CoRR

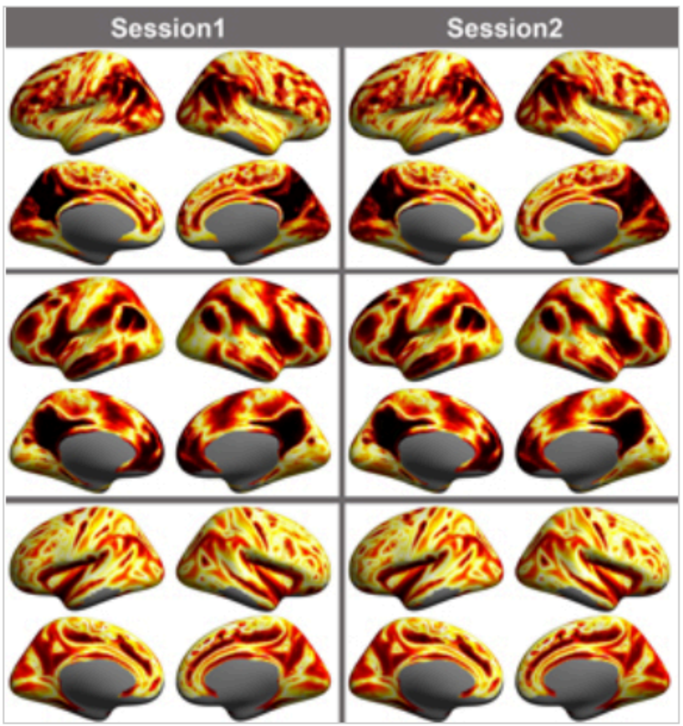
Consortium for Reliability and Reproducibility

An Open Science Resource for Establishing Reliability and Reproducibility in Connectomics

SCIENTIFIC DATA

Home | Archive | About ▼ | For Authors ▼ | For Referees | Data Policies ▼ | Collections ▼

Featured Data Descriptor



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

Zuo *et al.* | 9th December 2014

Resting state functional magnetic resonance imaging (rfMRI) is a powerful technique to map interactions between regions of the brain, but it remains unclear whether data from different sites or experimental designs can be reliably compared. This article describes rfMRI data from 1629 individuals, collected across 18 international sites. The data have been aggregated and openly shared by the Consortium for Reliability and Reproducibility (CoRR), providing a valuable resource for comparative brain mapping studies.

Reproducibility

Connectomics

Reliability

Big Data

Pipeline

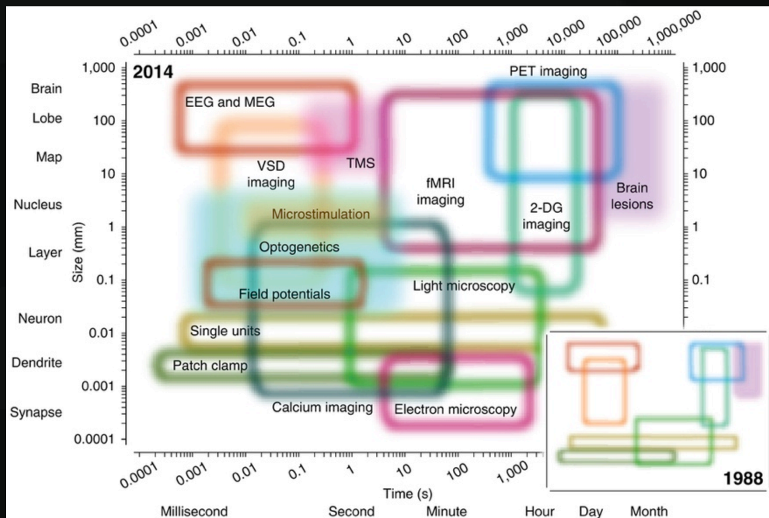
Connectome

(Concept)

脑连接组学

The whole functional interactions?

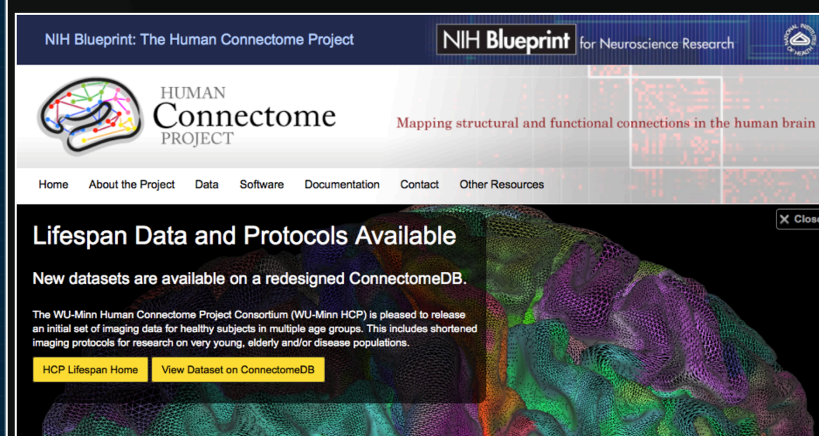
脑成像与连接组学



2014
1988
EEG and MEG
PET imaging
VSD imaging
TMS
fMRI imaging
2-DG imaging
Brain lesions
Microstimulation
Optogenetics
Field potentials
Light microscopy
Single units
Patch clamp
Calcium imaging
Electron microscopy
Brain
Lobe
Map
Nucleus
Layer
Neuron
Dendrite
Synapse
Size (mm)
1,000
100
10
1
0.1
0.01
0.001
0.0001
Time (s)
Millisecond
Second
Minute
Hour
Day
Month

心理所
MRI750

the WHITE HOUSE
PRESIDENT OBAMA IS CALLING ON THE SCIENCE COMMUNITY
TO JOIN HIM IN PURSUING A GRAND CHALLENGE
BRAIN INITIATIVE
BRAIN RESEARCH
THROUGH ADVANCING
INNOVATIVE
NEUROTECHNOLOGIES



NIH Blueprint: The Human Connectome Project
NIH Blueprint for Neuroscience Research
HUMAN Connectome PROJECT
Mapping structural and functional connections in the human brain
Home About the Project Data Software Documentation Contact Other Resources
Close
Lifespan Data and Protocols Available
New datasets are available on a redesigned ConnectomeDB.
The WU-Minn Human Connectome Project Consortium (WU-Minn HCP) is pleased to release an initial set of imaging data for healthy subjects in multiple age groups. This includes shortened imaging protocols for research on very young, elderly and/or disease populations.
HCP Lifespan Home
View Dataset on ConnectomeDB

Sporns 2005

Brain Connectome

OPEN ACCESS Freely available online

PLoS COMPUTATIONAL BIOLOGY

Review

The Human Connectome: A Structural Description of the Human Brain

Olaf Sporns*, Giulio Tononi, Rolf Kötter

ABSTRACT

The connection matrix of the human brain (the human "connectome") represents an indispensable foundation for basic and applied neurobiological research. However, the network of anatomical connections linking the neuronal elements of the human brain is still largely unknown. While some databases or collations of large-scale anatomical connection patterns exist for other mammalian species, there is currently no connection matrix of the human brain, nor is there a coordinated research effort to collect, archive, and disseminate this important information. We propose a research strategy to achieve this goal, and discuss its potential impact.

Experimental approaches to human cognition have been significantly enhanced by the arrival of functional neuroimaging [5], a set of techniques that can be applied to study a broad range of cognitive functions, with ever-increasing spatial and temporal resolution. But the mechanistic interpretation of neuroimaging data is limited, in part due to a severe lack of information on the structure and dynamics of the networks that generate the observed activation patterns. A potential theoretical framework for conceptualizing cognition as a network phenomenon is based on two main organizational principles found in the cerebral cortex, functional segregation, and functional integration [6,7]. Emerging network theories of cognition emphasize the contextual [8], distributed [9], dynamic [10], and degenerate [11,12] nature of structure–function mappings in the brain.

Hagmann
2008

Brain Connectome

OPEN ACCESS Freely available online PLOS BIOLOGY

Mapping the Structural Core of Human Cerebral Cortex

Patric Hagmann[1,2], Leila Cammoun[2], Xavier Gigandet[2], Reto Meuli[1], Christopher J. Honey[3], Van J. Wedeen[4], Olaf Sporns[3*]

1 Department of Radiology, University Hospital Center and University of Lausanne (CHUV), Lausanne, Switzerland, **2** Signal Processing Laboratory (LTS5), Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland, **3** Department of Psychological and Brain Sciences, Indiana University, Bloomington, Indiana, United States of America, **4** Martinos Center for Biomedical Imaging, Department of Radiology, Massachusetts General Hospital and Harvard Medical School, Boston, Massachusetts, United States of America

Structurally segregated and functionally specialized regions of the human cerebral cortex are interconnected by a dense network of cortico-cortical axonal pathways. By using diffusion spectrum imaging, we noninvasively mapped these pathways within and across cortical hemispheres in individual human participants. An analysis of the resulting large-scale structural brain networks reveals a structural core within posterior medial and parietal cerebral cortex, as well as several distinct temporal and frontal modules. Brain regions within the structural core share high degree, strength, and betweenness centrality, and they constitute connector hubs that link all major structural modules. The structural core contains brain regions that form the posterior components of the human default network. Looking both within and outside of core regions, we observed a substantial correspondence between structural connectivity and resting-state functional connectivity measured in the same participants. The spatial and topological centrality of the core within cortex suggests an important role in functional integration.

Biswal 2010

Brain Connectome

Toward discovery science of human brain function

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

[a]Department of Radiology, New Jersey Medical School, Newark, NJ 07103; [b]Phyllis Green and Randolph Cōwen Institute for Pediatric Neuroscience, New York University Child Study Center, NYU Langone Medical Center, New York, NY 10016; [c]FMRIB Centre, Oxford University, Oxford OX3 9DU, UK; [d]Howard Hughes Medical Institute, Harvard University, Cambridge, MA 02138; [e]School of Psychology, University of Wales, Bangor, UK; [f]Danish Research Centre for Magnetic Resonance, Copenhagen University Hospital Hvidovre, Hvidovre, Denmark; [g]Mood and Anxiety Disorders Program, National Institute of Mental Health/National Institutes of Health, Department of Health and Human Services, Bethesda, MD 20892; [h]Behavioral Neuroscience Department, Oregon Health & Science University, Portland, OR 97239; [i]Department of Diagnostic Radiology, Yale University School of Medicine, New Haven, CT 06511; [j]Division of Clinical Research, Nathan S. Kline Institute for Psychiatric Research, Orangeburg, NY 10962; [k]Biophysics Research Institute, Medical College of Wisconsin, Milwaukee, WI 53226; [l]Department of Diagnostic Radiology, Oulu University Hospital, Oulu, Finland; [m]Donders Institute for Brain, Cognition, and Behavior, Center for Neuroscience, Radboud University Nijmegen Medical Center, 6500 HB Nijmegen, The Netherlands; [n]Biophysics Research Institute, Medical College of Wisconsin, Milwaukee, WI 53226; [o]Institute of Neuroscience, National Yang-Ming University, Taiwan; [p]Imaging Institute, The Cleveland Clinic, Cleveland, OH 44195; [q]Brain Imaging and Analysis Center, Duke University Medical Center, Durham, NC, 27710; [r]Department of Cognitive Neurology, Max Planck Institute for Human Cognitive and Brain Sciences, 04103 Leipzig, Germany; [s]Department of Psychiatry and Department of Neurology, Emory University School of Medicine, Atlanta, GA 30322; [t]Centre for Advanced Imaging, University of Queensland, Brisbane, Australia; [u]Department of Psychology, University of Michigan, Ann Arbor, MI 48109; [v]Laboratory for Neurocognitive and Imaging Research, Kennedy Krieger Institute, Baltimore, MD, 21205; [w]Department of Psychiatry, Oregon Health & Science University, Portland, OR 97239; [x]F.M. Kirby Research Center for Functional Brain Imaging, Kennedy Krieger Institute, Baltimore, MD 21205; [y]Functional MRI Laboratory, University of Michigan, Ann Arbor, MI 48109; [z]McDonnell Center for Higher Brain Functions, Washington University School of Medicine, St. Louis, MO 63110; [aa]Departments of Neurology and Neuroradiology, Klinikum Rechts der Isar, Technische Universität München, 81675 Munich, Germany; [bb]Institute of Psychology and Department of Radiology, Leiden University Medical Center, Leiden University, Leiden, The Netherlands; [cc]Center for Brain Health and School of Behavioral and Brain Sciences, University of Texas at Dallas, Richardson, TX 75080; [dd]Department of Neurology, Washington University School of Medicine, St. Louis, MO 63110; [ee]Department of Neurology, Charité Univesitaetsmedizin-Berlin, 10117 Berlin, Germany; [ff]School of Kinesiology, University of Michigan, Ann Arbor, MI 48109; [gg]Department of Psychiatry, University of Pittsburgh, Pittsburgh, PA 15213; [hh]Department of Psychiatry, Klinikum Rechts der Isar, Technische Universität München, D-81675 Munich, Germany; [ii]Jiangsu Key Laboratory of Molecular and Functional Imaging, Department of Radiology, Zhong-Da Hospital, Southeast University, Nanjing 210009, China; [jj]Department of Psychiatry, Institute of Clinical Medicine and Department of Public Health Science, Institute of Health Science, University of Oulu, Oulu 90014, Finland; [kk]Berlin NeuroImaging Center, 10099 Berlin, Germany; [ll]Department of Psychiatry, Otto-von-Guericke University of Magdeburg, Magdeburg 39106, Germany; [mm]Laboratory for Higher Brain Function, Institute of Psychology, Chinese Academy of Sciences, Beijing 100864, China; [nn]Department of Brain and Cognitive Sciences, Harvard-MIT Division of Health Sciences and Technology, Massachusetts Institute of Technology, Boston, MA 02139; [oo]Department of Psychiatry, University of Western Ontario, London, ON N6A3H8, Canada; [pp]Center for Medical Physics and Biomedical Engineering, Medical University of Vienna, Vienna, Austria; and [qq]State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, Beijing 100875, China

Brain Connectome

Buckner 2013

REVIEW

FOCUS ON NEUROTECHNIQUES

nature neuroscience

Opportunities and limitations of intrinsic functional connectivity MRI

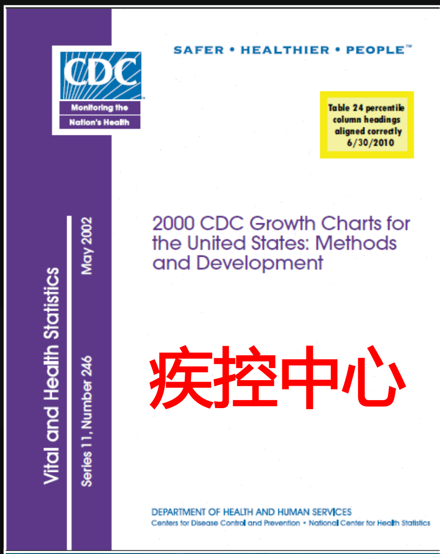
Randy L Buckner[1–3], Fenna M Krienen[1,3] & B T Thomas Yeo[4]

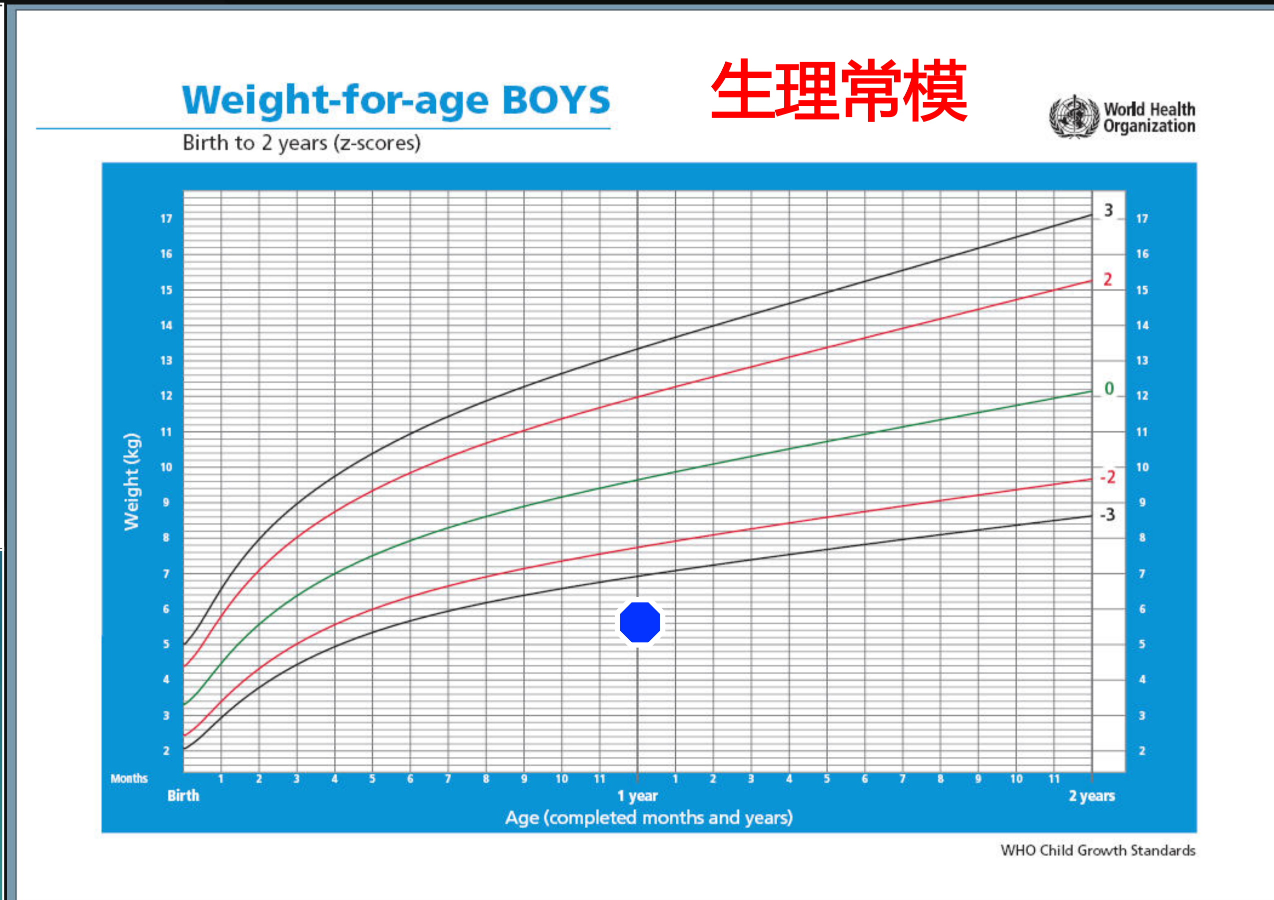
Intrinsic functional connectivity magnetic resonance imaging (fcMRI) has emerged as a powerful tool for mapping large-scale networks in the human brain. Robust and reliable functionally coupled networks can be detected in individuals that echo many known features of anatomical organization. Features of brain organization have been discovered, including descriptions of distributed large-scale networks interwoven throughout association cortex, interactions (including anticorrelations) between brain networks and insights into the topography of subcortical structures. But interpreting fcMRI is complicated by several factors. Functional coupling changes dynamically, suggesting that it is constrained by, but not fully dictated by, anatomic connectivity. Critically to study of between-group differences, fcMRI is sensitive to head motion and to differences in the mental states of participants during the scans. We discuss the potential of fcMRI in the context of its limitations.

信度与可重复性

Why we need reliable measures?

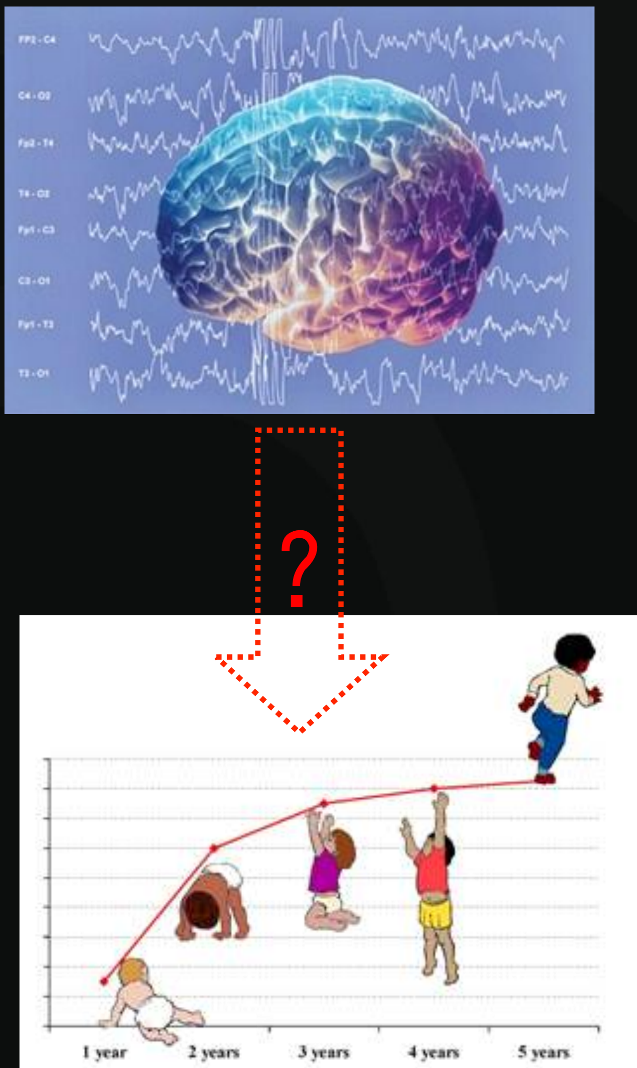
国人心理毕生发展常模





生长曲线：非常重要的发育监测工具
应用领域：儿科临床实践和公共卫生
重要意义：发育异常早期识别与诊断

国人心理毕生发展常模



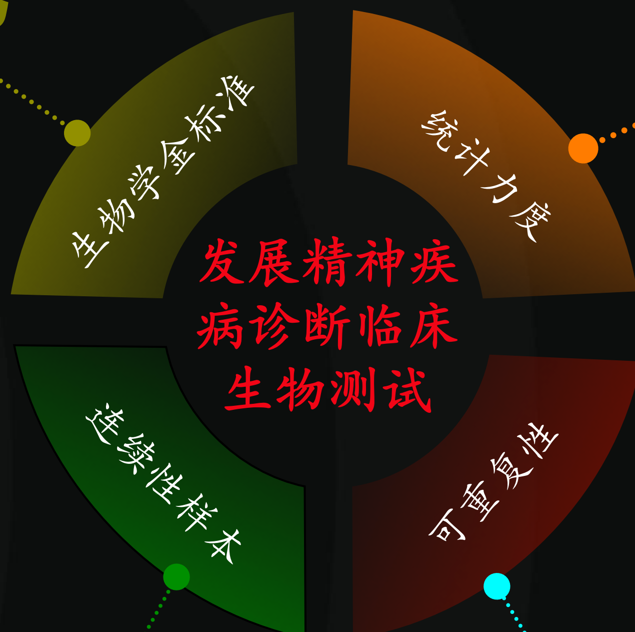
人脑常模

1、理解大脑结构功能
2、监测大脑发育进程
3、识别大脑发育异常
4、诊断大脑发育疾病
5、跟踪临床干预疗效
6、改善精神疾病诊断

基础研究与临床实践变革

1
症状学
生物学
常模轨线

2
大量的
小样本
统计比较

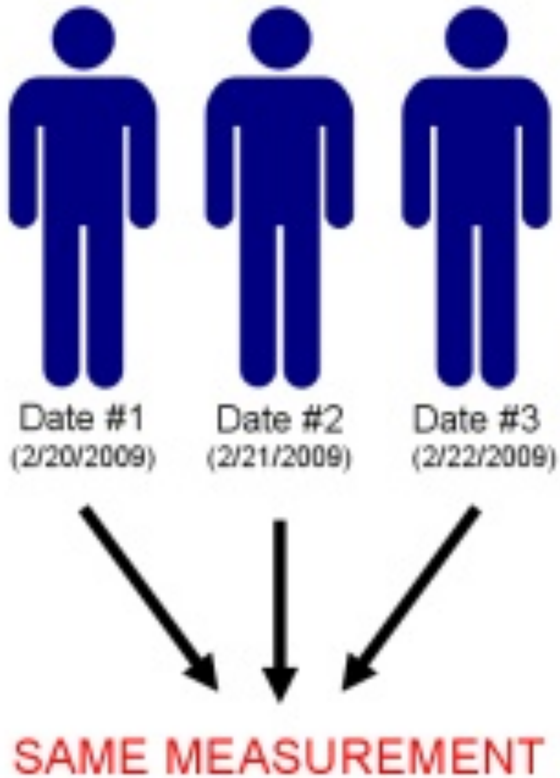


4
极端样本
疾病谱系
连续界定

3
重测信度
重复性
严格再现

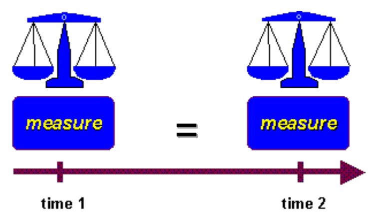
Kapur et al., 2012, *Molecular Psychiatry*

基础研究与临床实践变革



重测信度

$$ICC = \frac{MSb - MSw}{MSb + MSw}$$



$$A' = A + n(A)$$

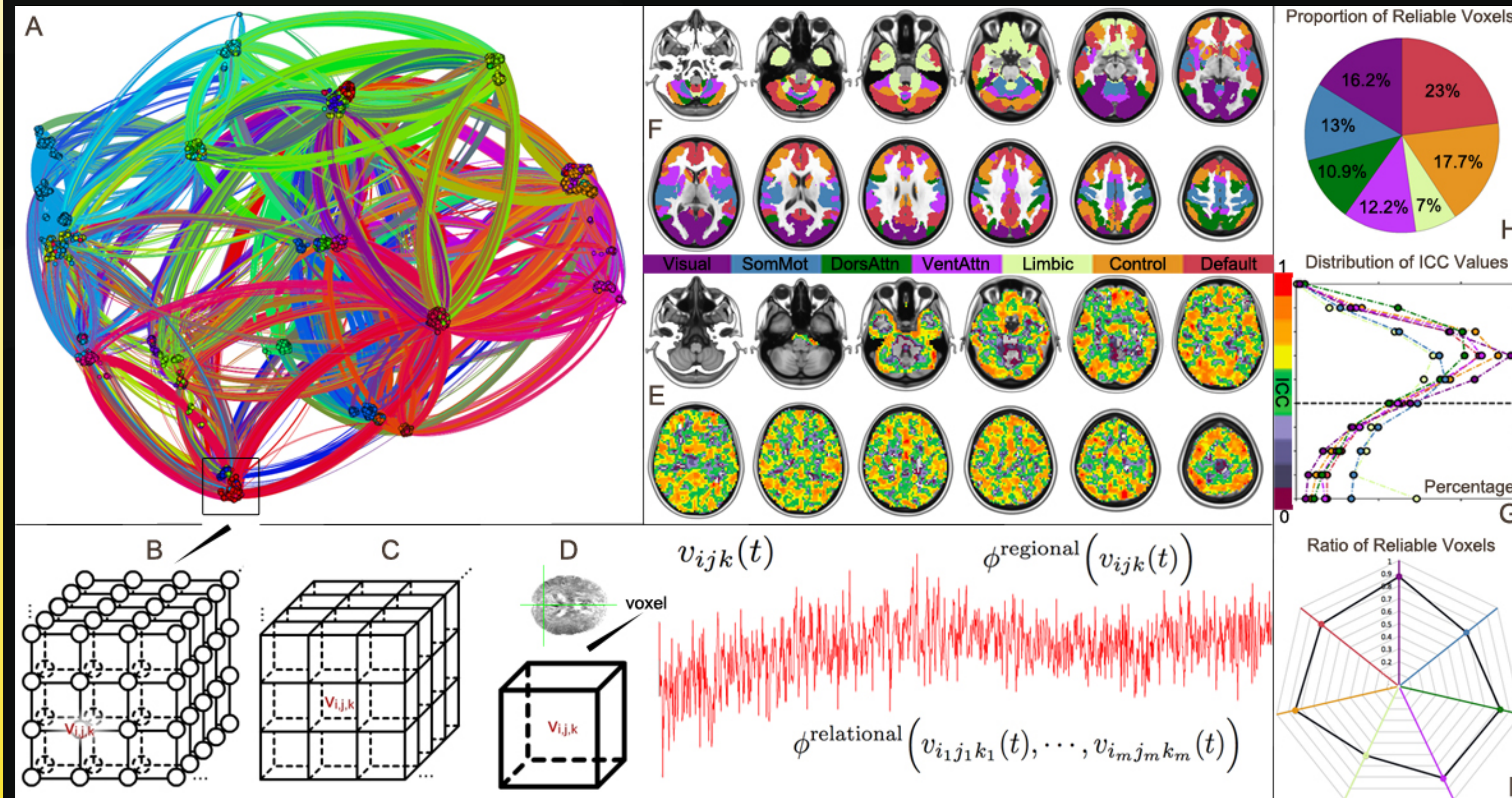
$$B' = B + n(B)$$

$$r(A',B') = r(A,B)\sqrt{ICC(A)ICC(B)}$$

Slight Fair Moderate Substantial Almost Perfect

Zuo and Xing, 2014, *Neuroscience Biobehavioral Reviews*

基础研究与临床实践变革



人脑功能连接组学规范

Zuo and Xing, 2014, *Neuroscience Biobehavioral Reviews*

Big Data

(Easy Sharing)

神经影像大数据

Integrated Neuroinformatics System?

Consortium for Reliability and Repeatability

- Project Director: Xi-Nian Zuo; Founders: Xi-Nian Zuo, Michael P. Milham

Table Of Contents

Quick search

Go

Enter search terms or a module, class or function name.

An open neuroscience resource brought to you by:

indi
International Neuroimaging Data-Sharing Initiative

CoRR Concept

Goal of CoRR

Total 18 sites, > 1600 participants, > 10,000 images

The overarching goal of CoRR is to create an open science resource for the imaging community that will facilitate the assessment of test-retest reliability and reproducibility for functional and structural connectomics. In order to accomplish this, we will aggregate resting state fMRI (R-fMRI) and diffusion imaging data across laboratories around the world, and share the data via the International Neuroimaging Data-sharing Initiative (INDI) to enable the:

1. Establishment of test-retest reliability and reproducibility for commonly used MR-based connectome metrics
2. Determination of the range of variation in the reliability and reproducibility of these metrics across imaging sites and retest study designs
3. Creation of a standard/benchmark test-retest dataset for the evaluation of novel metrics

Data Aggregation

Contributors: Any laboratory willing to openly share multimodal imaging datasets (including an R-fMRI scan and a corresponding anatomical image at a minimum) with at least one retest occasion. Institutional IRB/ethical committee approval or waiver (see below) is required prior to contribution of data. MRI data: Our primary focus is on R-fMRI data, with a secondary focus on diffusion imaging data. While we encourage sharing data with minimal movement, we are placing no exclusion criteria for motion. This decision was based on the realizations that: 1) there is no consensus on acceptable criteria for movement in functional MRI or diffusion imaging data, 2) high motion datasets are essential to the determination of the impact of motion on reliability, and 3) new approaches continue to be developed to account for movement artifacts. We also encourage submission of data from other modalities (e.g., ASL) or experimental paradigms (e.g. task data) when available for the same participants for whom R-fMRI data are being provided.

中国科学院 CHINESE ACADEMY OF SCIENCES

HARVARD UNIVERSITY

SOUTHWEST UNIVERSITY

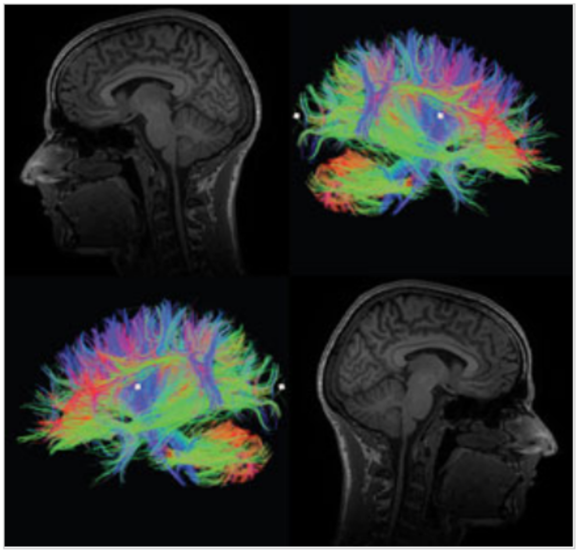
杭州师范大学 认知与脑疾病研究中心 Center for Cognition and Brain Disorders

CHILD MIND INSTITUTE

Zuo 2014

CoRR

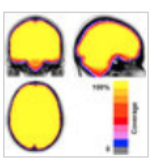
Featured Collection



Human Brain MRI Reproducibility

Collection | 20th January 2015

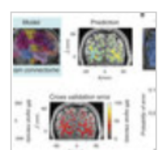
This collection presents a series of articles describing human brain scans – produced with a variety of magnetic resonance imaging (MRI) methods and modalities – which are designed to help researchers assess the reproducibility of brain imaging techniques and to develop new methods based on these data-types. Central to this collection are studies from the Consortium on Reliability and Reproducibility (CoRR), a major initiative that has organized the release of data from thousands of individual brain scans collected at 18 international sites.



Data Descriptor | 09 December 2014

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

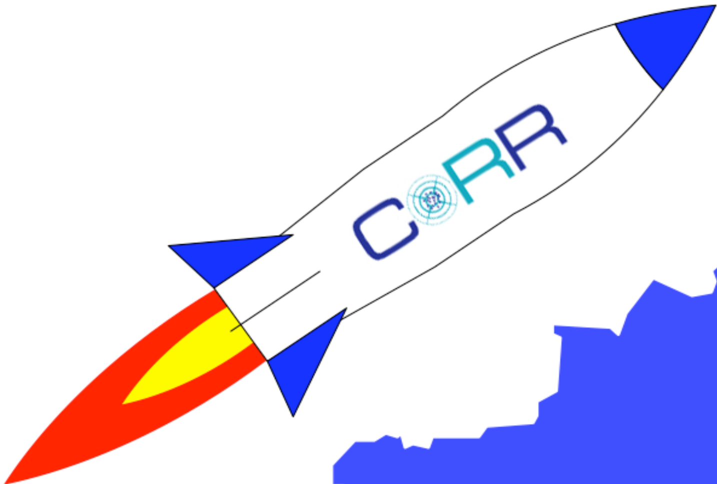
Xi-Nian Zuo, Jeffrey S Anderson [...] Michael P Milham

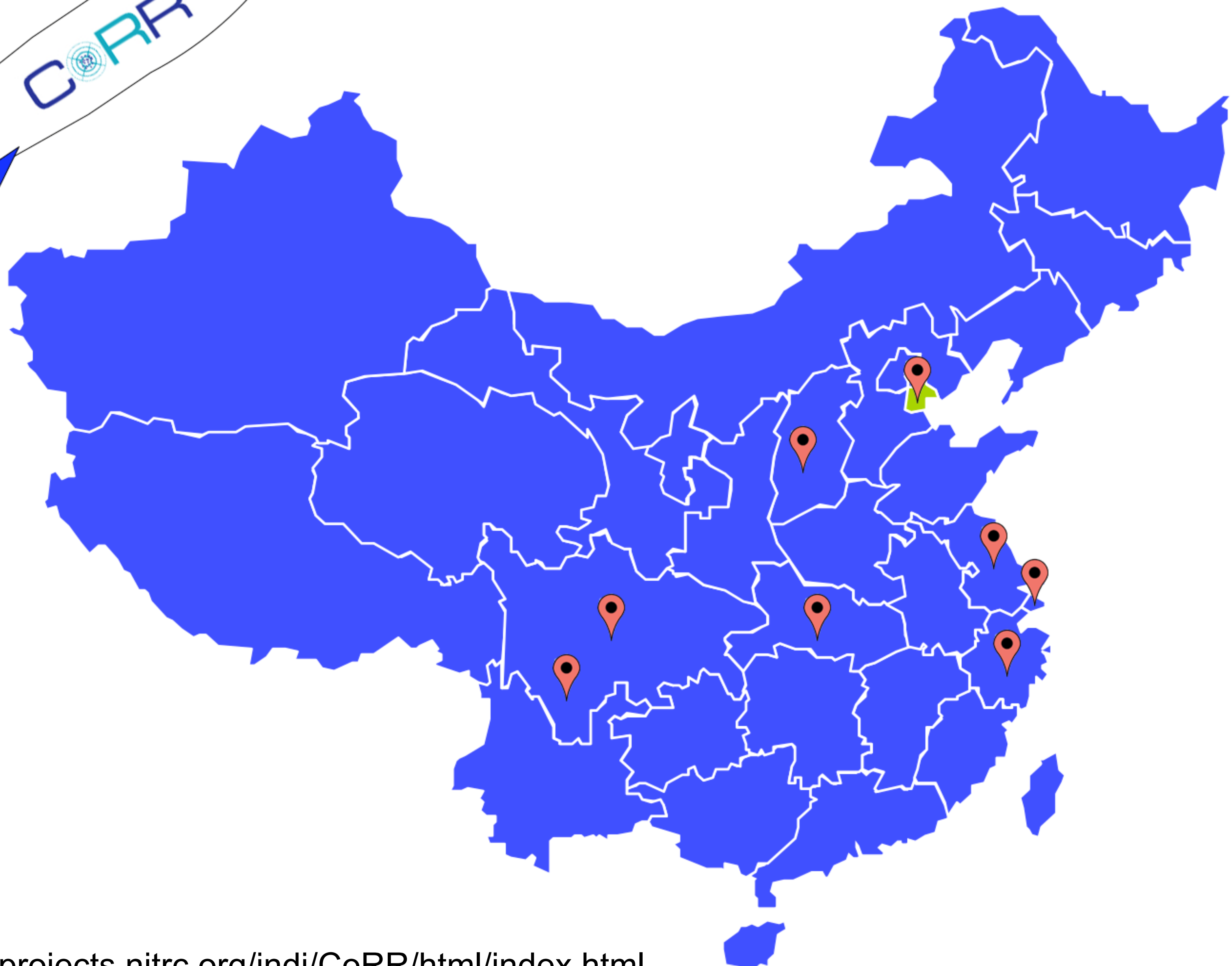


Comment | 20 January 2015

Test-retest measurements and digital validation for *in vivo* neuroscience

Franco Pestilli





http://fcon_1000.projects.nitrc.org/indi/CoRR/html/index.html

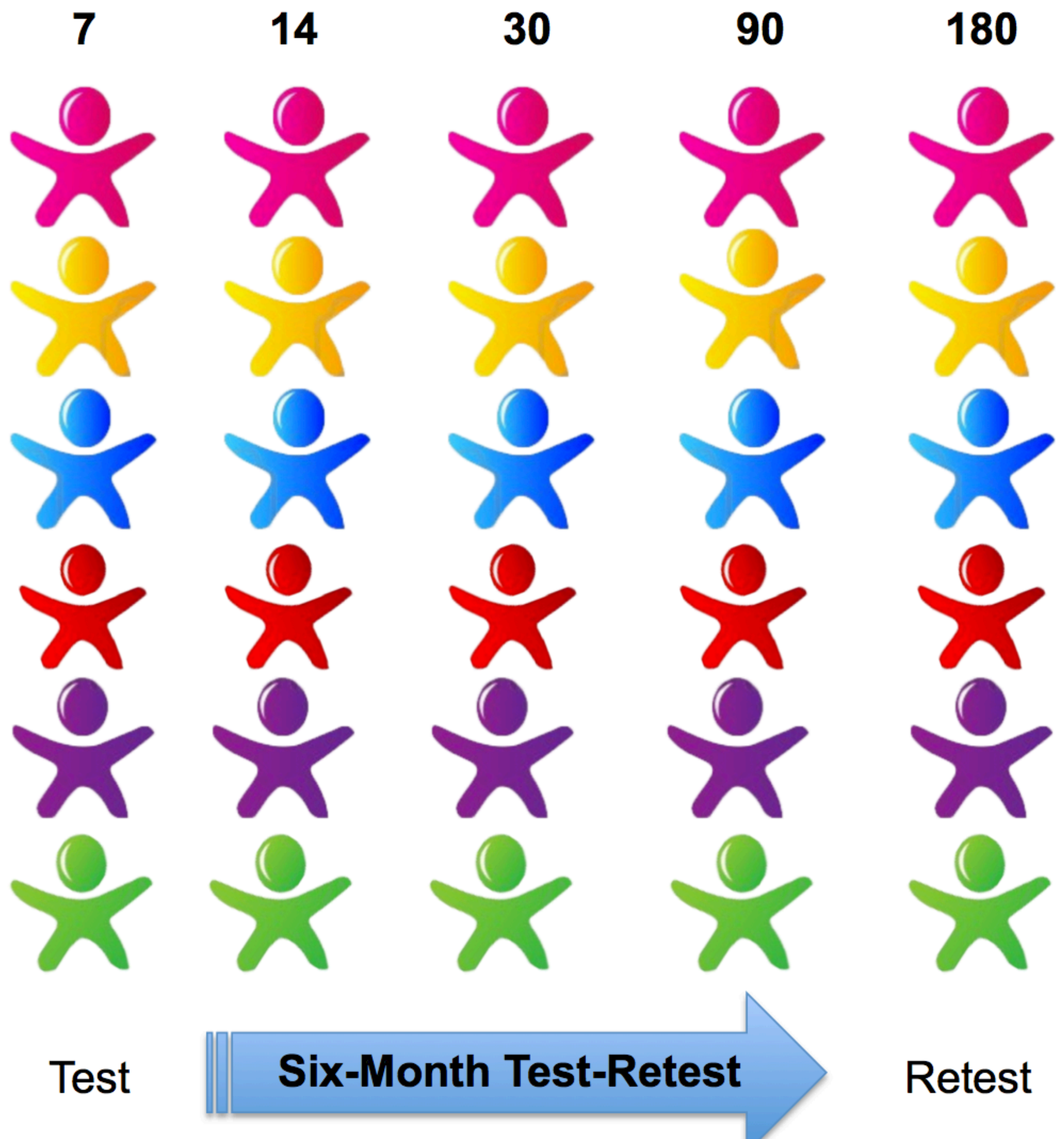
Test

One-Year Test-Retest

Total 243 Subjects

Retest

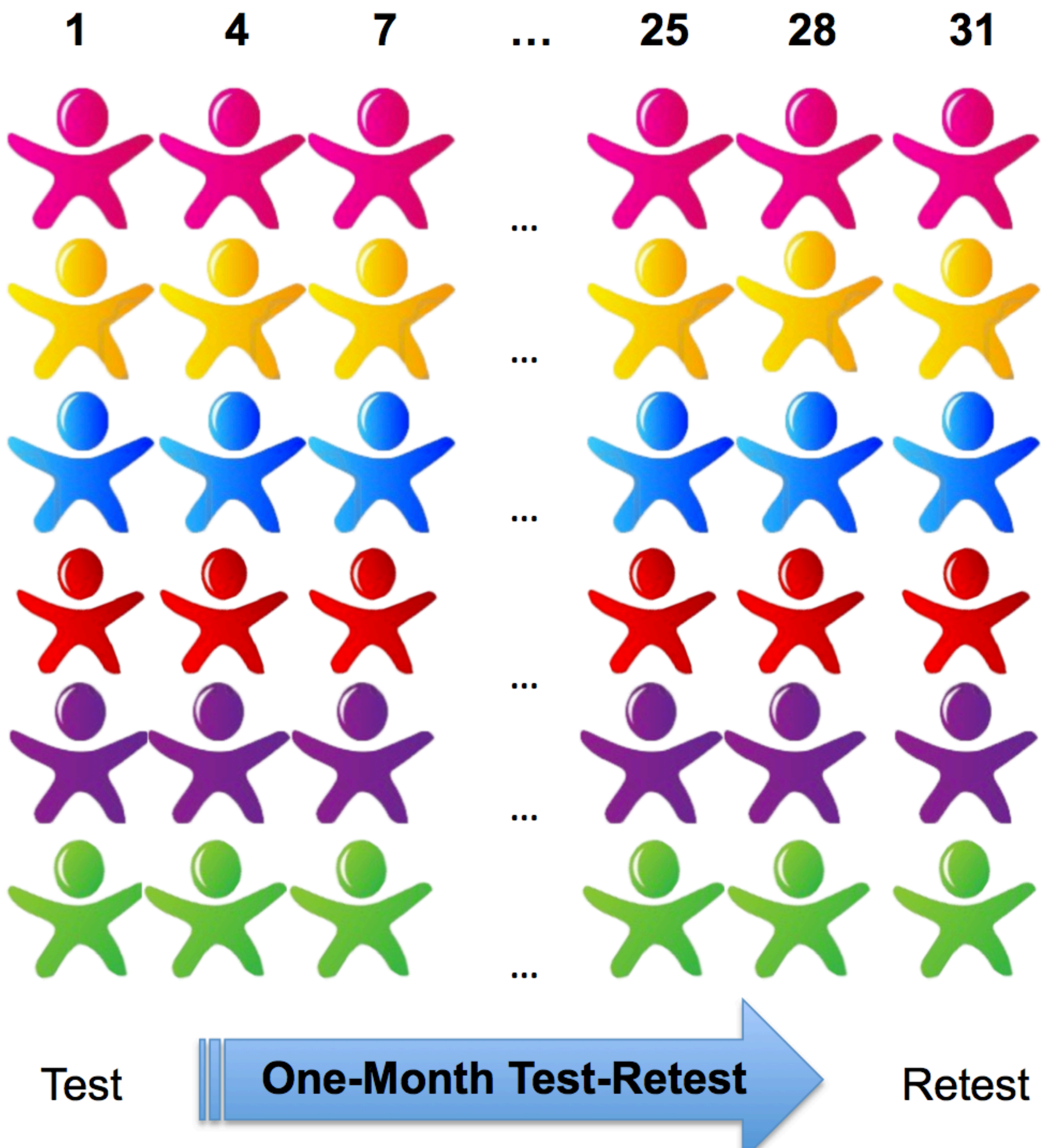
(PI: Jiang Qiu)



Total 23 Subjects (4 Retests/Subject)

Xuanwu Hospital
Capital Medical University

(PI: Kuncheng Li)

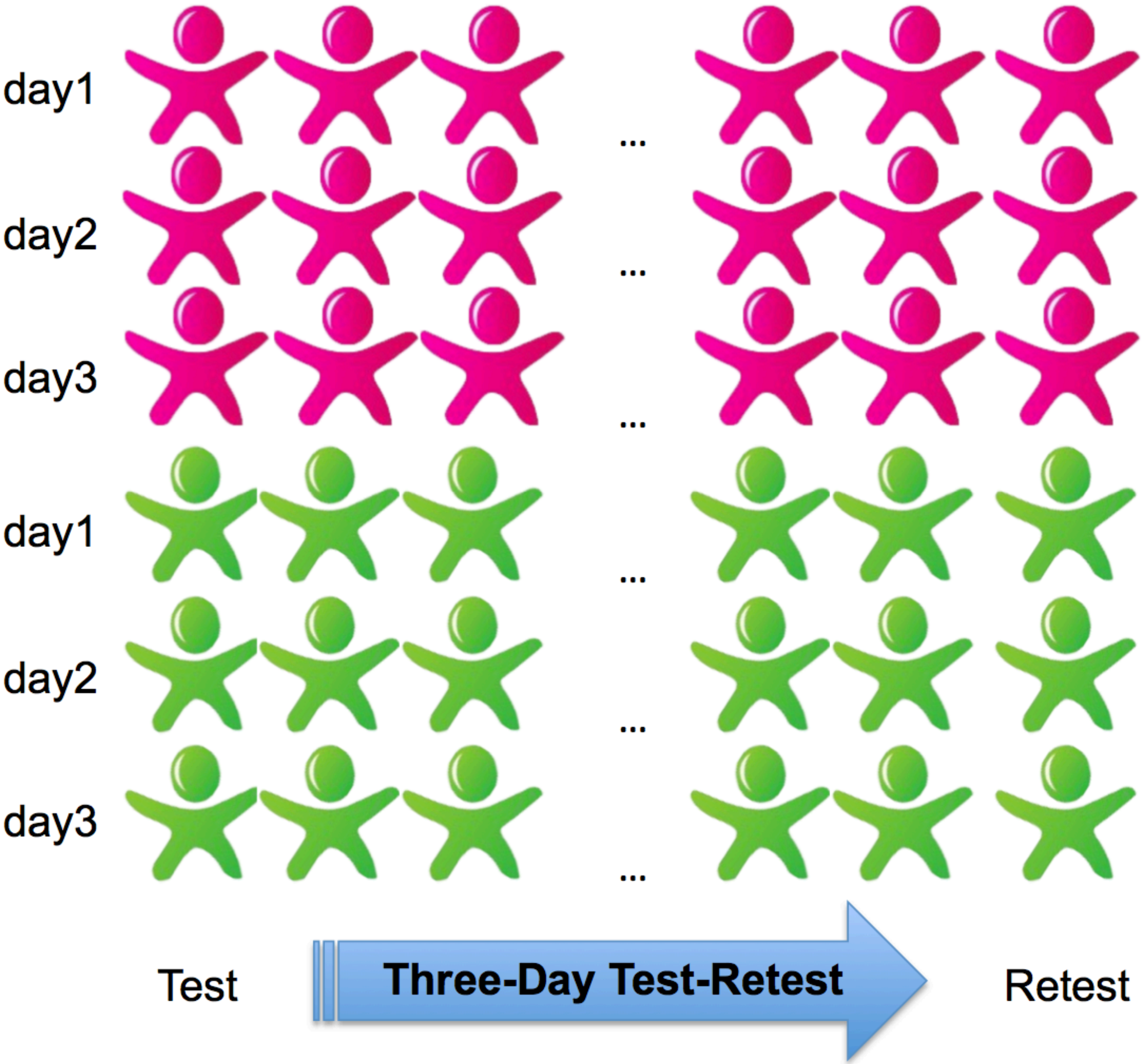


Total 30 Subjects (9 Retests/Subject)

杭州师范大学
认知与脑疾病研究中心
Center for Cognition and Brain Disorders

(PI: Xuchu Weng)

8AM ~ 8PM: 3 scans per hour



Total 2 Subjects (44 Retests/Subject)

(PI: Xi-Nian Zuo)

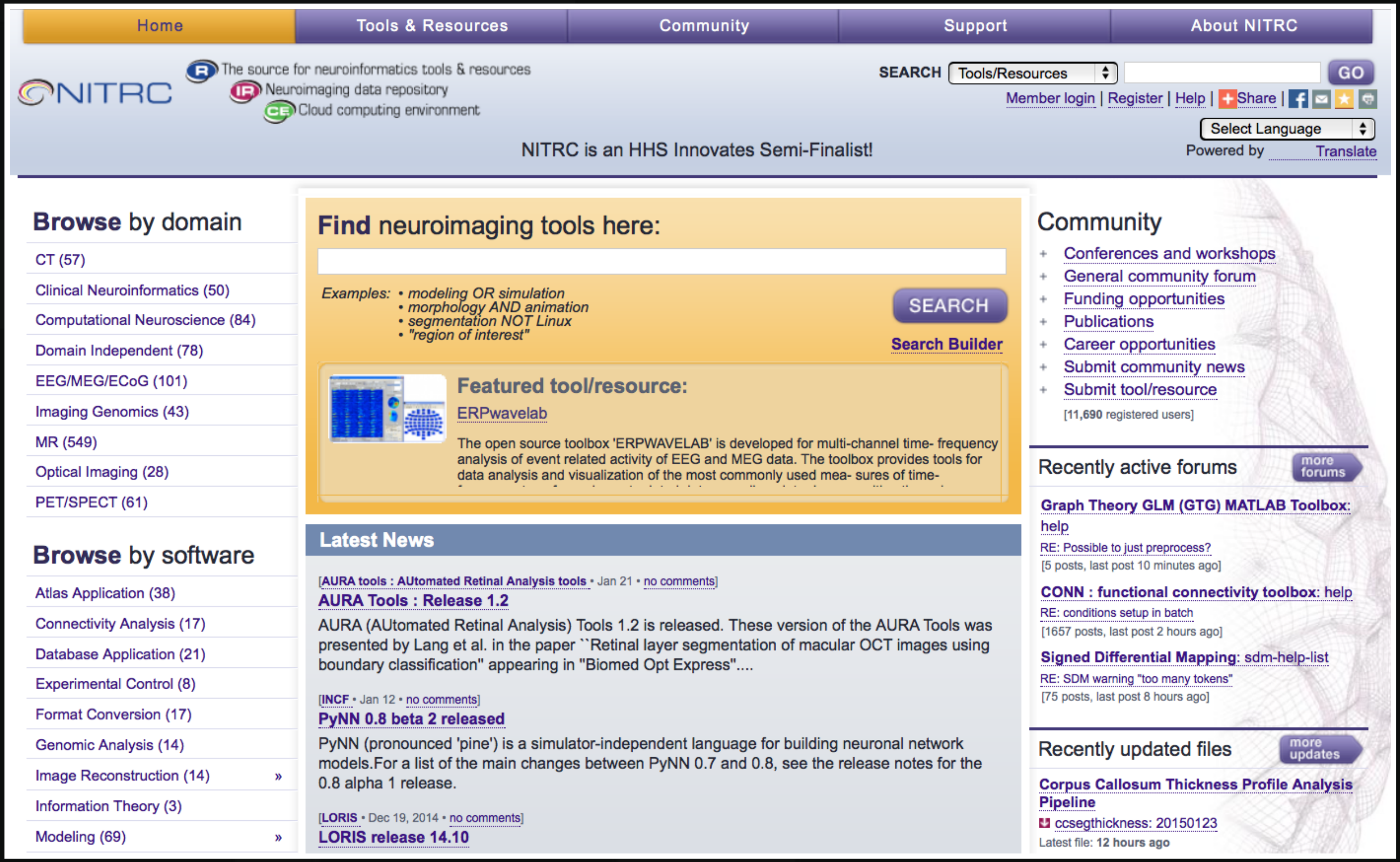
Pipeline
(Databasing)

计算流水线与数据库

Integrated with Data-sharing Platform?

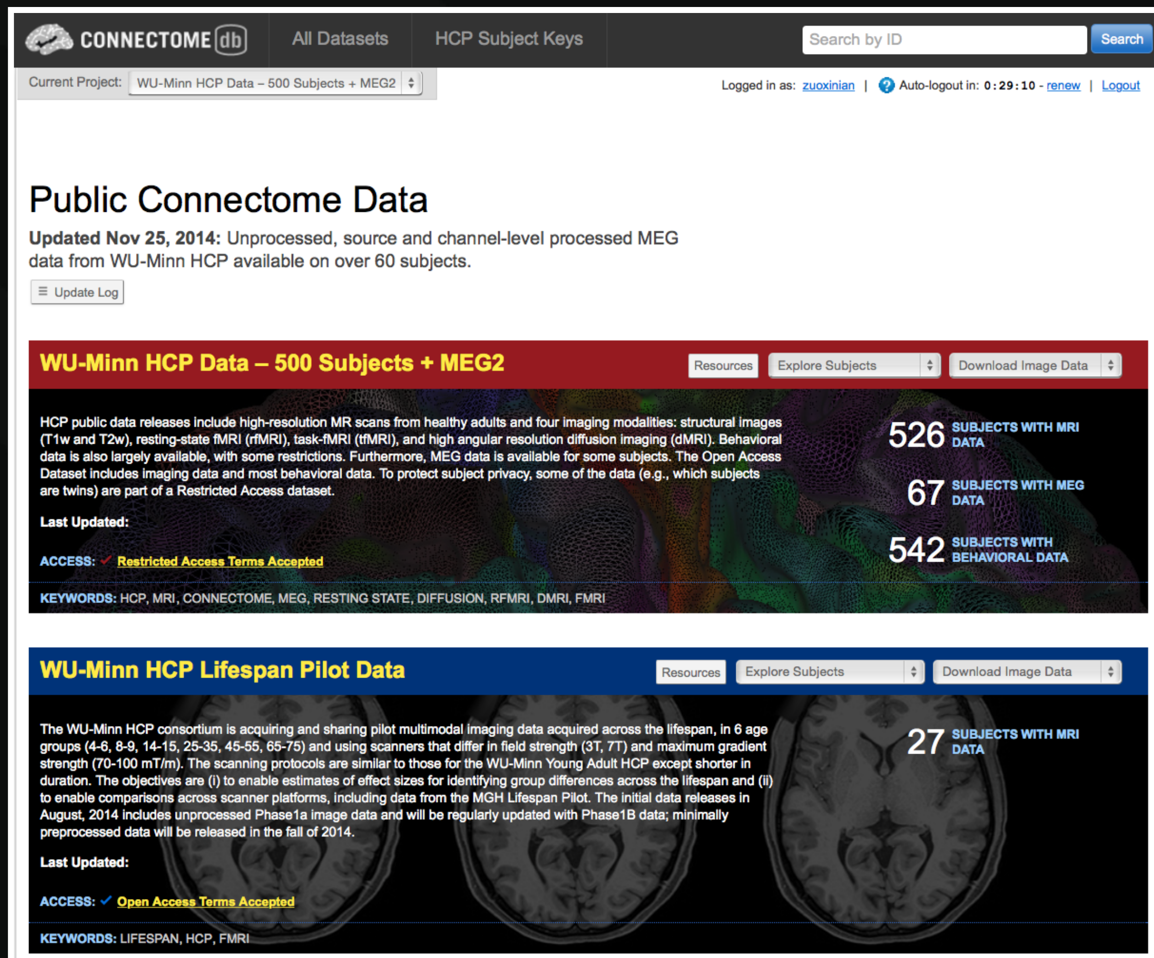
Data Base

NITRC



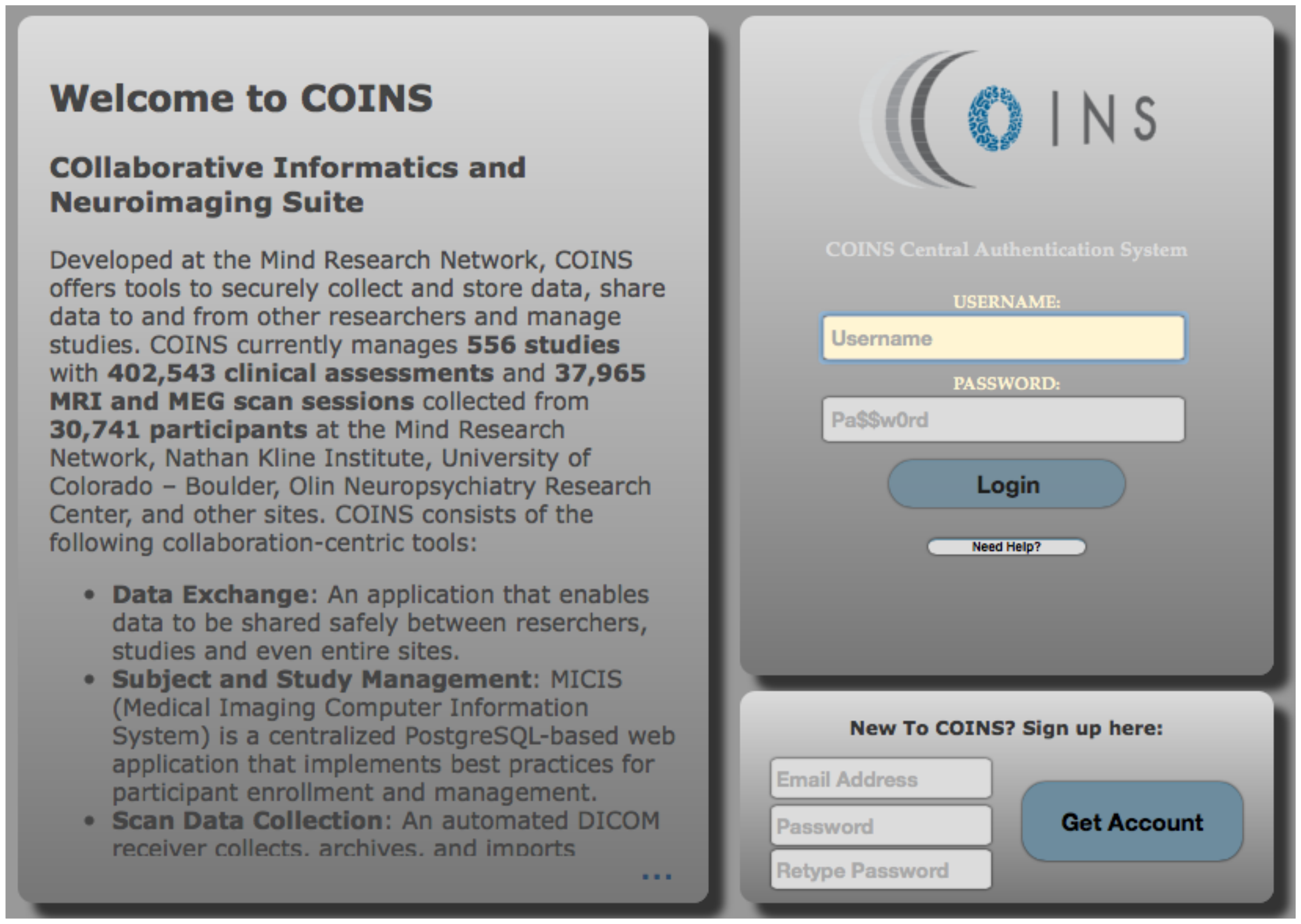
Data Base

HCP

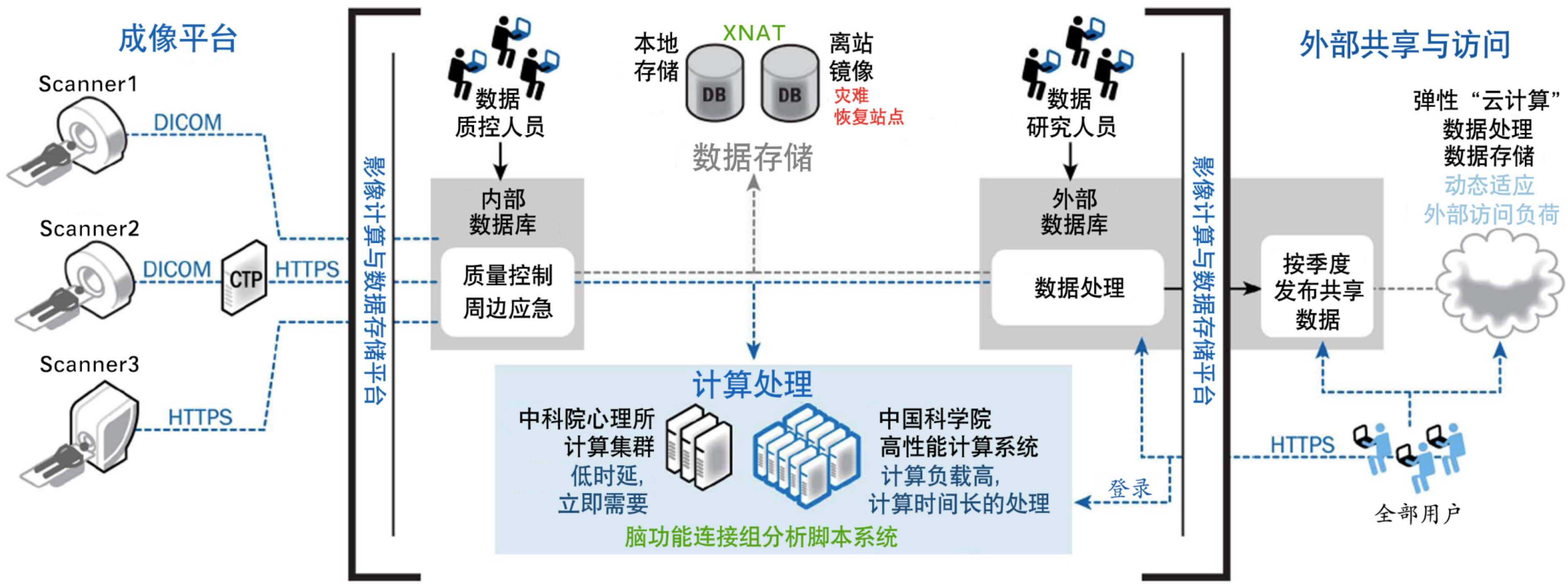


Data Base

COINs



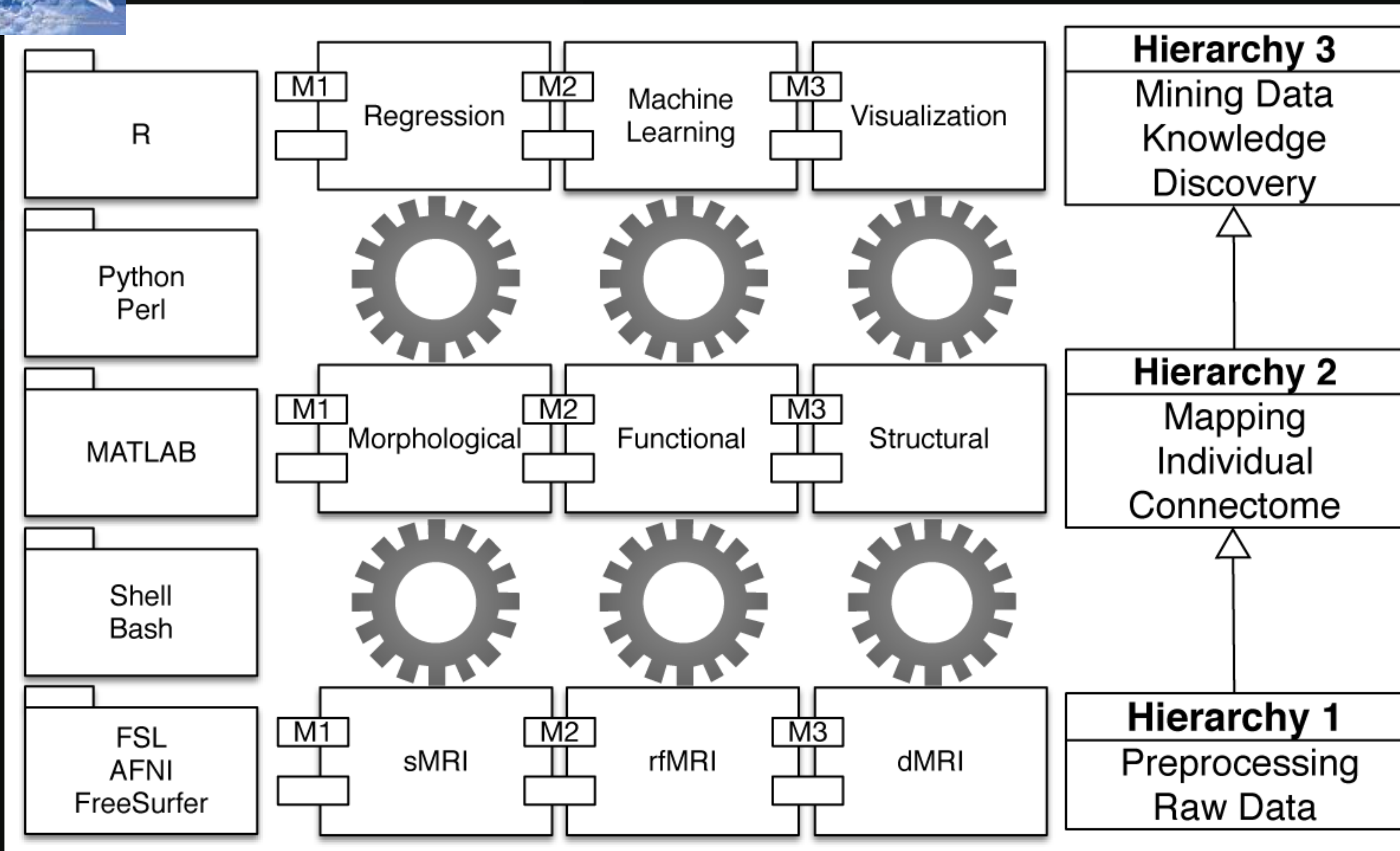
中国人脑科学大数据平台



脑科学大数据平台建设不仅包括多维度脑功能数据的采集，更体现在开发整合从基因-脑-行为海量数据到应对如此前所未有的系统复杂性的计算平台挑战上。一旦上述挑战克服，计算环境与大数据的实现无缝整合，长期实际数据积累，将会辅助实现从个体到社会的心理精神健康评估和疾病预测。


Science
Bulletin

CCS 2015


R
Python
Perl
MATLAB
Shell
Bash
FSL
AFNI
FreeSurfer
M1
Regression
M2
Machine Learning
M3
Visualization
M1
Morphological
M2
Functional
M3
Structural
M1
sMRI
M2
rfMRI
M3
dMRI
Hierarchy 3
Mining Data Knowledge Discovery
Hierarchy 2
Mapping Individual Connectome
Hierarchy 1
Preprocessing Raw Data

敬请批评指正！

谢谢！