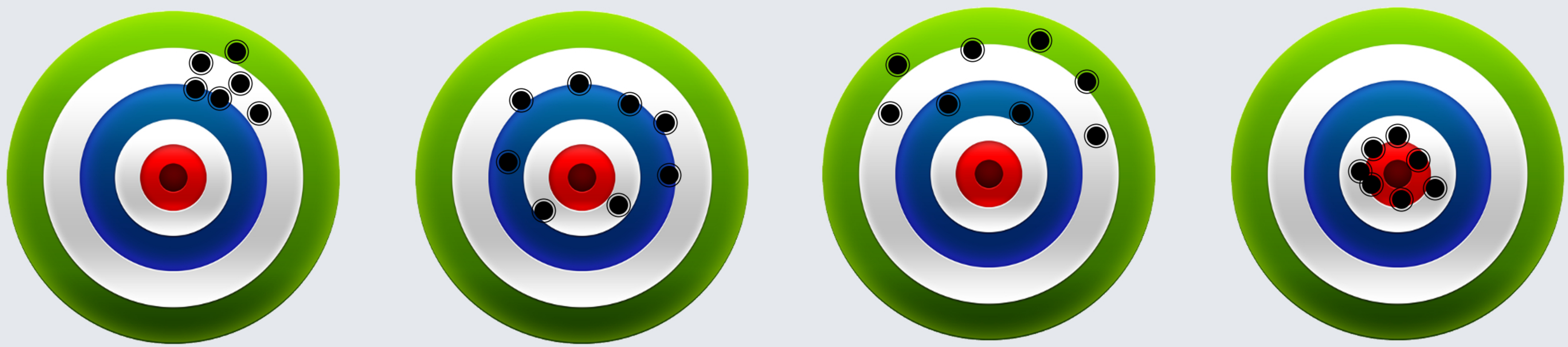
# Standard: Reliability & Validity





**Individual Differences**

$$\text{validity} = V_d / V_s$$

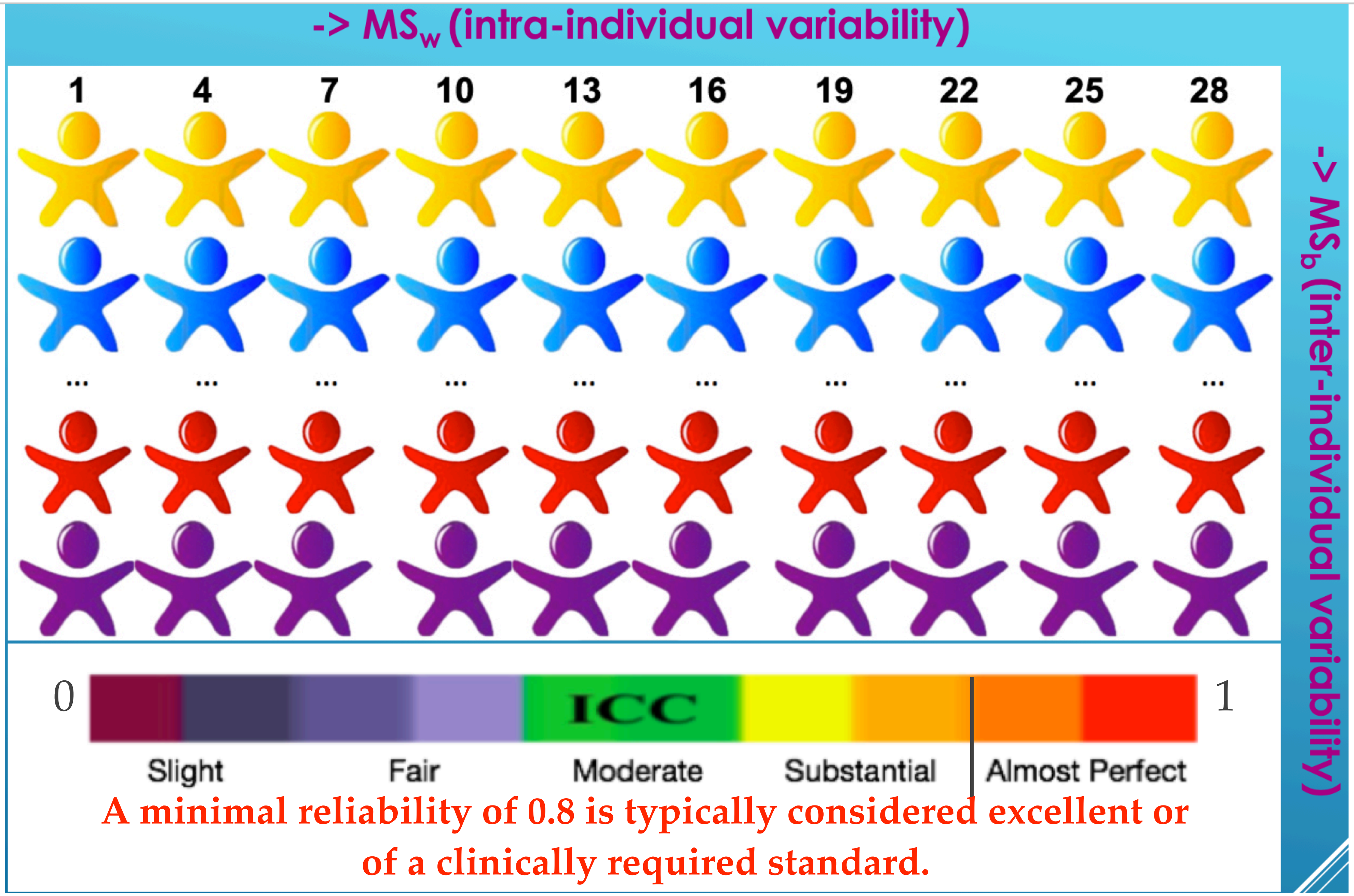
$$\text{reliability} = (V_d + V_c) / V_s$$

$$V_s = V_d + V_c + V_r$$

$$\text{validity} \Leftarrow \text{reliability}$$

Annu Rev Clin Psychol. 2014; 10: 111-30.

# Reliability: ICC=(MSb-MSw)/(MSb+MSw)




Neurosci Biobehav Rev. 2014; 45: 100-18.

PLoS One. 2015; 10: e0144963; Statistical Methods for rates and proportions. 1981.

# Reliability: Why Big Data?

| True $r$ | Measure A | Measure B | Observable $r$ | N true | N obs. |
|---|---|---|---|---|---|
| .7 | .8 | .8 | .56 | 13 | 22 |
| .7 | .6 | .6 | .42 | 13 | 42 |
| .7 | .4 | .7 | .37 | 13 | 55 |
| .5 | .8 | .8 | .4 | 29 | 46 |
| .5 | .6 | .6 | .3 | 29 | 84 |
| .5 | .4 | .7 | .26 | 29 | 113 |
| .3 | .8 | .8 | .24 | 84 | 133 |
| .3 | .6 | .6 | .18 | 84 | 239 |
| .3 | .4 | .7 | .16 | 84 | 304 |

$$\boxed{r(measure\ \ A,\ \ measure\ \ B)} = \boxed{r(true\ \ A, true\ \ B)}\sqrt{reliability\ \ (Measure\ \ A) reliability (Measure\ \ B)}$$

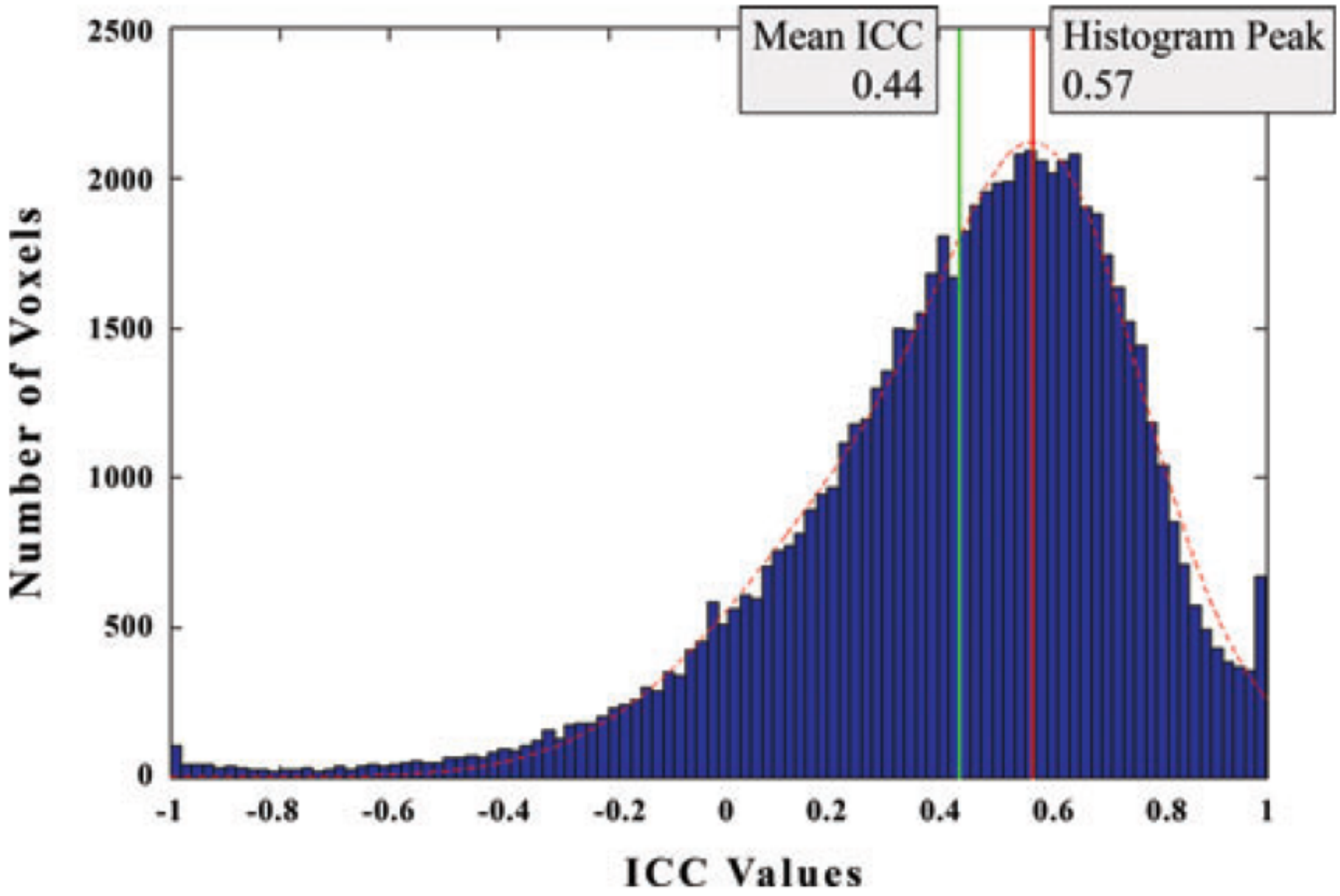
Behav Res. 2018; 50: 1166-1186.

# MRI Reliability: State of The Art

| Measure | Study 1 CCBD | Study 2 GSP |
|---|---|---|
| Thickness (CT) | .816 | .890 |
| Gyrification (GI) | .945 | .941 |
| *Fractal dimensionality* | | |
| Dilation filled ($FD_f$) | .842 | .936 |
| Dilation surface | .845 | .936 |
| Boxcount filled | .799 | .879 |
| Boxcount surface | .769 | .849 |
| SPHARM surface | .977 | .982 |

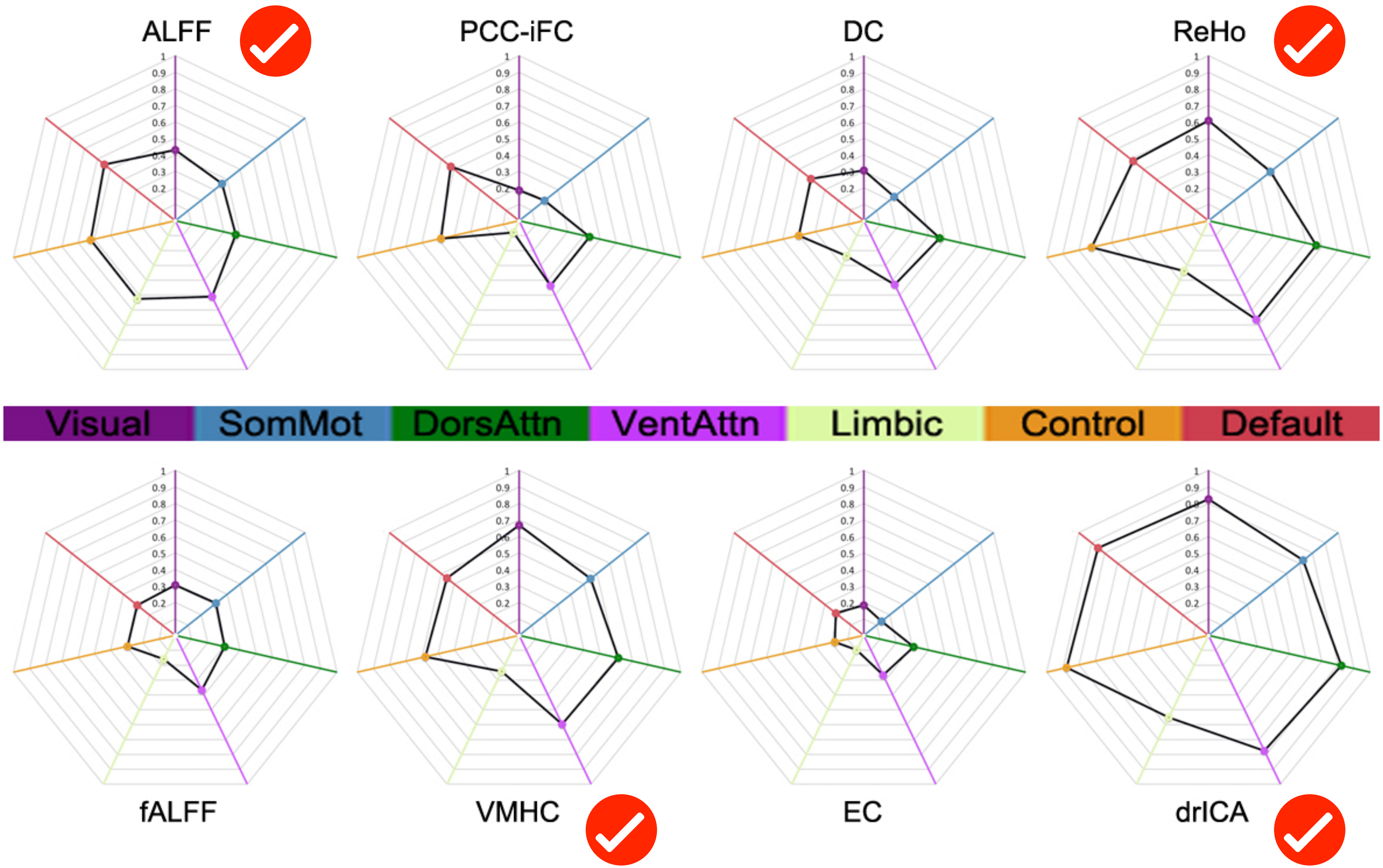
Brain Inform. 2017; 4: 107-21.

# tFMRI Reliability: State of The Art



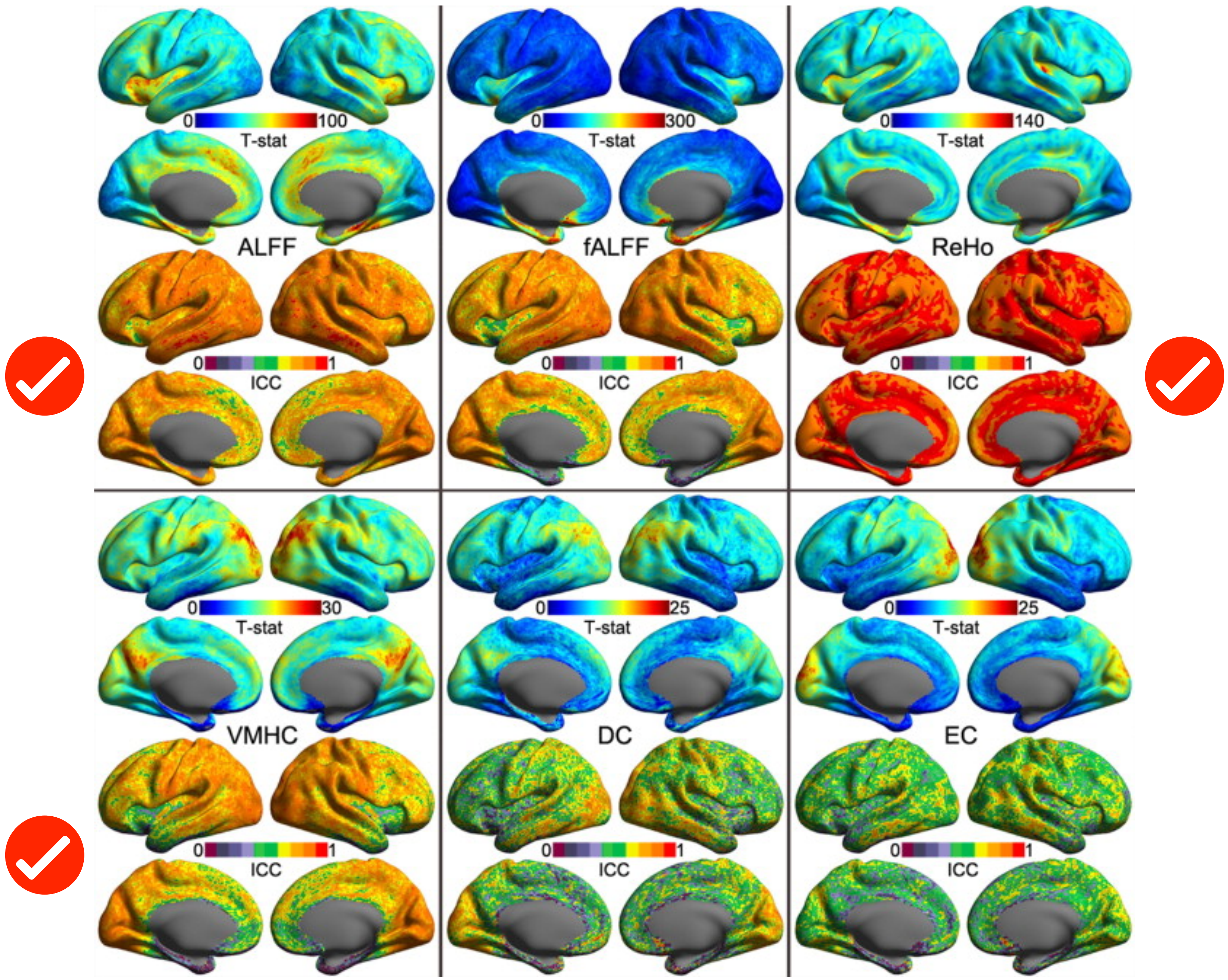

Ann N Y Acad Sci. 2010; 1191: 133-55.

# rFMRI Reliability: State of The Art




Neurosci Biobehav Rev. 2014; 45: 100-18.

# rFMRI Reliability: State of The Art

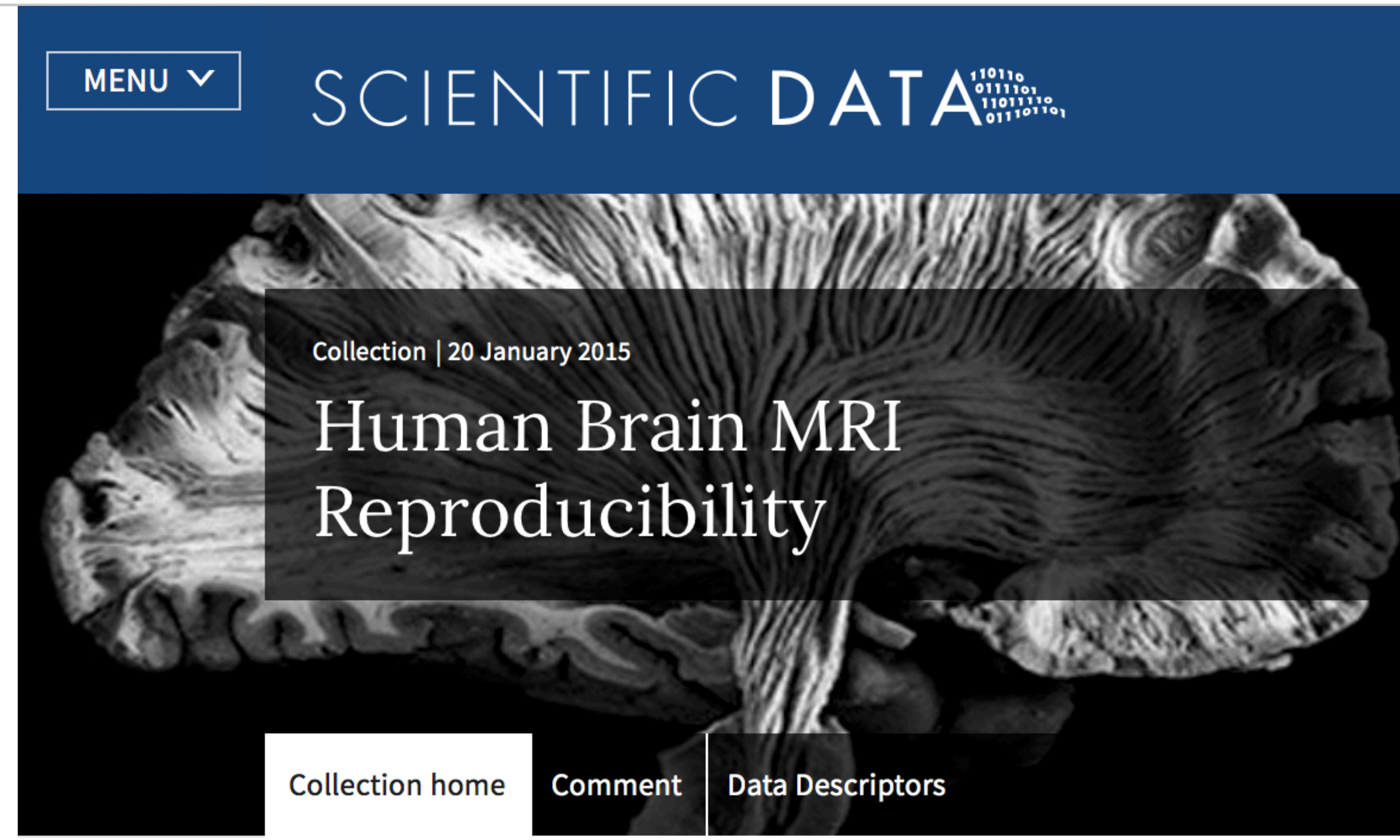


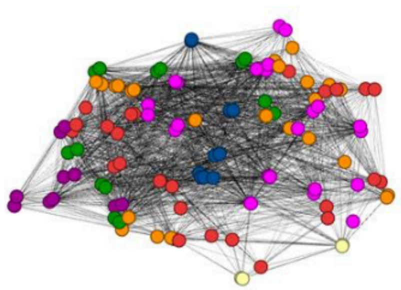

Neurosci Biobehav Rev. 2014; 45: 100-18.

# Resources: Big Data for Reliability

## An open science resource for establishing reliability and reproducibility in functional connectomics

Xi-Nian Zuo, Jeffrey S Anderson, Pierre Bellec, Rasmus M Birn, Bharat B Biswal, Janusch Blautzik, John C.S Breitner, Randy L Buckner, Vince D Calhoun, F. Xavier Castellanos, Antao Chen, Bing Chen, Jiangtao Chen, Xu Chen, Stanley J Colcombe, William Courtney, R Cameron Craddock, Adriana Di Martino, Hao-Ming Dong, Xiaolan Fu, Qiyong Gong, Krzysztof J Gorgolewski, Ying Han, Ye He, Yong He, Erica Ho, Avram Holmes, Xiao-Hui Hou, Jeremy Huckins, Tianzi Jiang, Yi Jiang, William Kelley, Clare Kelly, Margaret King, Stephen M LaConte, Janet E Lainhart, Xu Lei, Hui-Jie Li, Kaiming Li, Kuncheng Li, Qixiang Lin, Dongqiang Liu, Jia Liu, Xun Liu, Yijun Liu, Guangming Lu, Jie Lu, Beatriz Luna, Jing Luo, Daniel Lurie, Ying Mao, Daniel S Margulies, Andrew R Mayer, Thomas Meindl, Mary E Meyerand, Weizhi Nan, Jared A Nielsen, David O'Connor, David Paulsen, Vivek Prabhakaran, Zhigang Qi, Jiang Qiu, Chunhong Shao, Zarrar Shehzad, Weijun Tang, Arno Villringer, Huiling Wang, Kai Wang, Dongtao Wei, Gao-Xia Wei, Xu-Chu Weng, Xuehai Wu, Ting Xu, Ning Yang, Zhi Yang, Yu-Feng Zang, Lei Zhang, Qinglin Zhang, Zhe Zhang, Zhiqiang Zhang, Ke Zhao, Zonglei Zhen, Yuan Zhou, Xing-Ting Zhu & Michael P Milham - Show fewer authors



Research Topic

**Reliability and Reproducibility in Functional Connectomics**

Comment

1

2 4 2 1 12

**CoRR release shared 5093 rFMRI scans of 1629 individuals from 18 international sites**

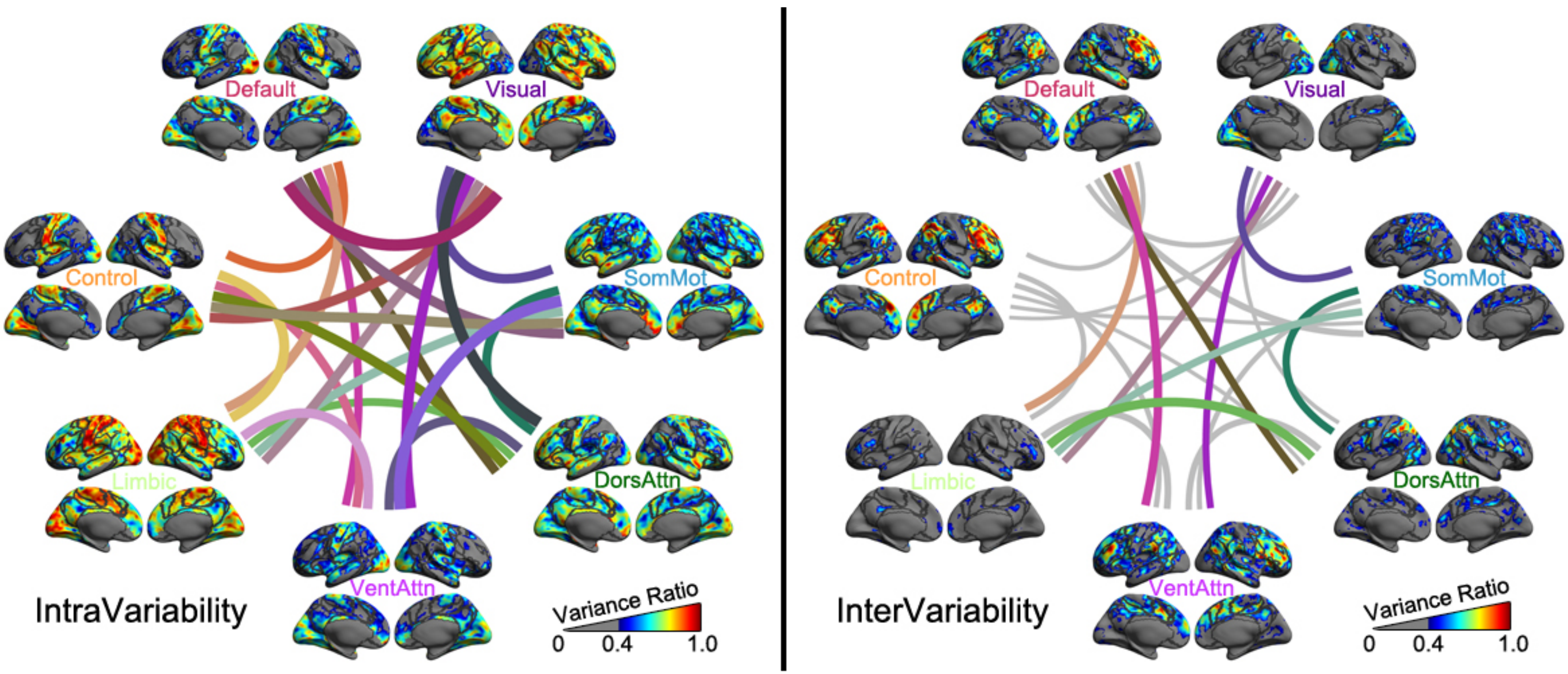
| Overview | 12 Articles | 60 Authors | Impact | 1 Comments | VIEWS 24,876 |
|---|---|---|---|---|---|

CoRR - Consortium for Reliability and Reproducibility; Sci Data. 2014; 1: 140049.

# Resources: CoRR Use Demos

## Individual Variability and Test-Retest Reliability Revealed by Ten Repeated Resting-State Brain Scans over One Month

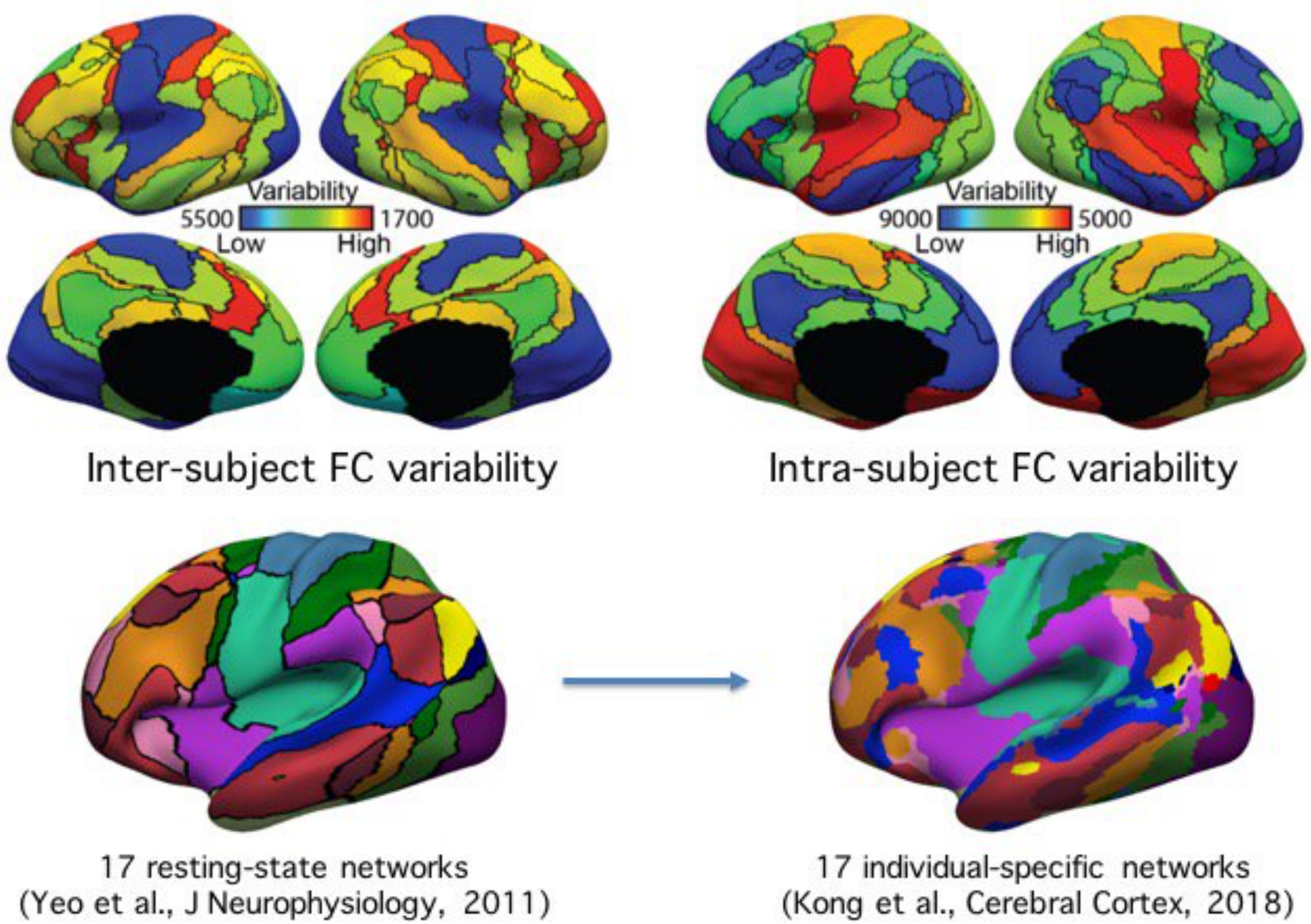
Bing Chen, Ting Xu, Changle Zhou, Luoyu Wang, Ning Yang, Ze Wang, Hao-Ming Dong, Zhi Yang, Yu-Feng Zang, Xi-Nian Zuo, Xu-Chu Weng



# Resources: CoRR Use Demos

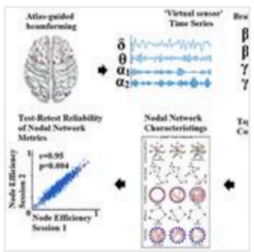
**Spatial Topography of Individual-Specific Cortical Networks Predicts Human Cognition, Personality, and Emotion.**

Kong R[1], Li J[1], Orban C[1], Sabuncu MR[2], Liu H[3], Schaefer A[1], Sun N[1], Zuo XN[4,5], Holmes AJ[6], Eickhoff SB[7,8], Yeo BTT[1,3,9,10].




Cereb Cortex. 2018; doi: 10.1093/cercor/bhy123.

# Advances: Special Topic Articles



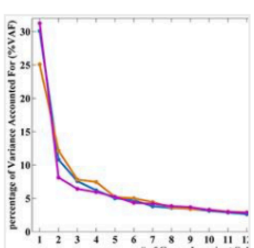
### Reliability of Static and Dynamic Network Metrics in the Resting-State: A MEG-Beamformed Connectivity Analysis

Stavros I. Dimitriadis , Bethany Routley, David E. Linden and Krish D. Singh

**Original Research** The resting activity of the brain can be described by so-called intrinsic connectivity networks (ICNs), which consist of spatially and temporally distributed, but functionally connected, nodes. The coordinated activity of the resting state can be ...

Published on 03 August 2018
Front. Neurosci. doi: 10.3389/fnins.2018.00506





### Intra- and Inter-scanner Reliability of Scaled Subprofile Model of Principal Component Analysis on ALFF in Resting-State fMRI Under Eyes Open and Closed Conditions

Li-Xia Yuan , Jian-Bao Wang , Na Zhao , Yuan-Yuan Li , Yilong Ma , Dong-Qiang Liu , Hong-Jian He , Jian-Hui Zhong and Yu-Feng Zang

## Topic Editors

**Xi-Nian Zuo**
Institute of Psychology (CAS)
Beijing, China

**107** publications



**Bharat B Biswal**
University of Medicine and Dentistry of New Jersey
Newark, United States

**39** publications

**Russell A Poldrack**
Stanford University
Stanford, United States

**187** publications

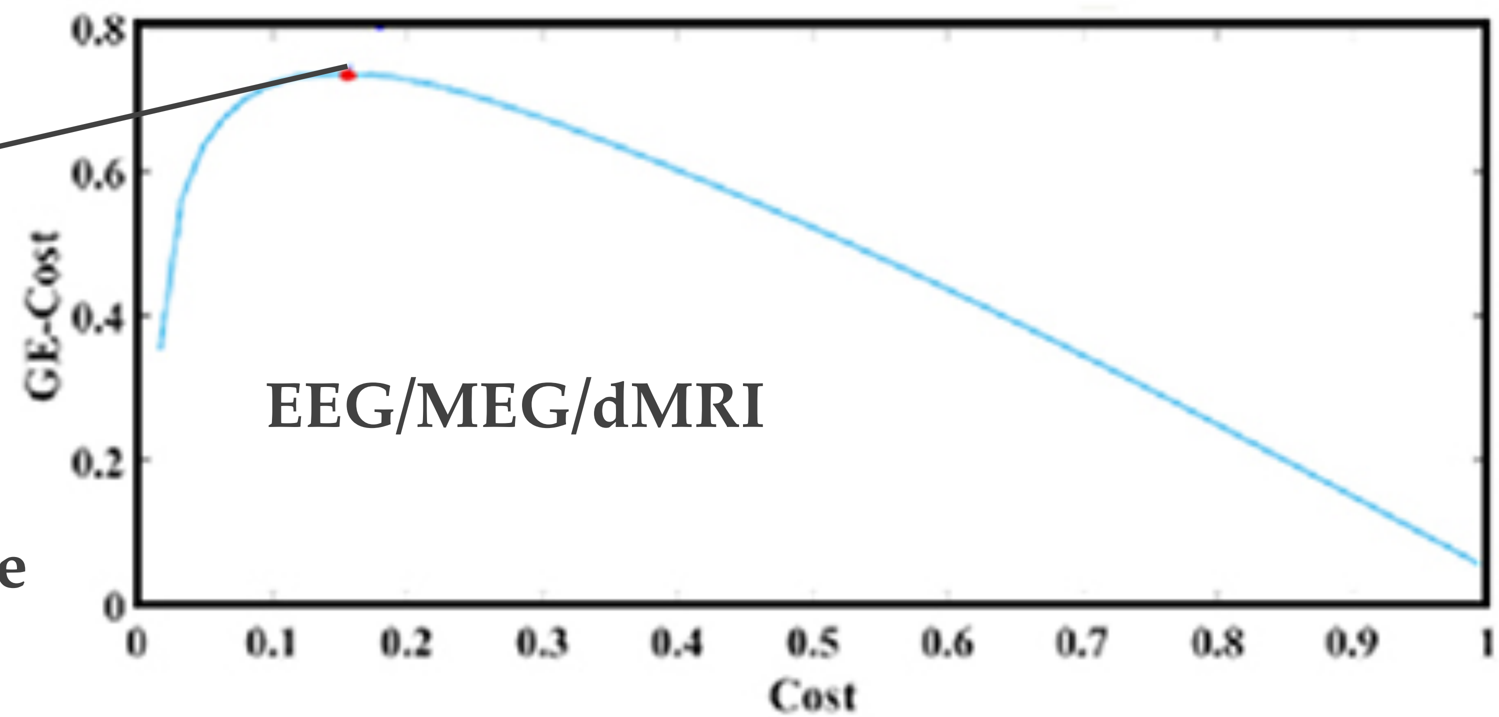
https://www.frontiersin.org/research-topics/5137/reliability-and-reproducibility-in-functional-connectomics#overview

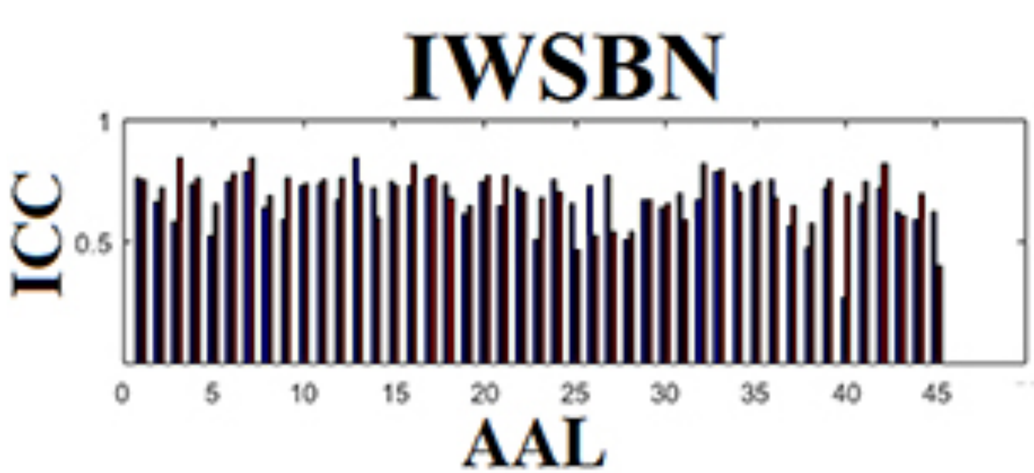
# Advances: Graph Theory

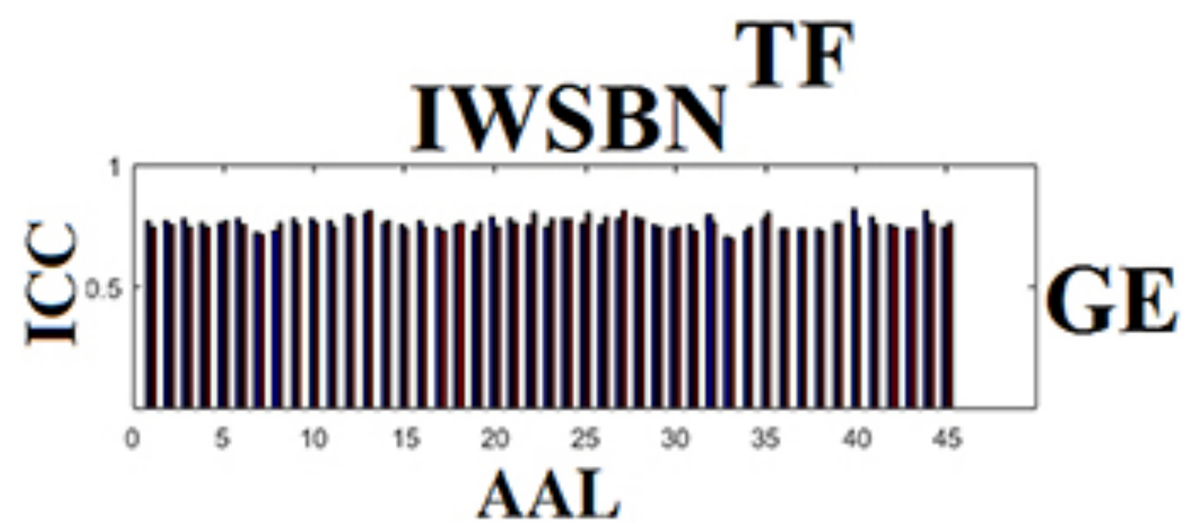
**Individualized Brain Graphs**

$$J_{GCE}^{OMSTs} = GE - Cost$$

**Orthogonal Minimal Spanning Tree**



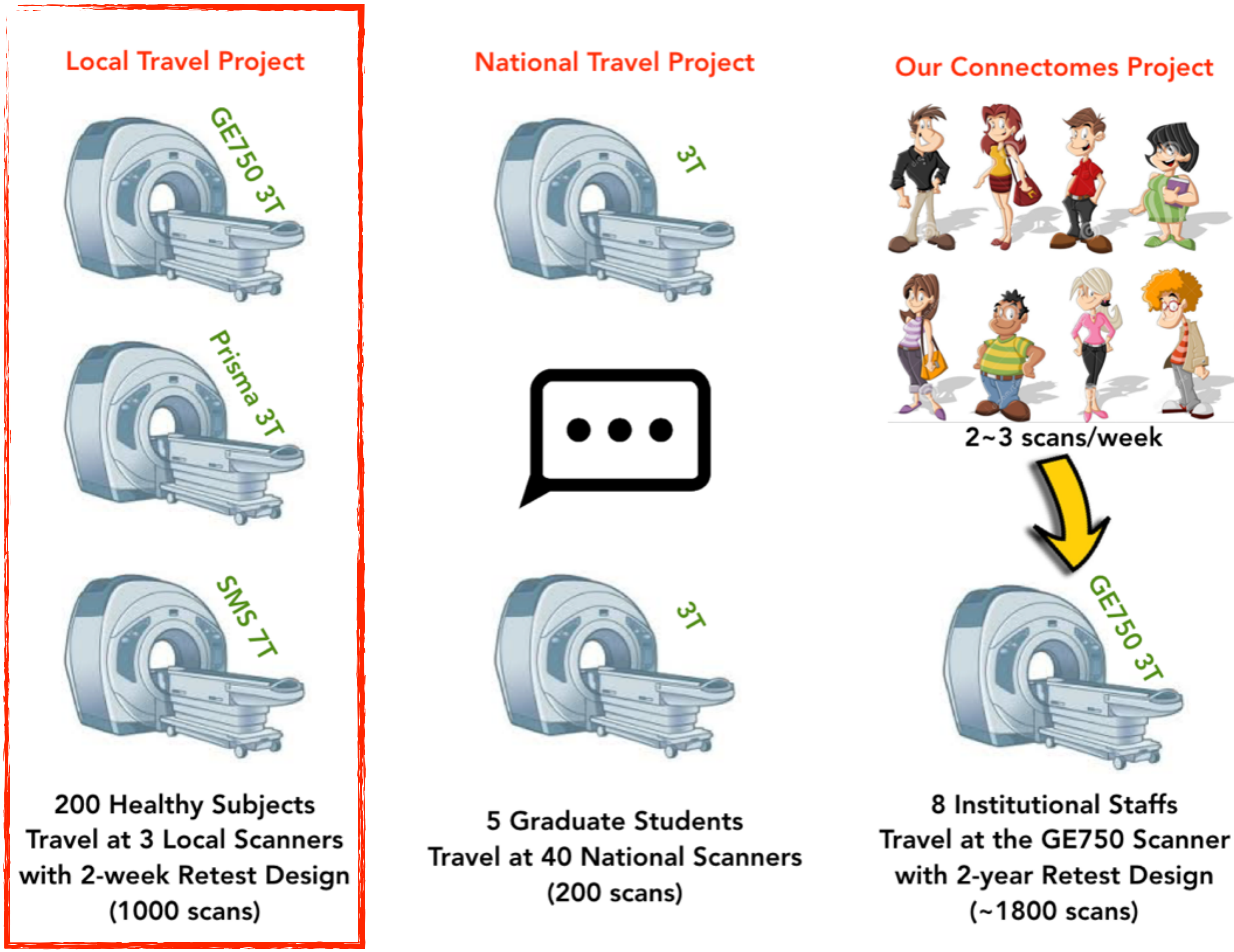




Cereb Cortex. 2018; doi: 10.1093/cercor/bhy123.

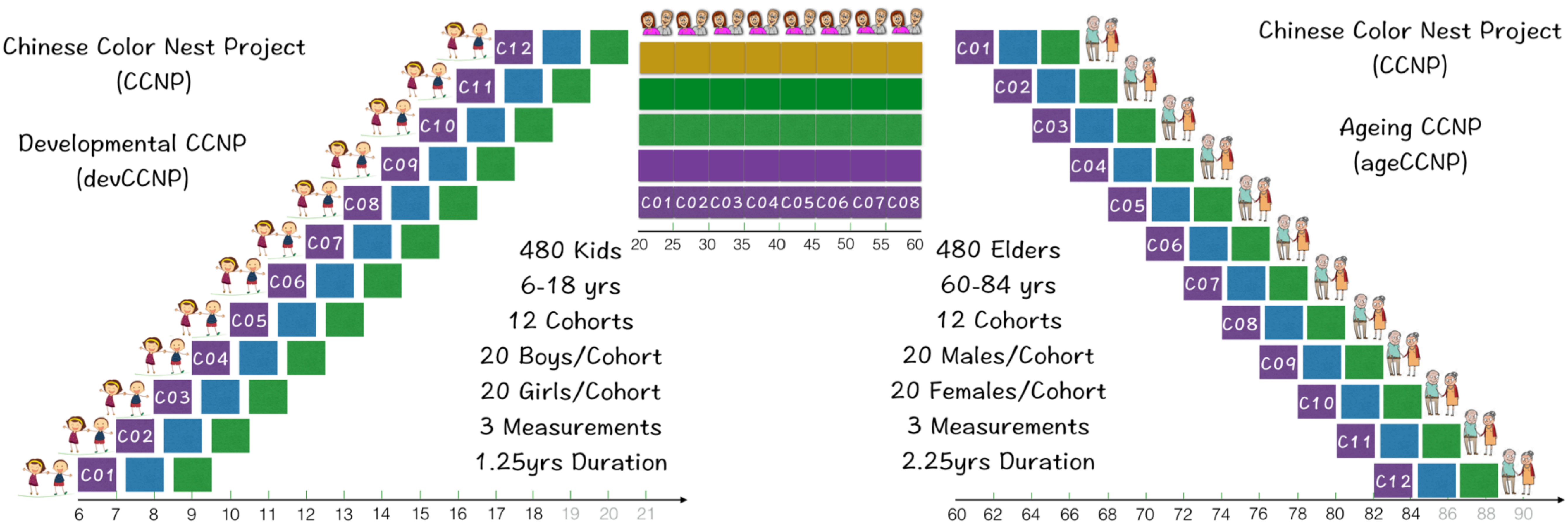
# Resources: R3BRAIN

Data Release Soon …



# Resources: CCNP

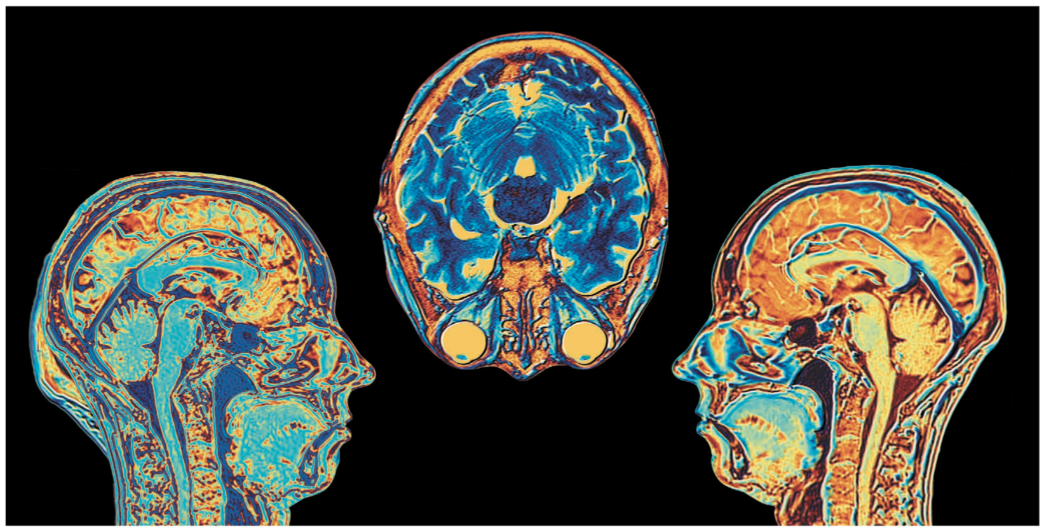
Within-Session Retest Design




Chinese Color Nest Project (CCNP: 2013-2022)
A Lifespan Sample of 1200 People (6-85 yrs)
Total 6000 visits with A Mixed Multicohort Design
http://zuolab.psych.ac.cn/colornest.html

Zuo, Castellanos, Milham, Sporns 2012-2017, NSFC Grant; Zuo et al., 2017, Trends in Cogn Sci.

# Resources: Chinese Twin Brain Project

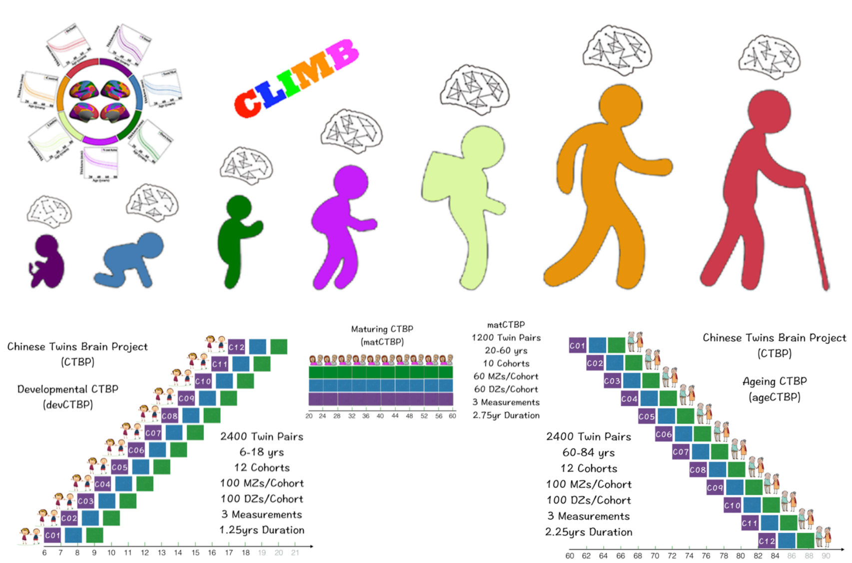


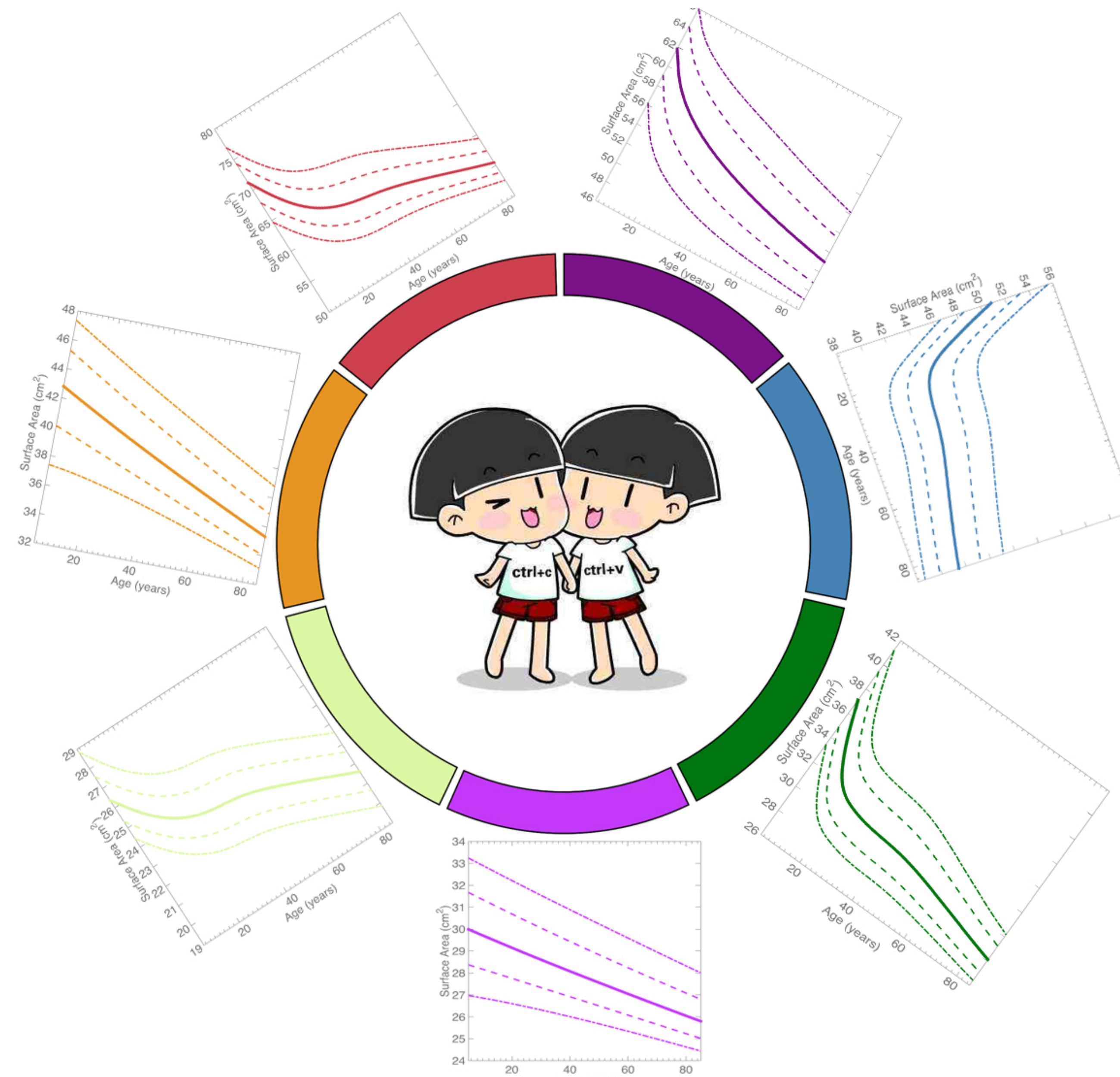
China's new brain-science centre will host some 50 principal investigators and will also support external researchers.

CHINA

## Beijing launches pioneering neuroscience centre

*Large research facility will be key part of much-anticipated brain initiative.*

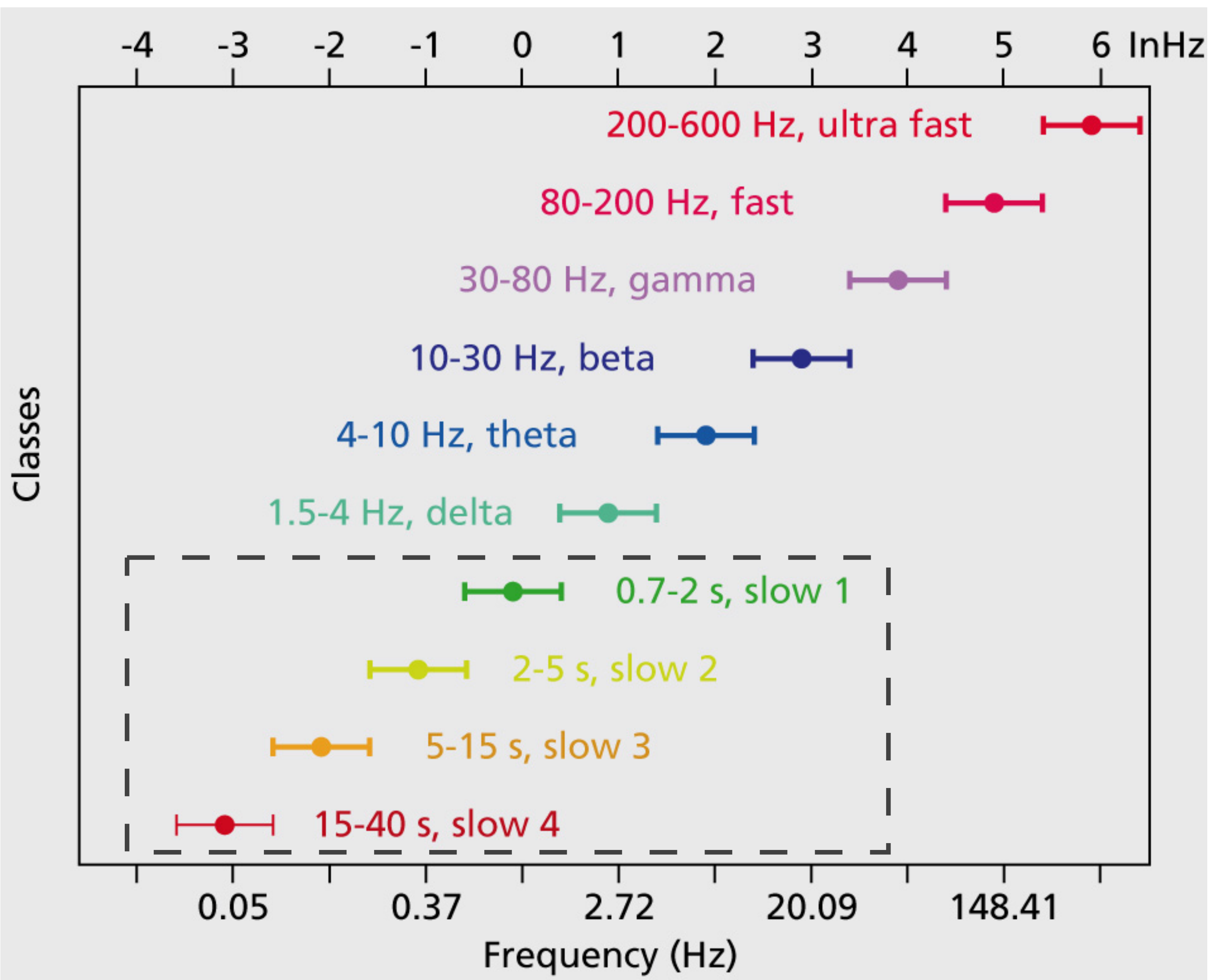



Similar Design as CCNP but for 6000 Pairs of Twins across 12 National Sites

# Methodology: Data + Theory

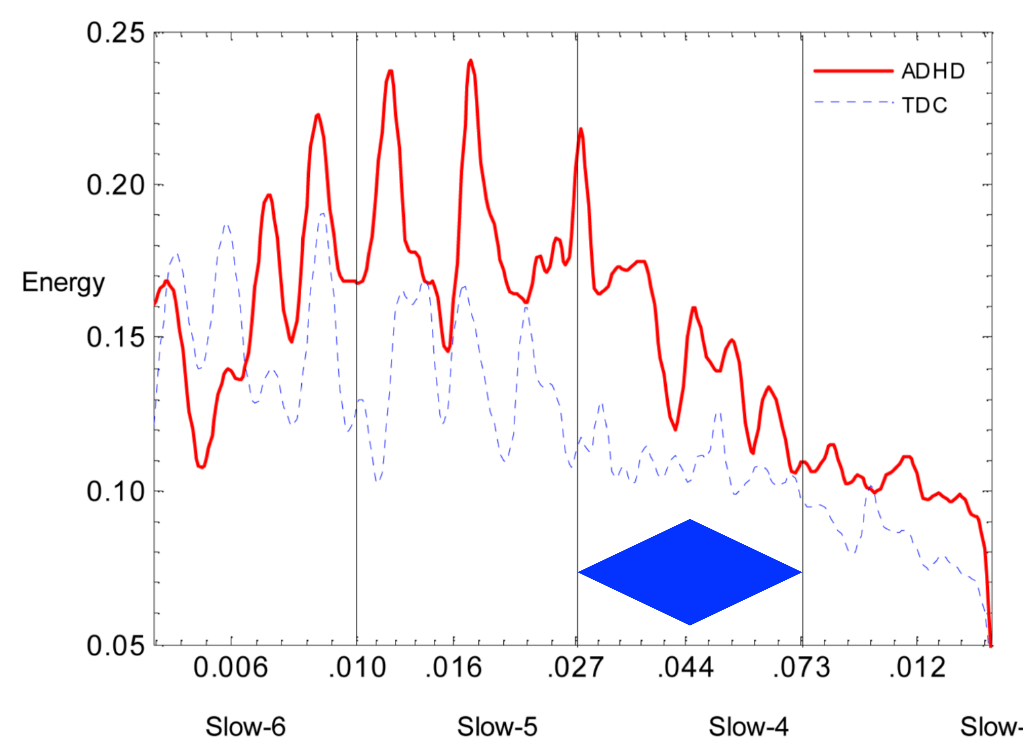
**Space and Time in The Brain**
**Rhythms of The Brain**




**Slow** $n$ $\left[e^{0.5-n}, e^{1.5-n}\right]$

Varies with sampling rates and durations

(TR = 3s, in total 15 mins)



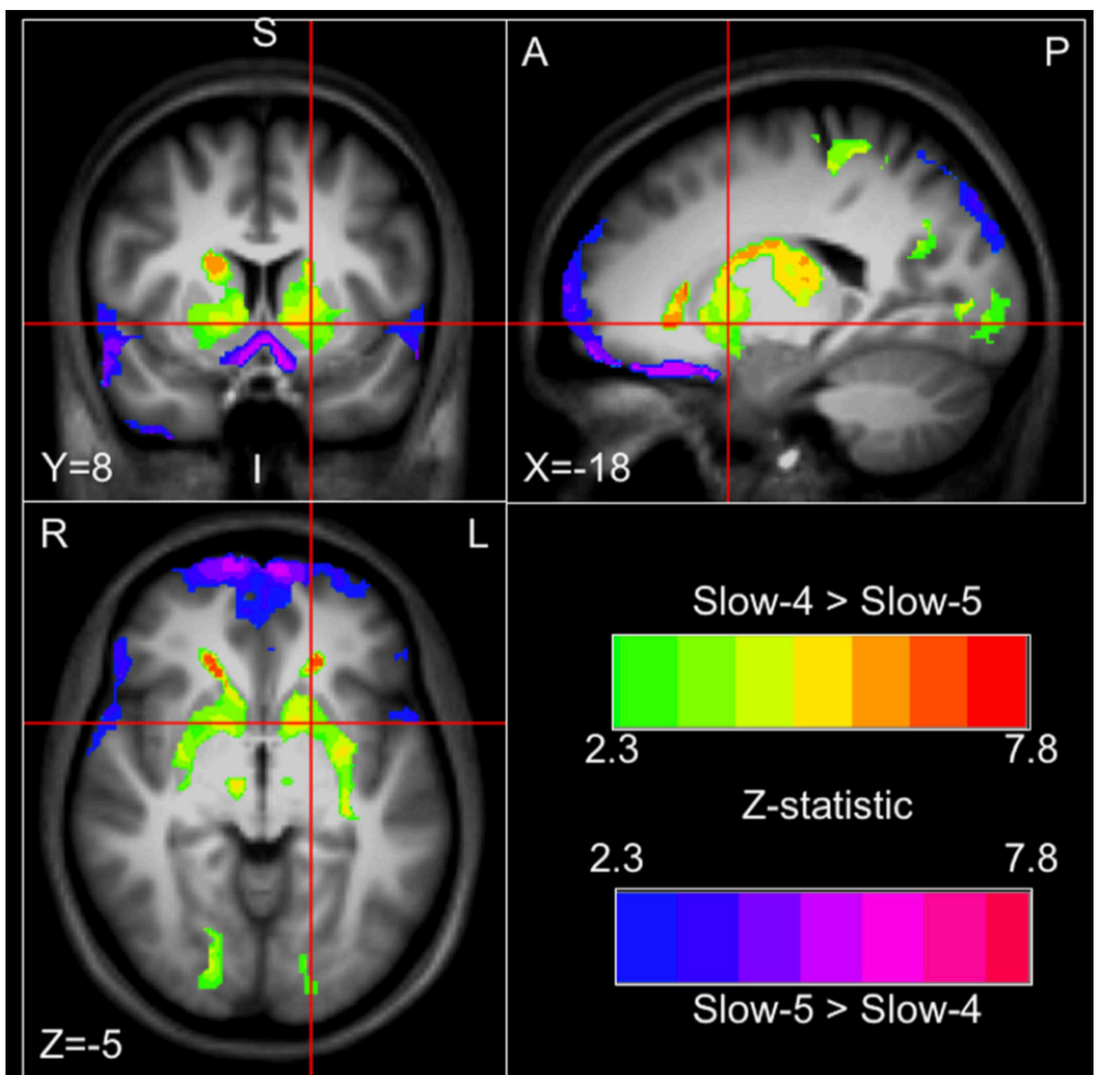

Science, 2004. 304:1926–1929; Biol Psychiat, 2008. 64: 607–614 .

# Methodology: Data + Theory

NeuroImage
Volume 49, Issue 2, 15 January 2010, Pages 1432-1445

## The oscillating brain: Complex and reliable

Xi-Nian Zuo [a], Adriana Di Martino [a], Clare Kelly [a], Zarrar E. Shehzad [a], Dylan G. Gee [a], Donald F. Klein [a, b, d], F. Xavier Castellanos [a, b], Bharat B. Biswal [b, c], Michael P. Milham [a]




**DREAM: A Toolbox to Decode Rhythms of the Brain System**

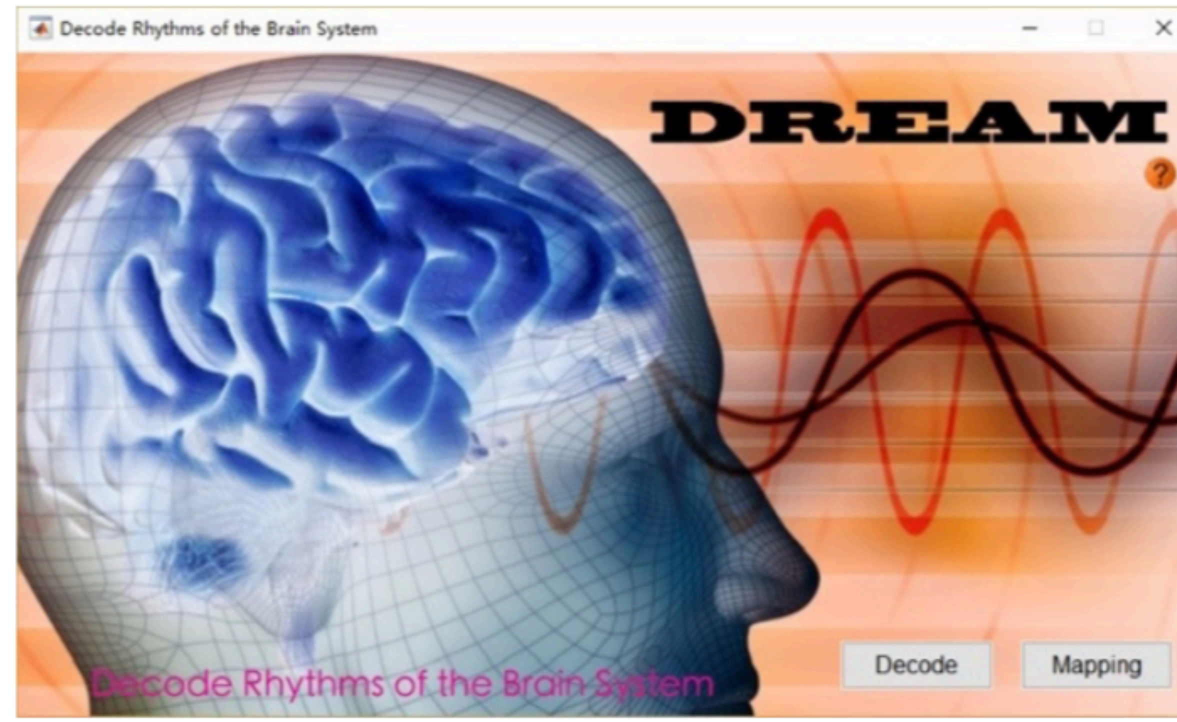
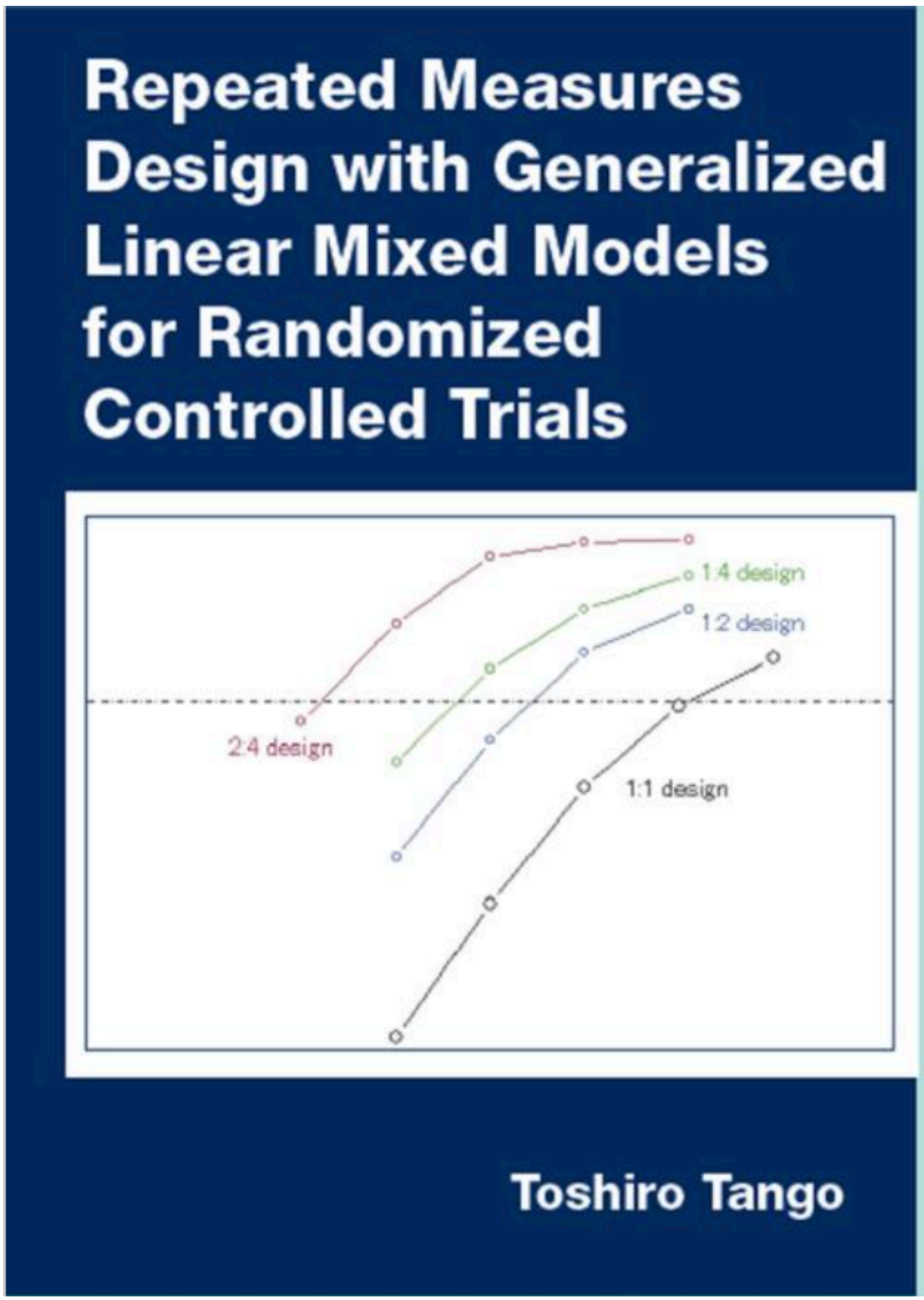
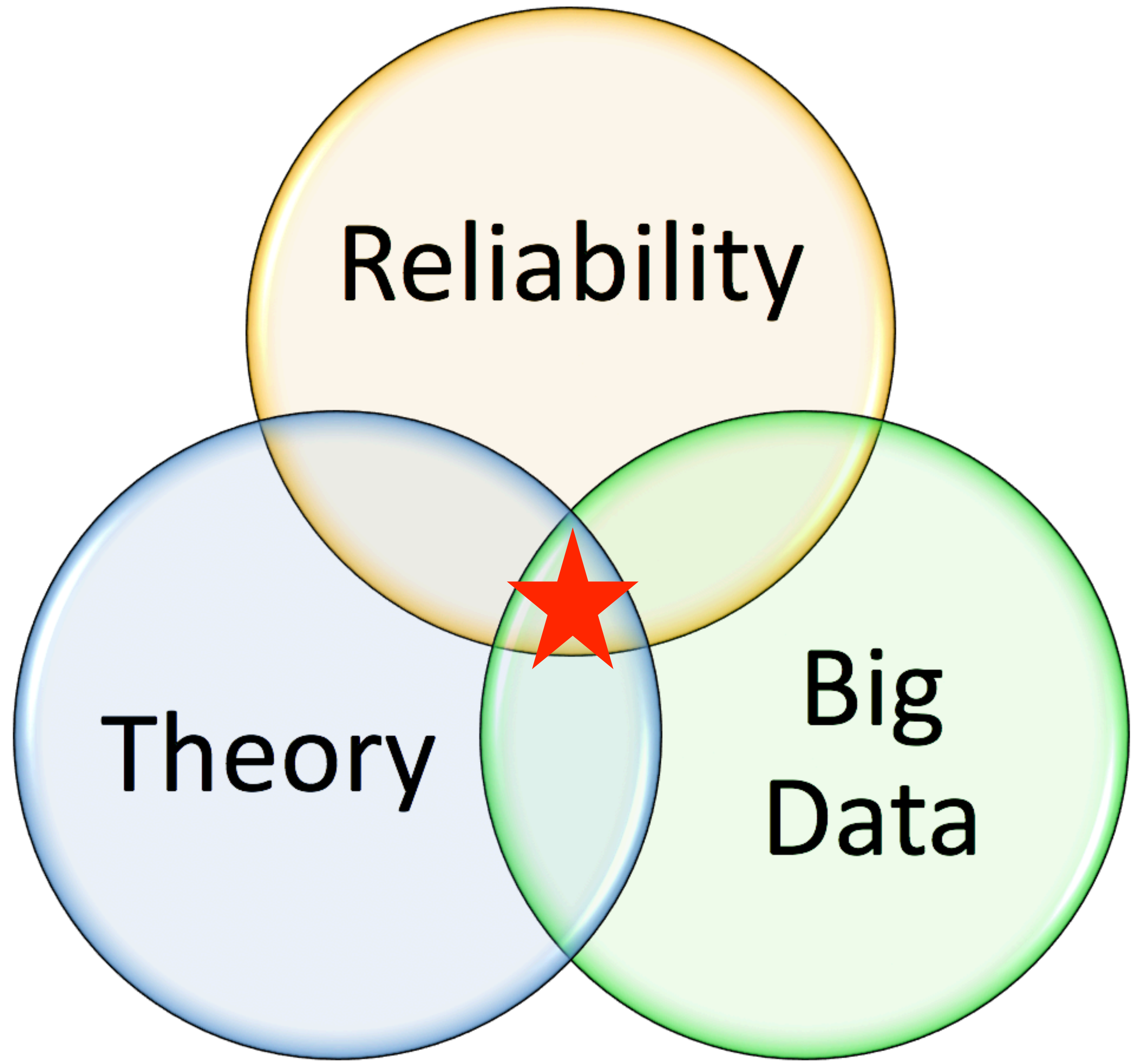



Fig. 1. The graphical user interface of DREAM.

Fig. 2. The mock scanner at CLIMB.

# Methodology: Data + Theory



# Thank you! Come to Our Posters :)


Zhu-Qing Gong

17-B

6-B

Peng Gao