发展群体神经科学

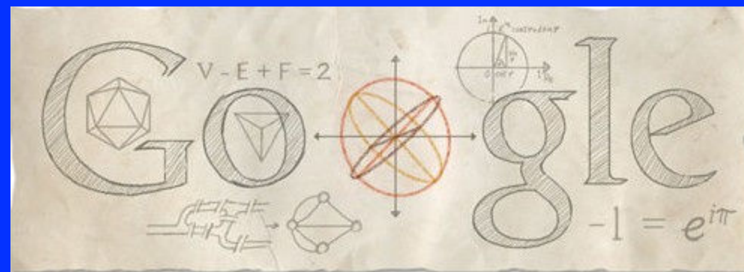
Developmental Population Neuroscience

左西年 (应用数学博士)

行为科学重点实验室
磁共振成像研究中心
脑智毕生发展研究中心
中国科学院心理研究所
中国科学院大学心理系

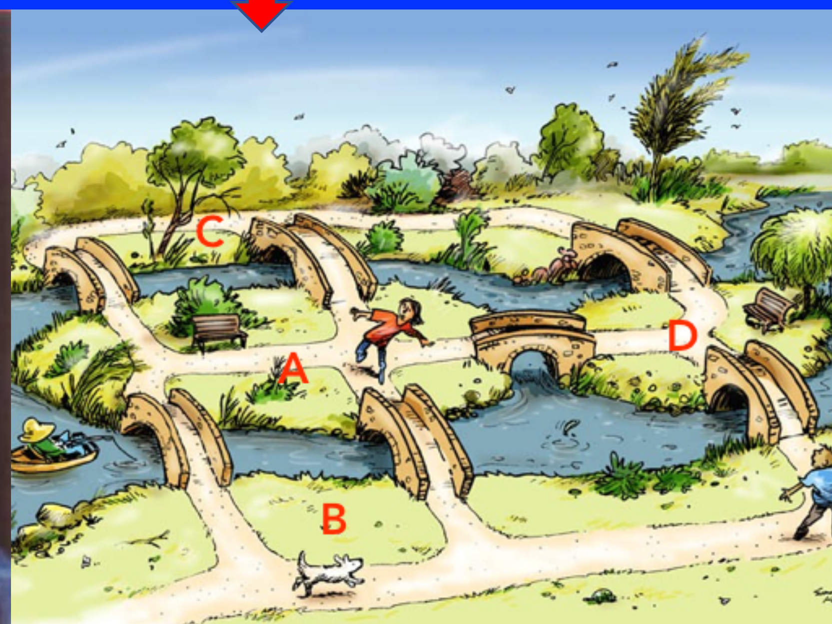
欧拉生平

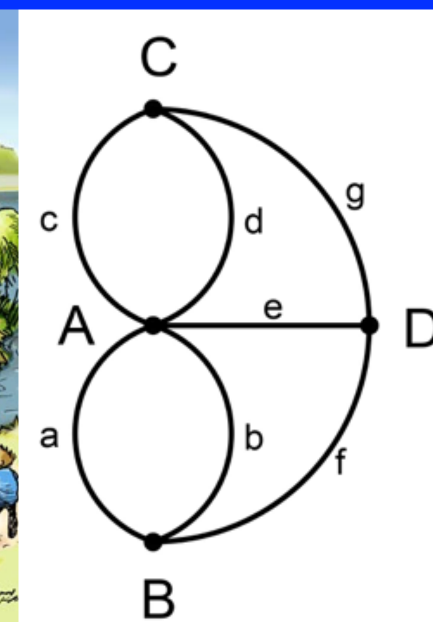
出生于牧师家庭，自幼受父亲的影响。13岁读大学，15岁大学毕业，16岁硕士毕业，19岁开始发表论文，直到76岁，其科学著作的整理共耗时47年



被誉为数学全才，勤奋的化身，心算和记忆力超群，管理能力卓越，生活丰富多彩，热爱音乐，两次婚姻，育有13个孩子，矢志不渝的爱国者-瑞士

Leonhard Euler
(1707-1783)





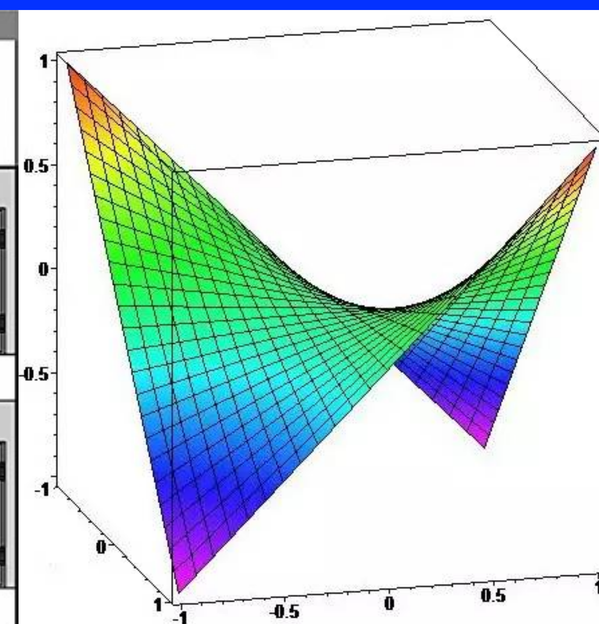
图论的缔造者（哥尼斯堡七桥问题）

纳什生平

出生于中产家庭，父亲是一战老兵，母亲是中小学教师。从小性格内向孤僻，社交障碍，特立独行，四年级就表现出数学才华，21岁得纳什均衡

被誉为孤独天才，疯子的化身，严重的精神分裂症，坚定的婚姻，妻子精心照顾30年，世俗偏见致数次错失菲尔兹和诺奖，赢取了人生博弈均衡

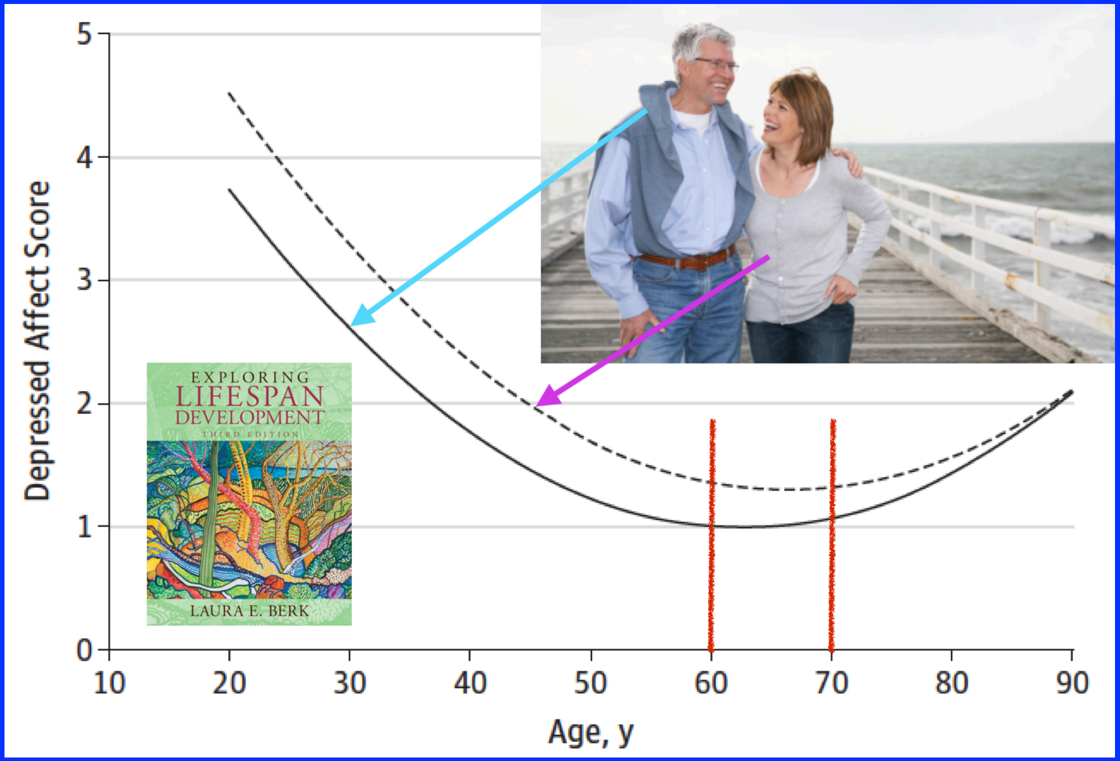
John Nash
(1928-2015)



博弈论的缔造者（纳什均衡问题）

毕生发展心理学

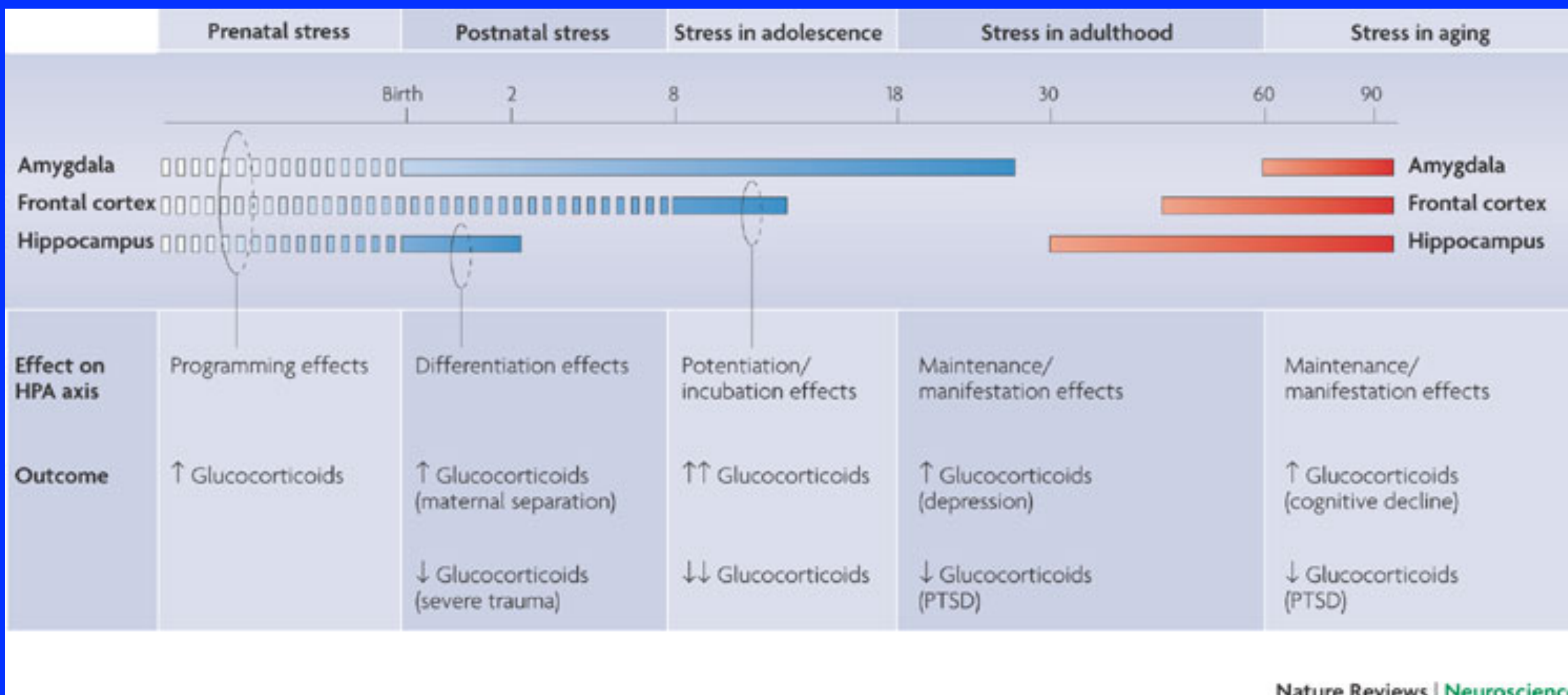
人类心理和行为（心智）的发展是涵盖整个生命周期的连续过程，其一般规律、个体差异和可塑性对于个体基本素质、内在潜力和创新的持续提高与保持乃至精神卫生健康都至关重要。



Sutin et al. 2014, *JAMA Psychiatry*

脑科学与心理学

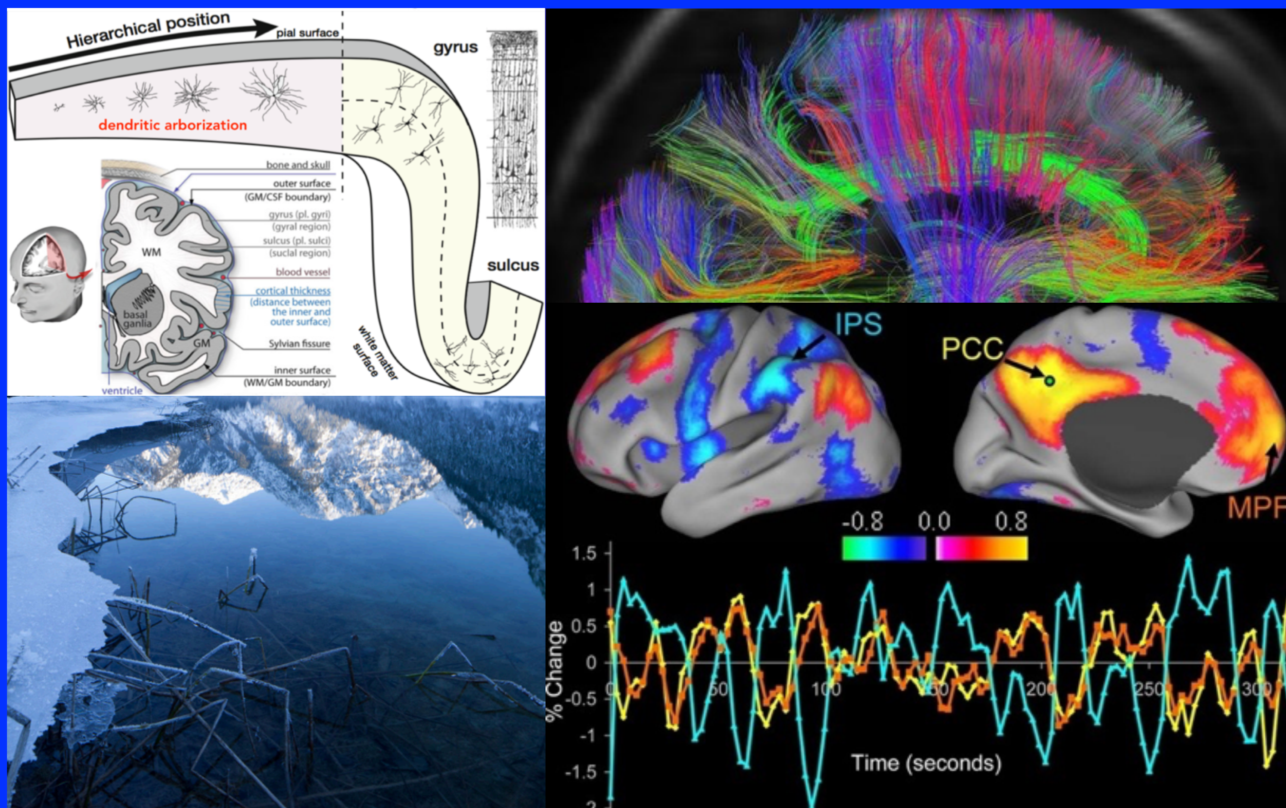
脑科学是现代心理学重要组成部分，为传统心理学研究提供神经科学的实证研究方法，为全面了解毕生发展中先天基因和后天环境之间的相互关系架设了中间桥梁。



Lupien et al. 2009, *Nat Rev Neurosci*

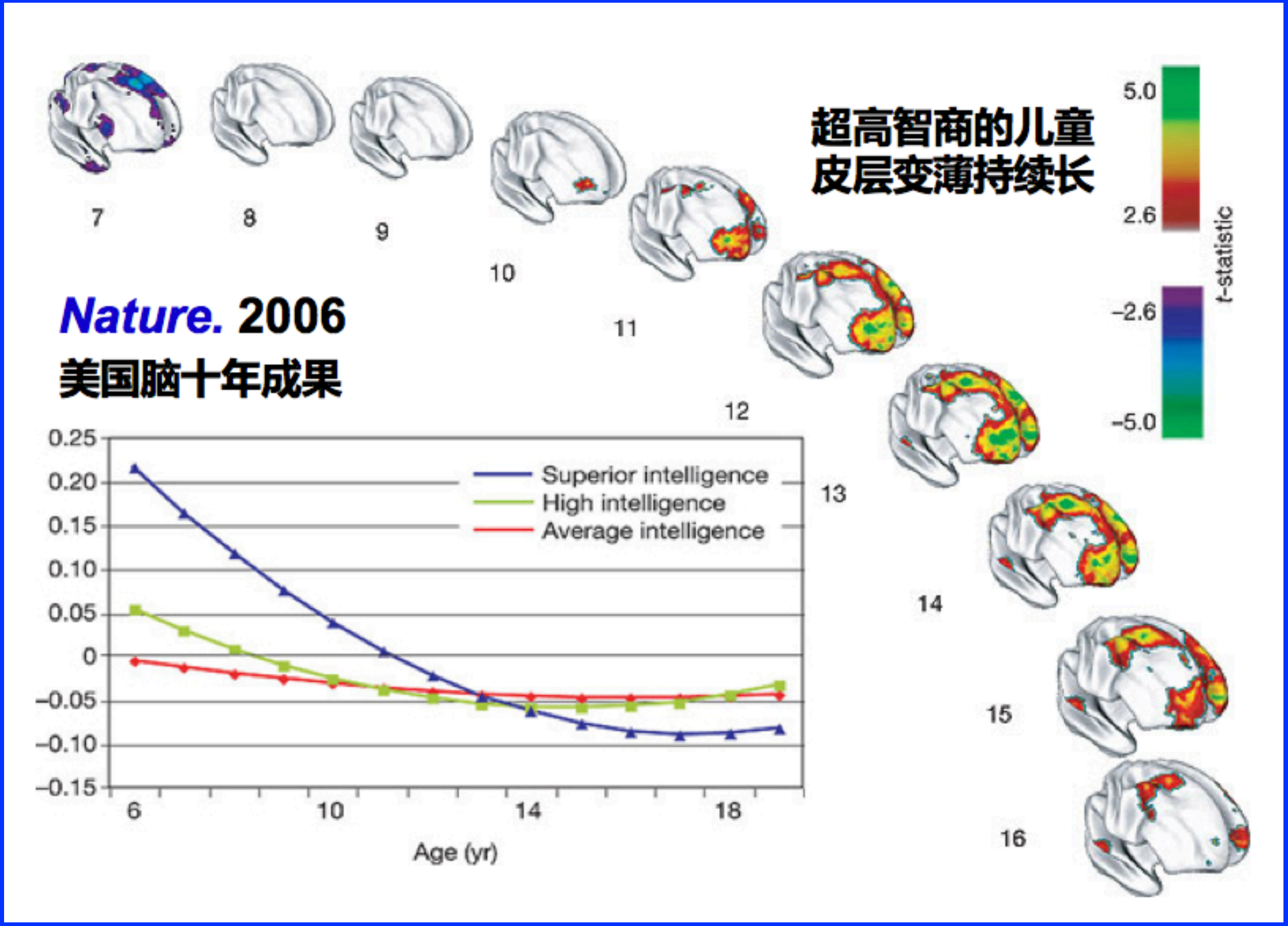
脑科学与影像学

现代脑成像技术可以非常安全的可视化人脑的结构组成和功能组织形式，高清晰脑图谱绘制技术的发展是推动脑科学进步的原始动力之一



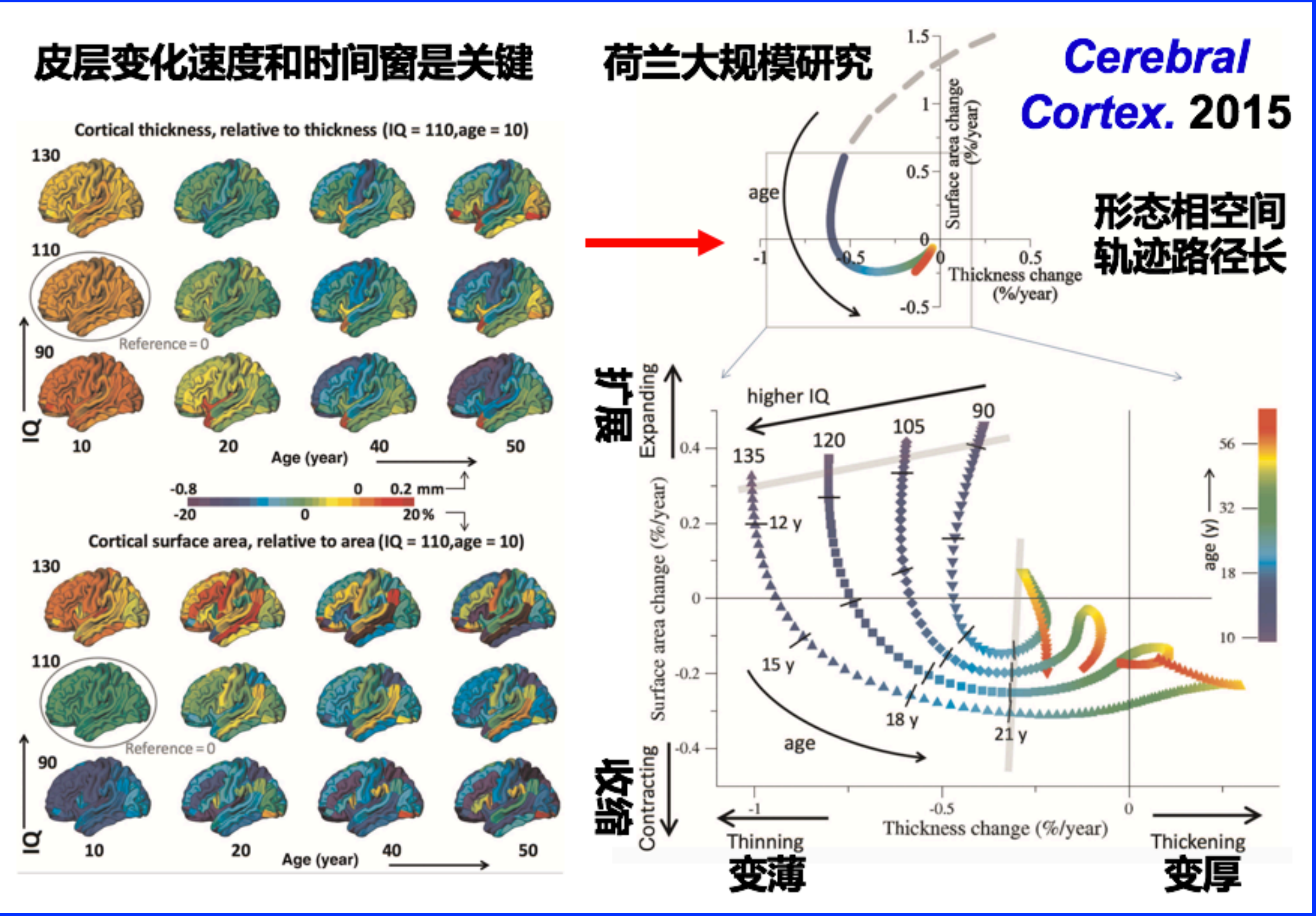
Smith et al. 2015, *Nat Neurosci*; Fox et al. 2005, *PNAS*

人类脑智图谱



Shaw et al. 2006, *Nature*

人类脑智图谱



Schnack et al. 2015, *Cerebral Cortex*

人类脑智图谱

Review

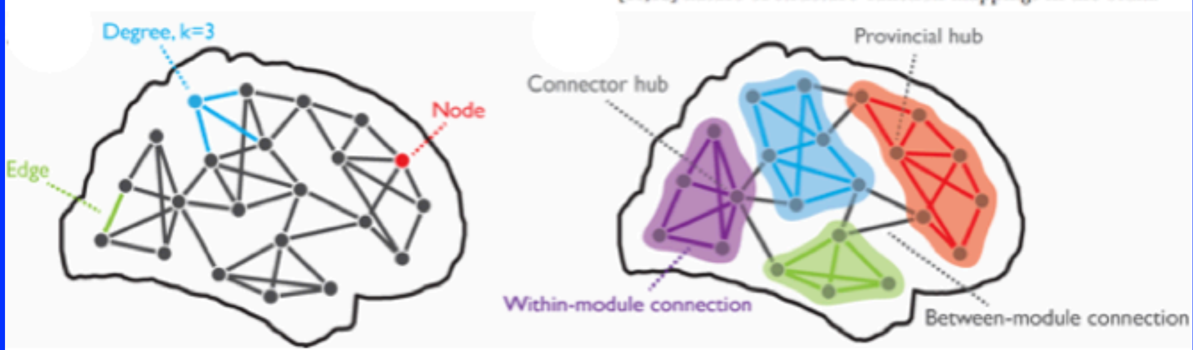
The Human Connectome: A Structural Description of the Human Brain

Olaf Sporns*, Giulio Tononi, Rolf Kötter

ABSTRACT

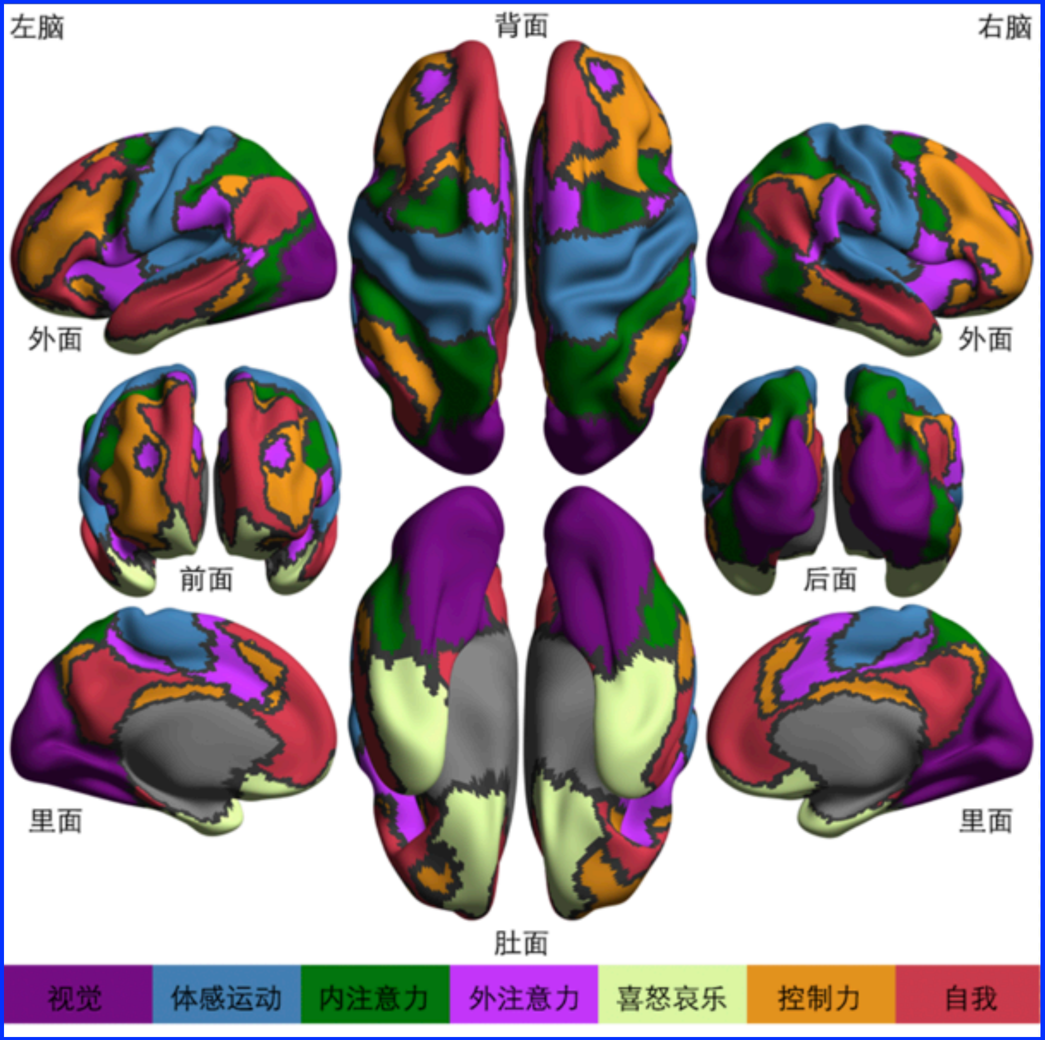
The connection matrix of the human brain (the human "connectome") represents an indispensable foundation for basic and applied neurobiological research. However, the network of anatomical connections linking the neuronal elements of the human brain is still largely unknown. While some databases or collations 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.



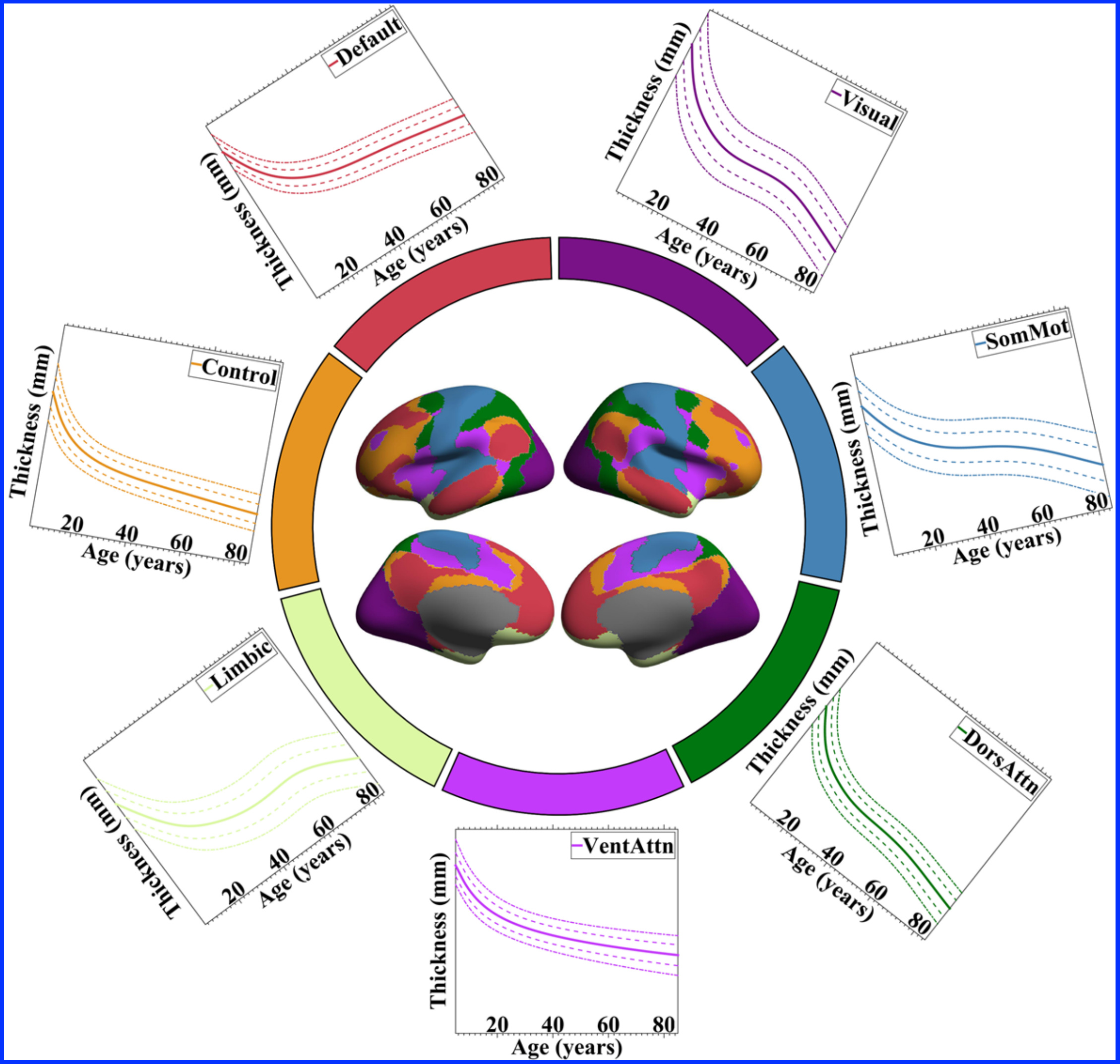
Sporns et al. 2005, *PLoS Comp Biol;*
Sporns & Betzel, 2016, *Annu Rev Psychol*

人类脑智图谱



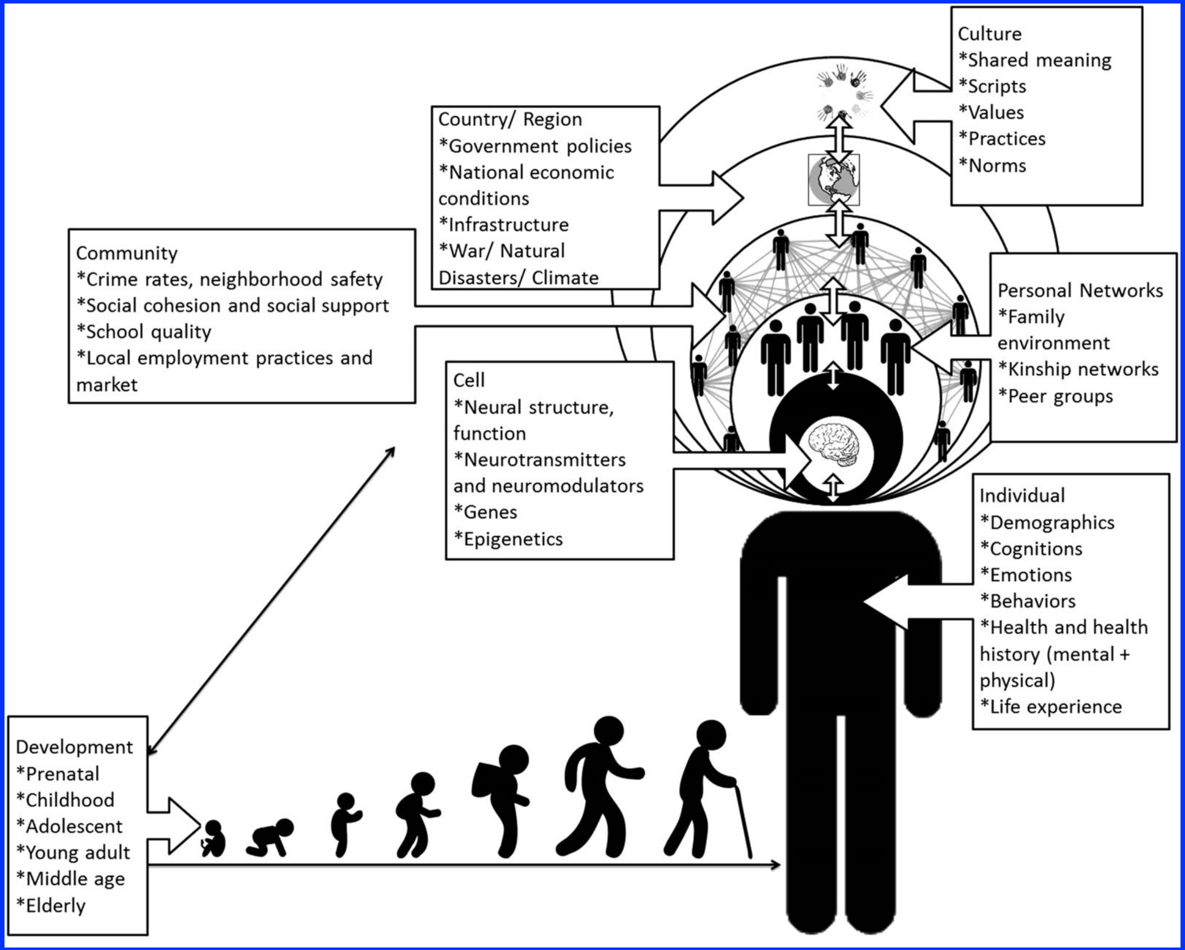
Yeo et al. 2011, *Journal of Neurophysiology*

人类脑智图谱



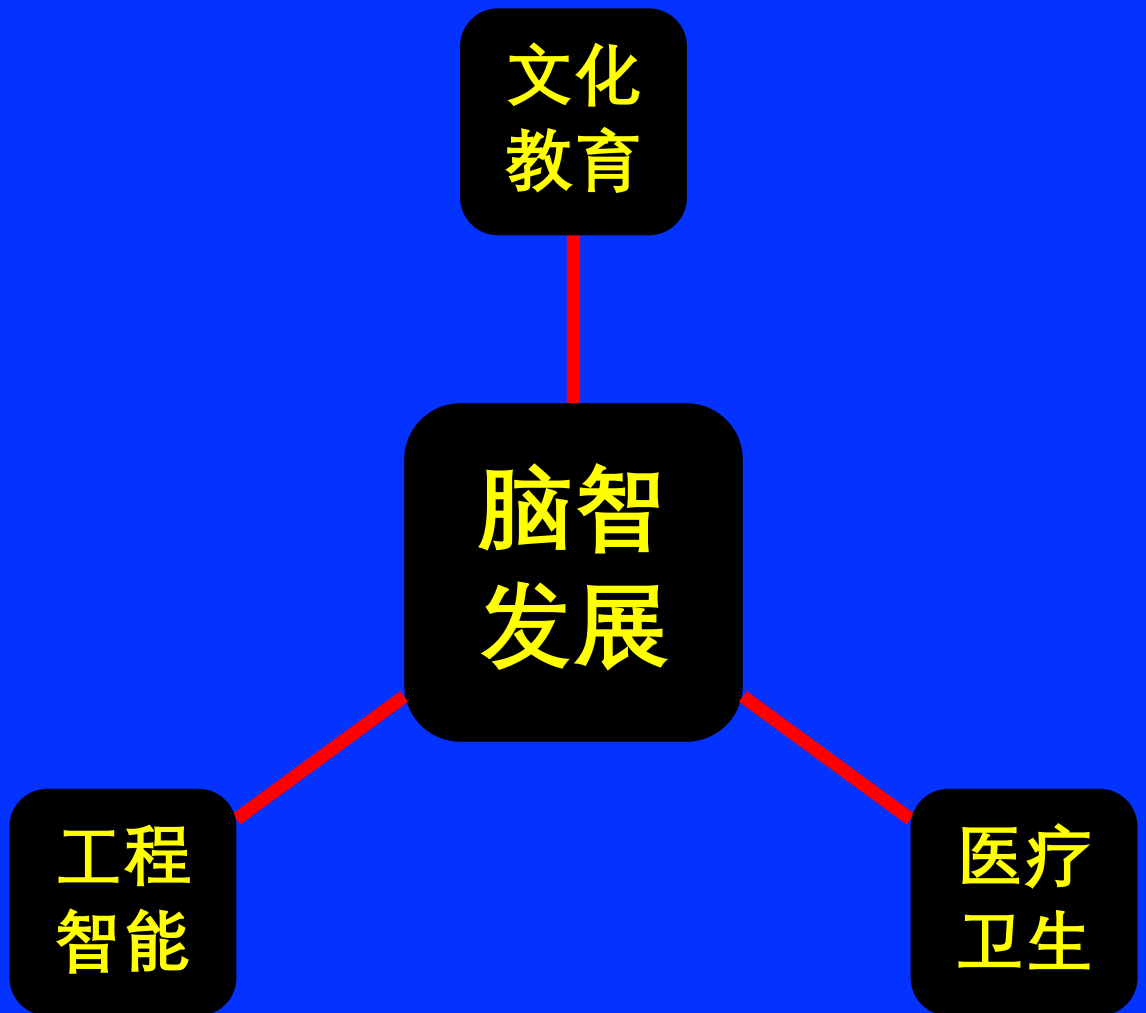
Xu & Yang et al. 2015, *Sci Bull*

发展群体神经科学：科学问题

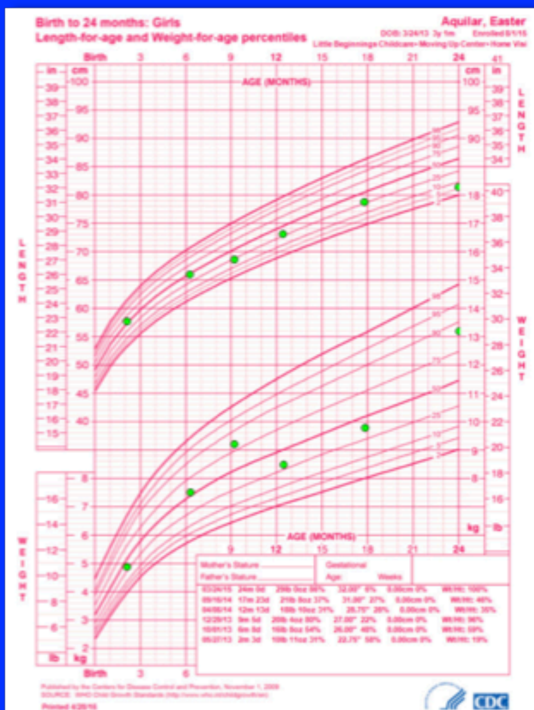


遗传和环境如何调控和塑造人类终身发展？

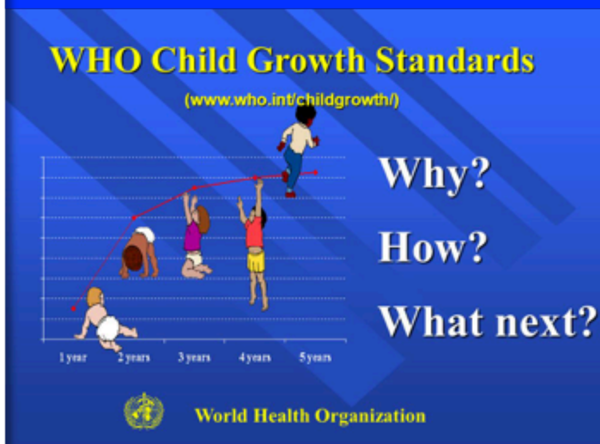
发展群体神经科学：国家需求



如何服务医疗卫生？-生长发育曲线常模

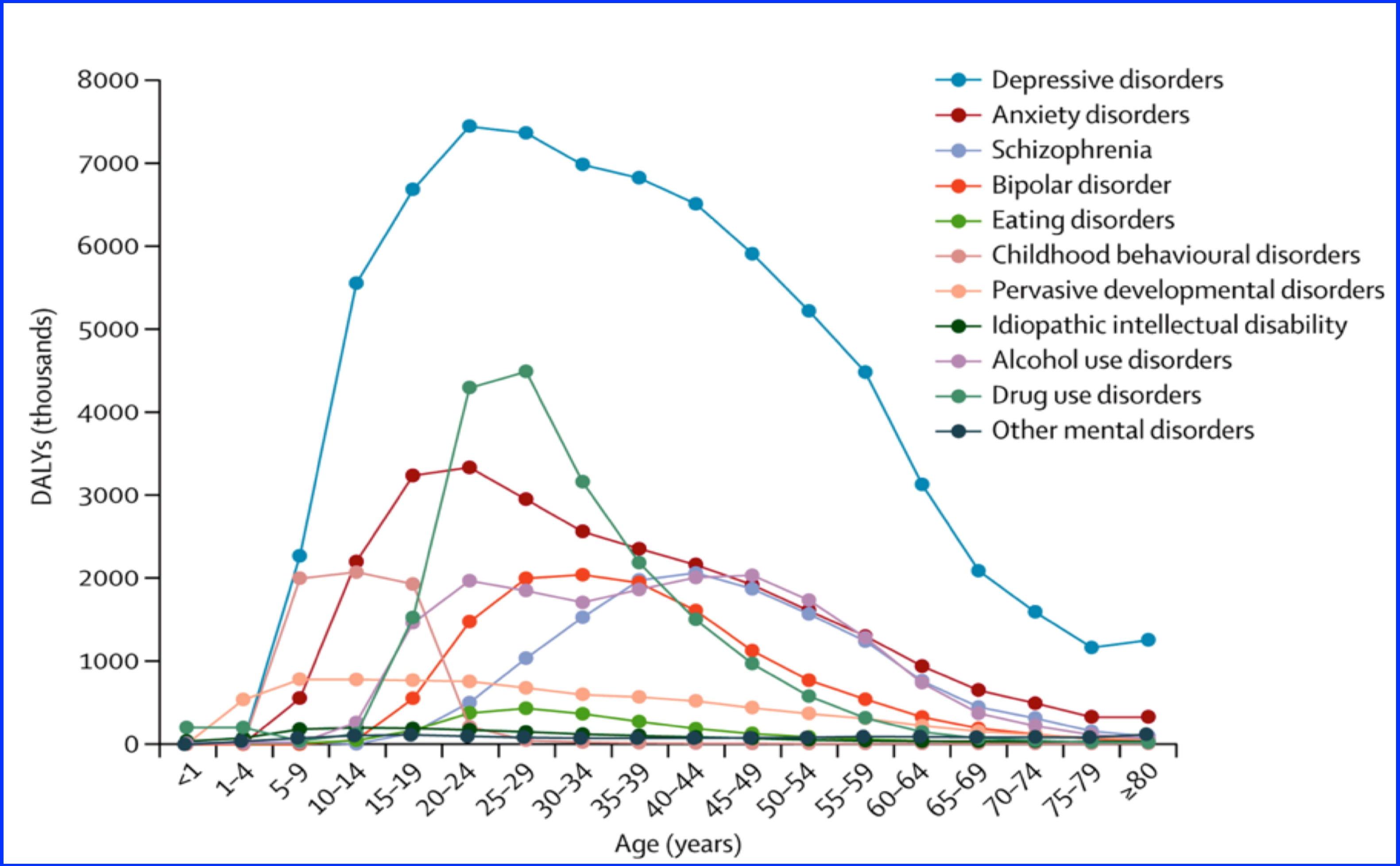


重要发育监测工具



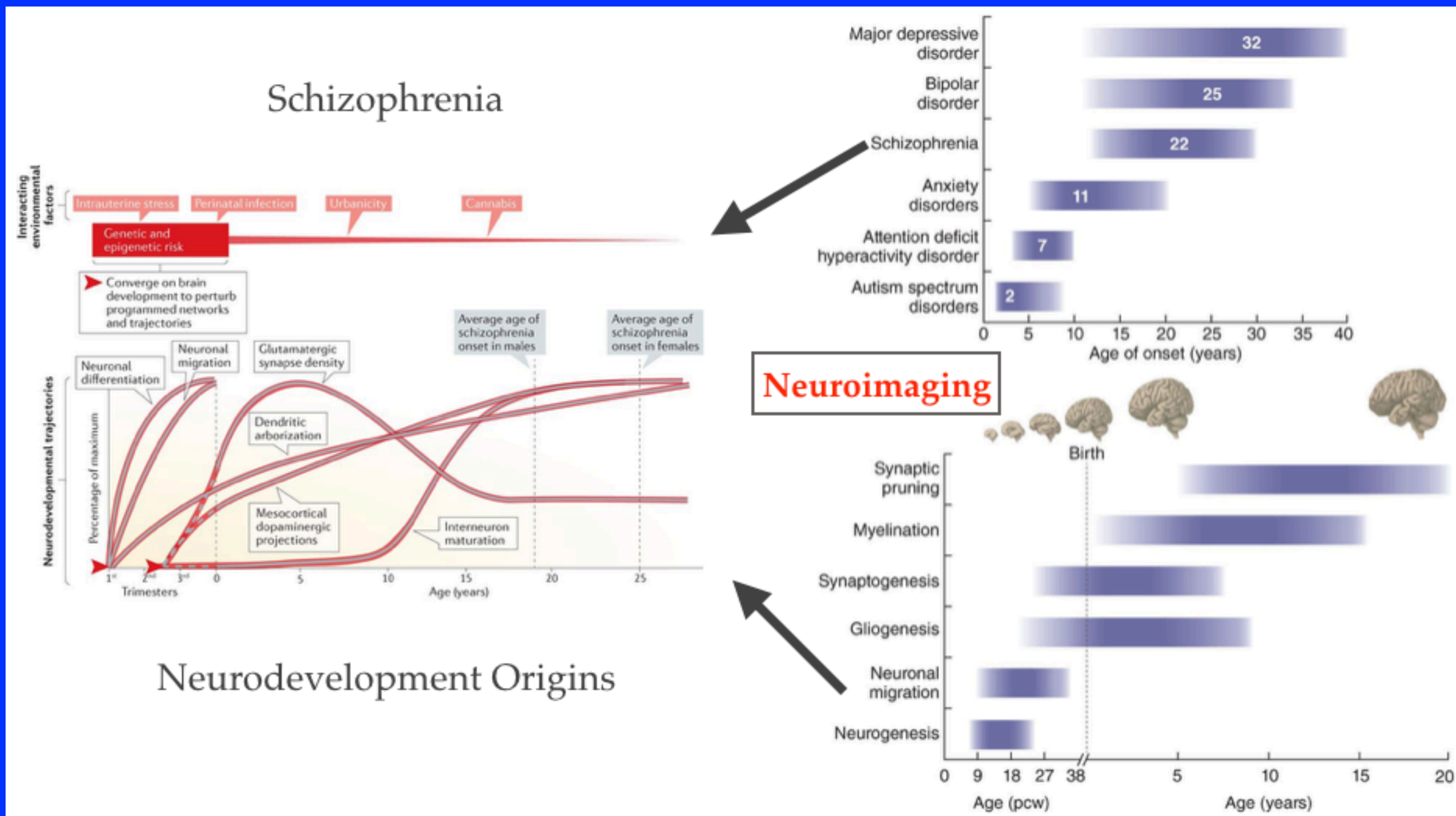
发育障碍早期预警

精神卫生健康-一个终生发展话题



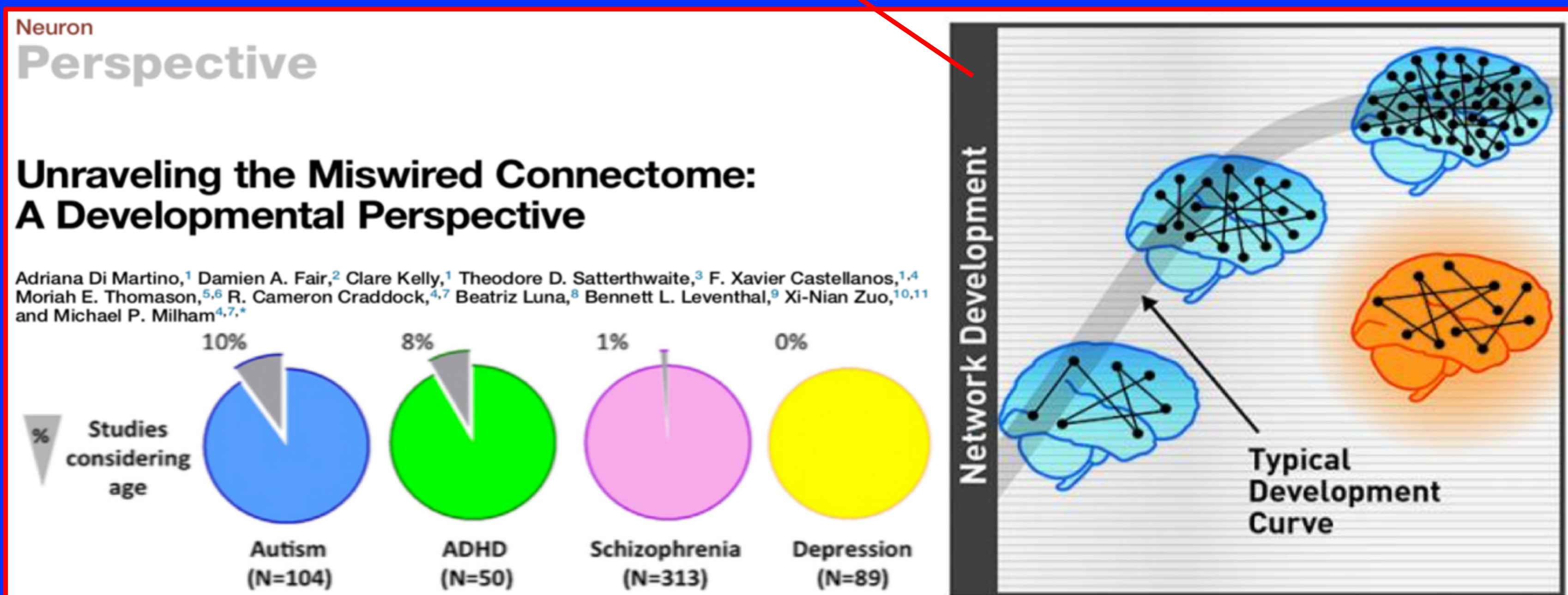
Whiteford et al. 2010, *Lancet;* Kapur et al. 2013, *Mol Psychiatry*

精神卫生健康与神经发育



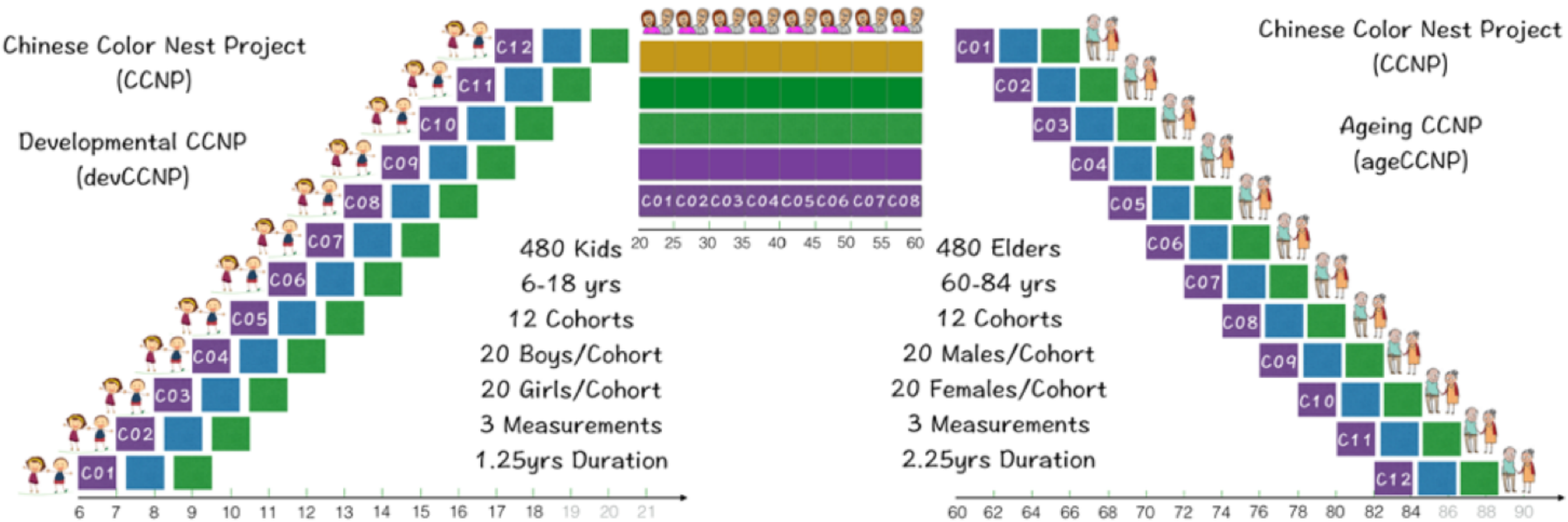
Birnbaum & Weinberger 2017, *Nat Rev Neurosci;* Marin 2016, *Nat Med*

精神卫生健康与神经发育



Di Martino et al., 2014, *Neuron*

中国彩巢计划



Chinese Color Nest Project (CCNP: 2013-2022)

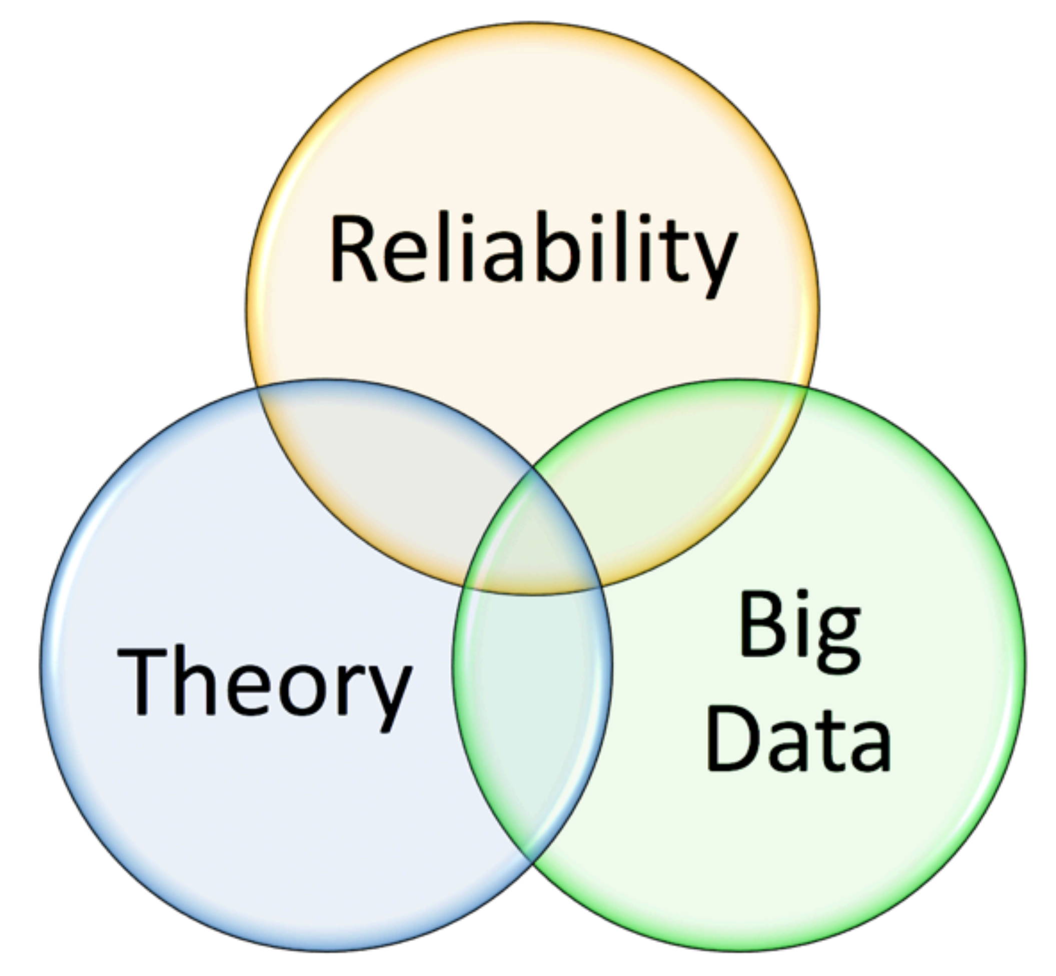
A Lifespan Sample of 1200 People (6-85 yrs)

Total 6000 visits with A Mixed Multicohort Design

http://zuolab.psych.ac.cn/colornest.html

Zuo et al., 2017, *Trends Cogn Sci*

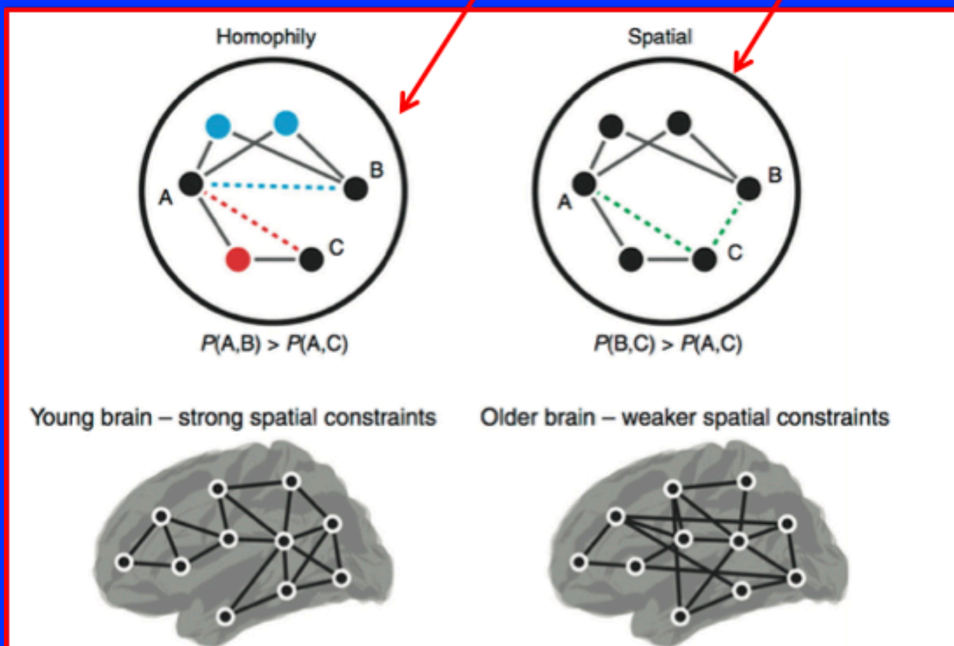
中国彩巢计划-三大基础



Zuo et al., 2017, *Trends Cogn Sci*

理论-人脑连接组毕生发展

$$P(u,v) = K(u,v)^{\gamma} \times E(u,v)^{\eta}$$




Trends in Cognitive Sciences

CellPress

Review

Human Connectomics across the Life Span

Xi-Nian Zuo,[1,2,3,4,5,@,*] Ye He,[1,2,3,6] Richard F. Betzel,[7] Stan Colcombe,[8] Olaf Sporns,[6] and Michael P. Milham[8,9,*]

Connectomics has enhanced our understanding of neurocognitive development and decline by the integration of network sciences into studies across different stages of the human life span. However, these studies commonly occurred independently, missing the opportunity to test integrated models of the dynamical brain organization across the entire life span. In this review article, we survey empirical findings in life-span connectomics and propose a generative framework for computationally modeling the connectome over the human life span. This framework highlights initial findings that across the life span, the human connectome gradually shifts from an 'anatomically driven' organization to one that is more 'topological'. Finally, we consider recent advances that are promising to provide an integrative and systems perspective of human brain plasticity as well as underscore the pitfalls and challenges.

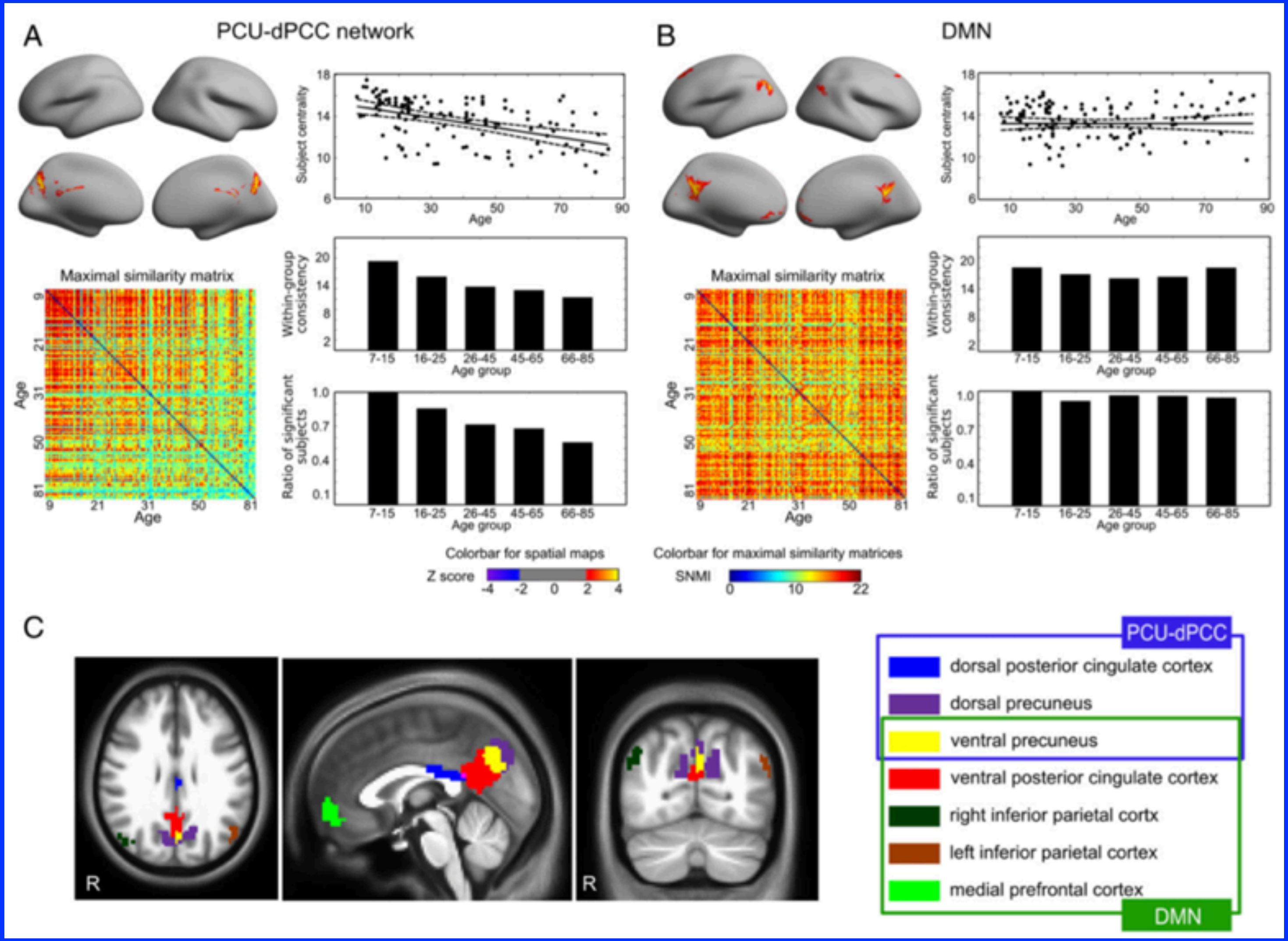
A Connectome's Life Span

Trends

Why Life-Span Connectomics?

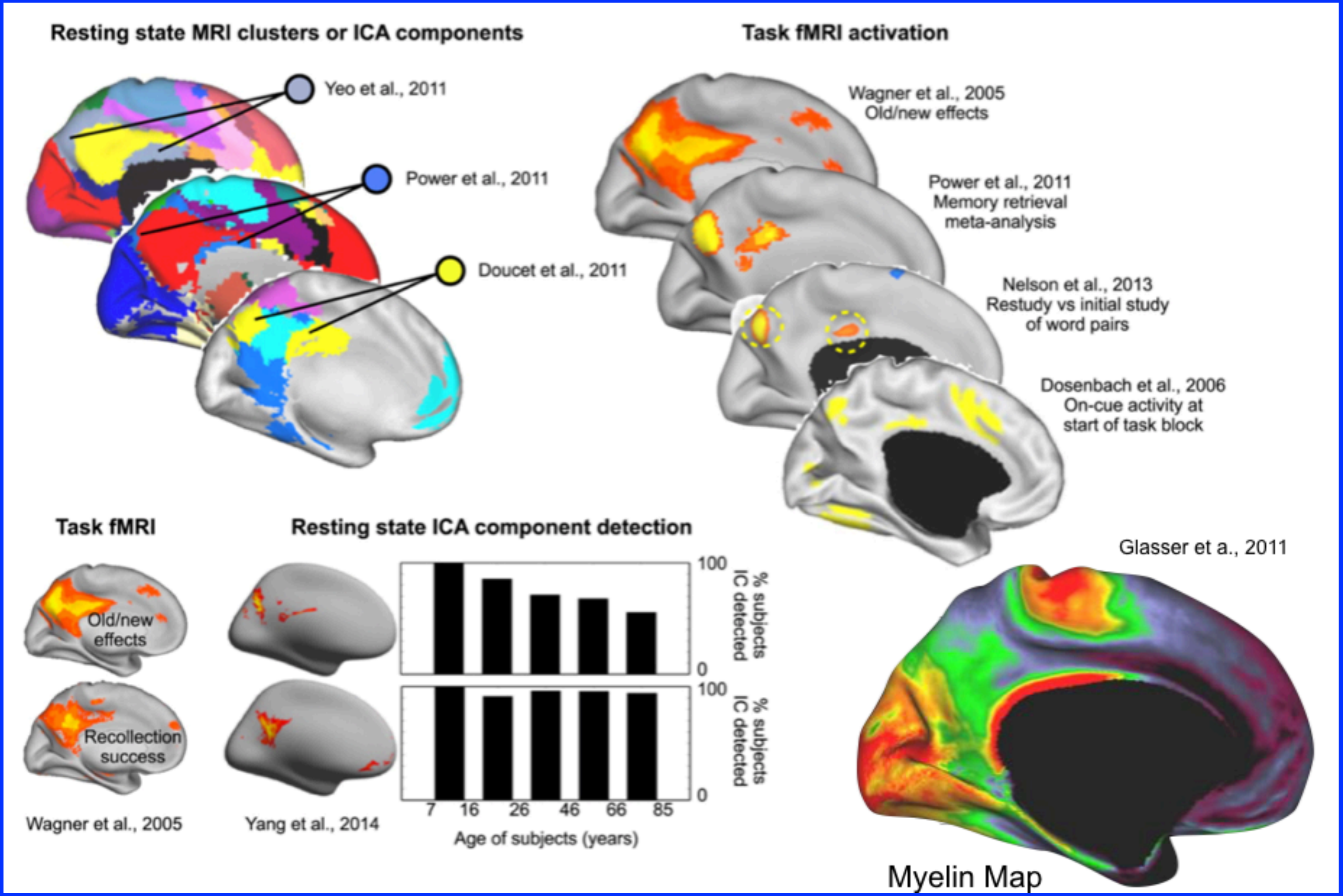
Zuo et al., 2017, *Trends Cogn Sci*

发现-人脑顶叶记忆网络



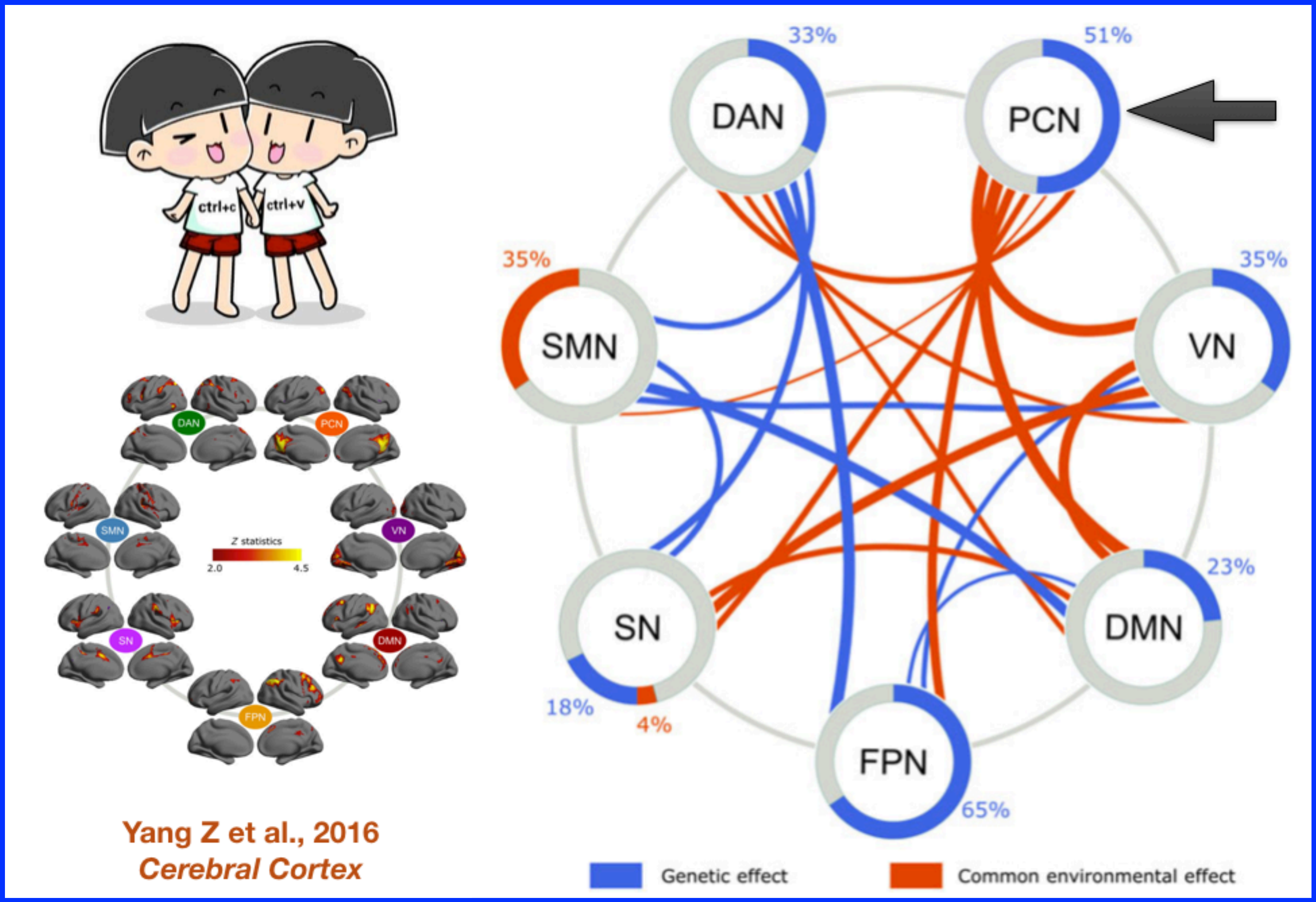
Yang et al., 2014, *NeuroImage*

发现-人脑顶叶记忆网络



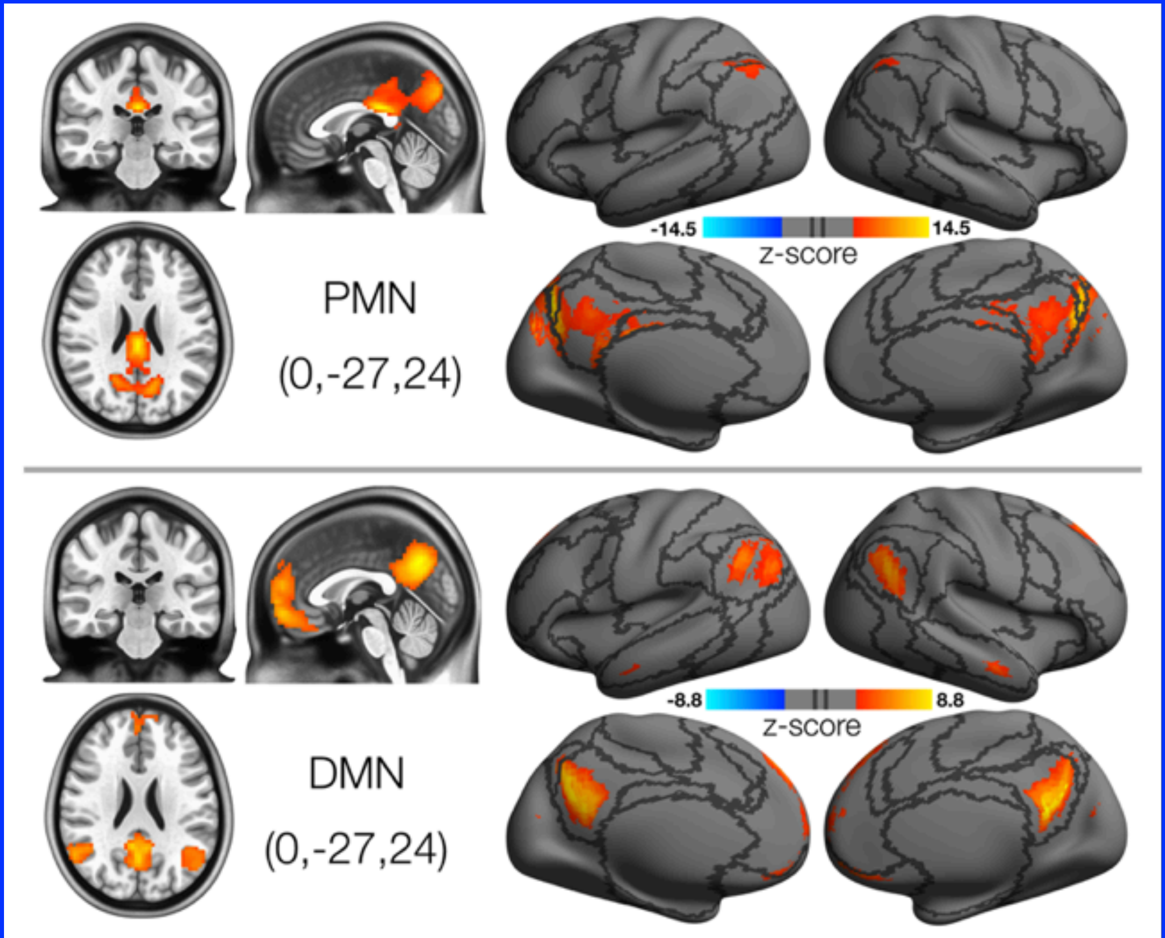
Power et al., 2014, *Neuron*

发现-人脑顶叶记忆网络



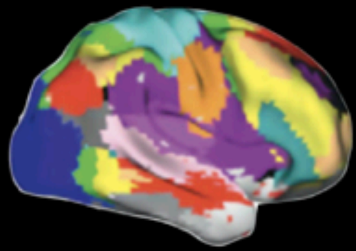
Yang et al., 2016, *Cerebral Cortex*

发现-人脑顶叶记忆网络

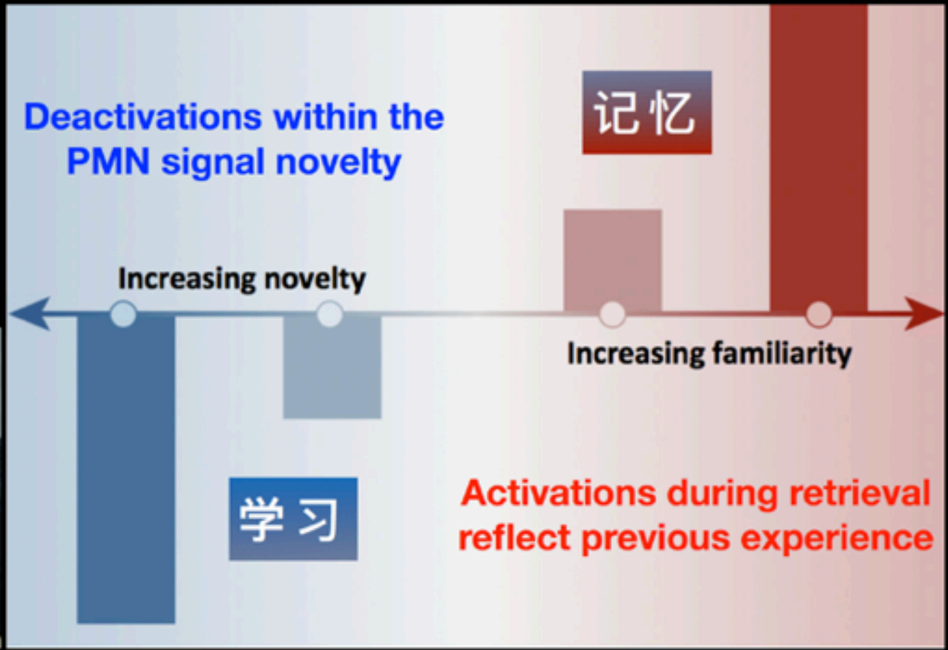


Hu et al., 2016, *Sci Bull*

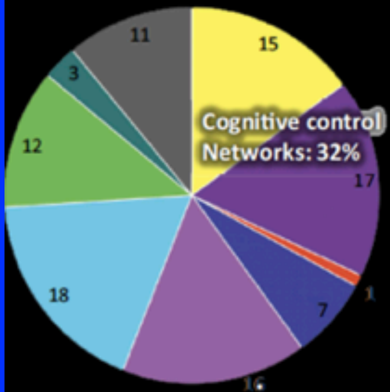
发现-人脑顶叶记忆网络



流体智力

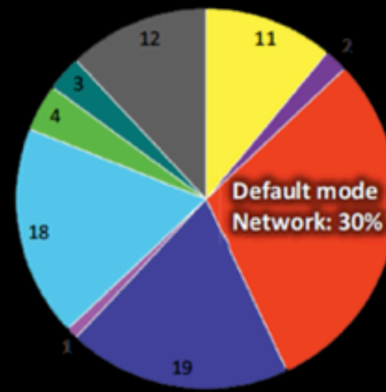


晶体智力

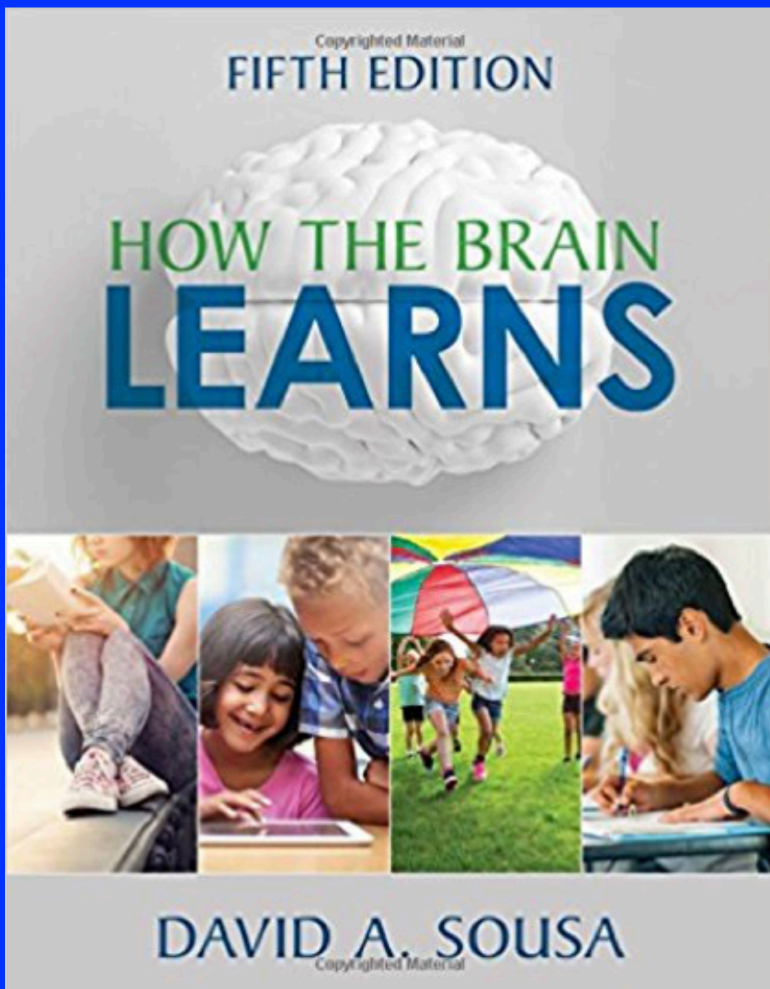


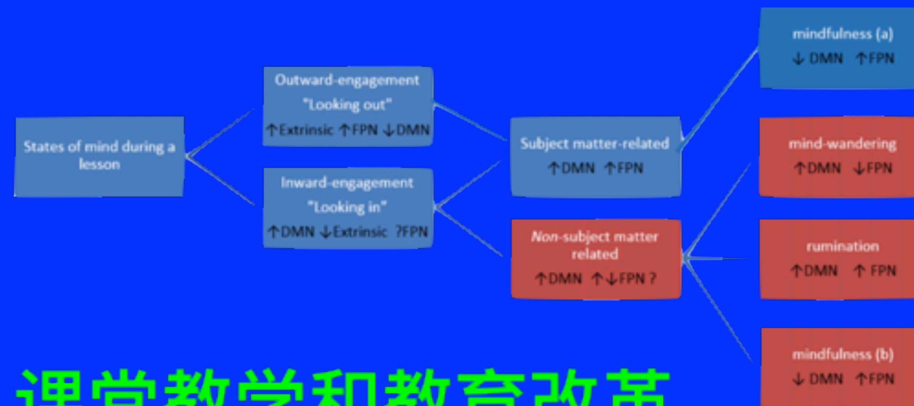
顶叶记忆网络是额顶认知控制网络的顶叶模块，与流体智力密切相关，默认网络则处理自我认知的相关过程，与晶体智力密切相关，这为认知的毕生发展规律找到了人脑网络神经科学基础。

Barbey, 2018, *Trends in Cognitive Sciences*
Gu et al., 2015, *Nature Communications*
Yin et al., 2016, *The Journal of Neurosciences*



发现-人脑顶叶记忆网络





课堂教学和教育改革

Original

The neurological development of the child with the educational enrichment in mind

Gerry Leisman[a,b,c,*], Raed Mualem[a,d], Safa Khayat Mughrabi[a]

[a] The National Institute for Brain and Rehabilitation Sciences, Nazareth, Israel
[b] Biomechanics Laboratory, O.R.T. – Braude College of Engineering, Karmiel, Israel
[c] Facultad Manuel Fajardo, Universidad de Ciencias Médicas de la Habana, Cuba
[d] Oranim Academic College, Qiriat, Tivon, Israel

Original

The emerging role of educational neuroscience in education reform

Janet N. Zadina*

Tulane University School of Medicine, New Orleans, U.S.A.

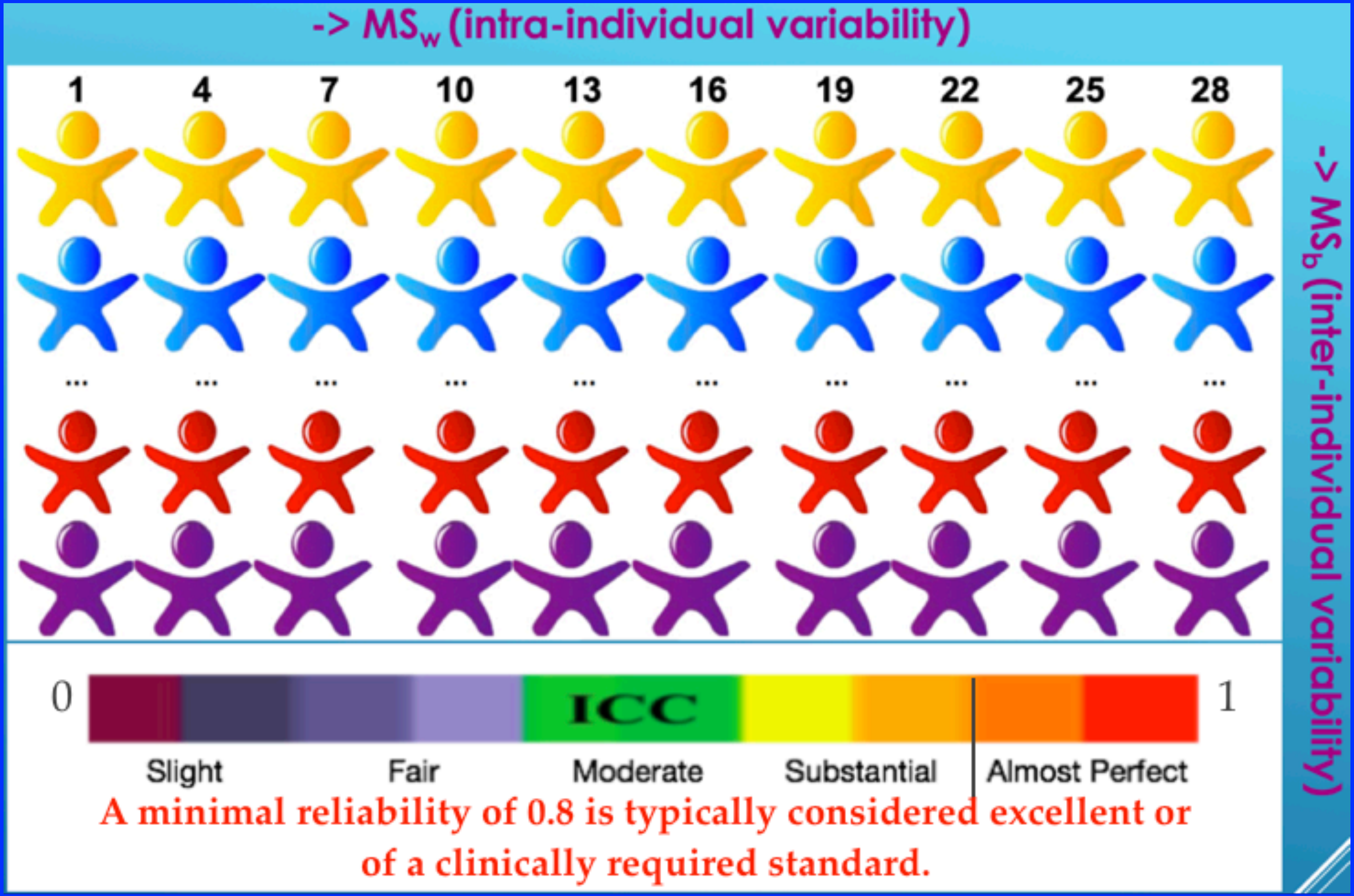
Original

Neuroscience and education: We already reached the tipping point

Manuel Martín-Loeches*

Centro de Evolución y Comportamiento Humanos, UCM-ISCIII, Madrid, Spain. Departamento de Psicobiología, Universidad Complutense, Madrid, Spain

信度-人脑连接组毕生发展



Zuo & Xing, 2014, *Neurosci Biobehav Rev*

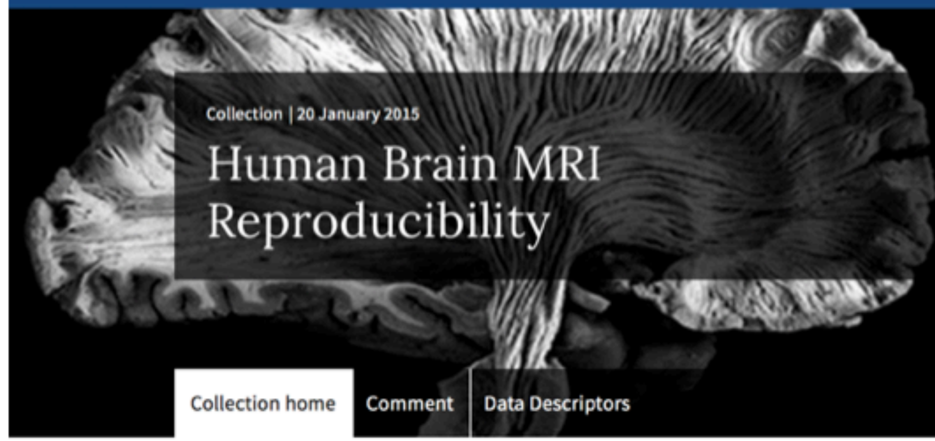
信度-人脑连接组毕生发展

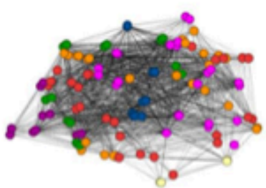
An open science resource for establishing reliability and reproducibility in functional connectomics

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

MENU

SCIENTIFIC DATA





Research Topic

Reliability and Reproducibility in Functional Connectomics

Comment 1

f 2 | 4 | g+ 2 | in 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.

Zuo et al, 2014, *Sci Data*

信度-人脑连接组毕生发展

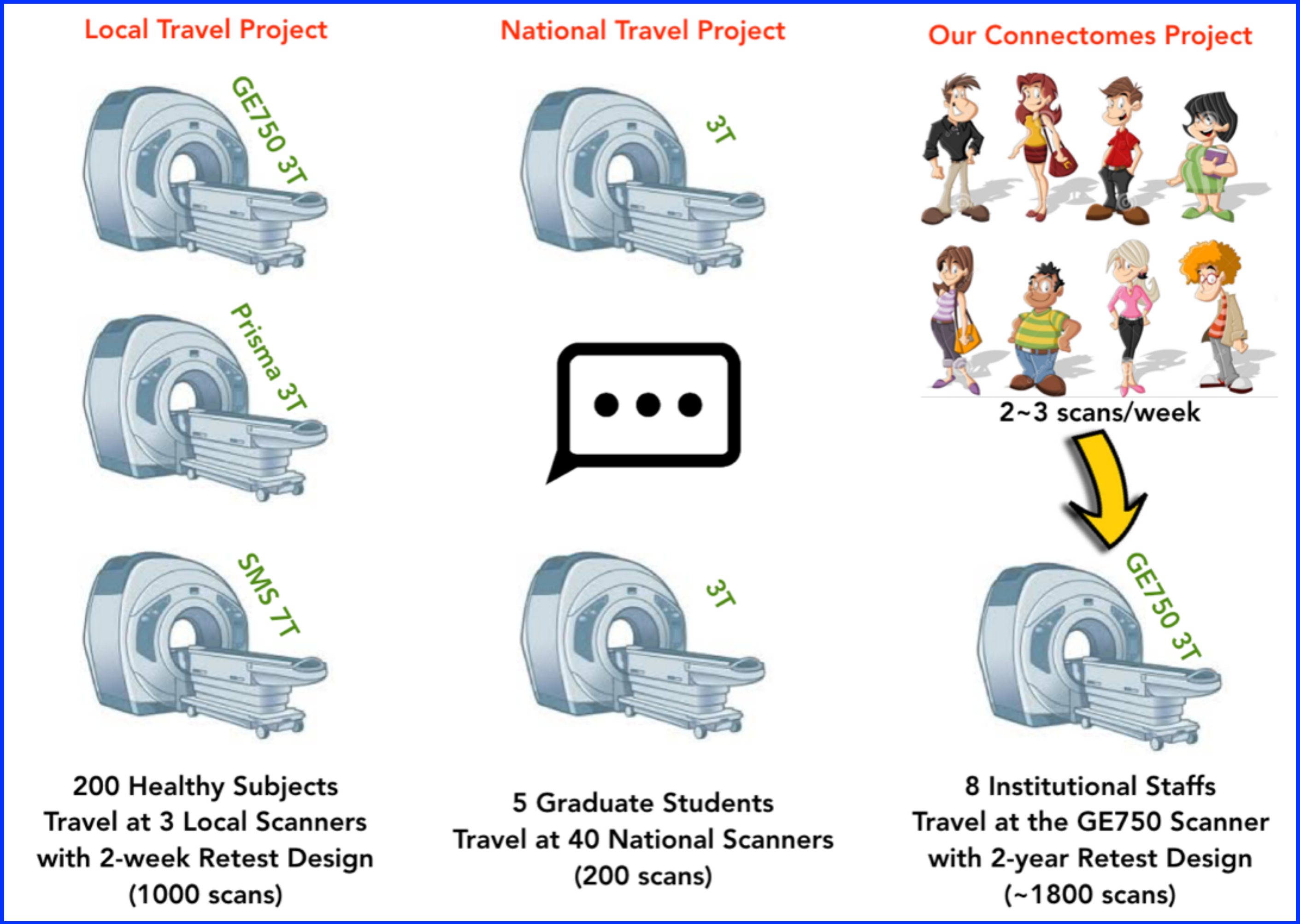
“心理学脑成像专业委员会”专题报告一

时间：11 月 3 日　　15:40-17:40　　地点：203-C 会议厅

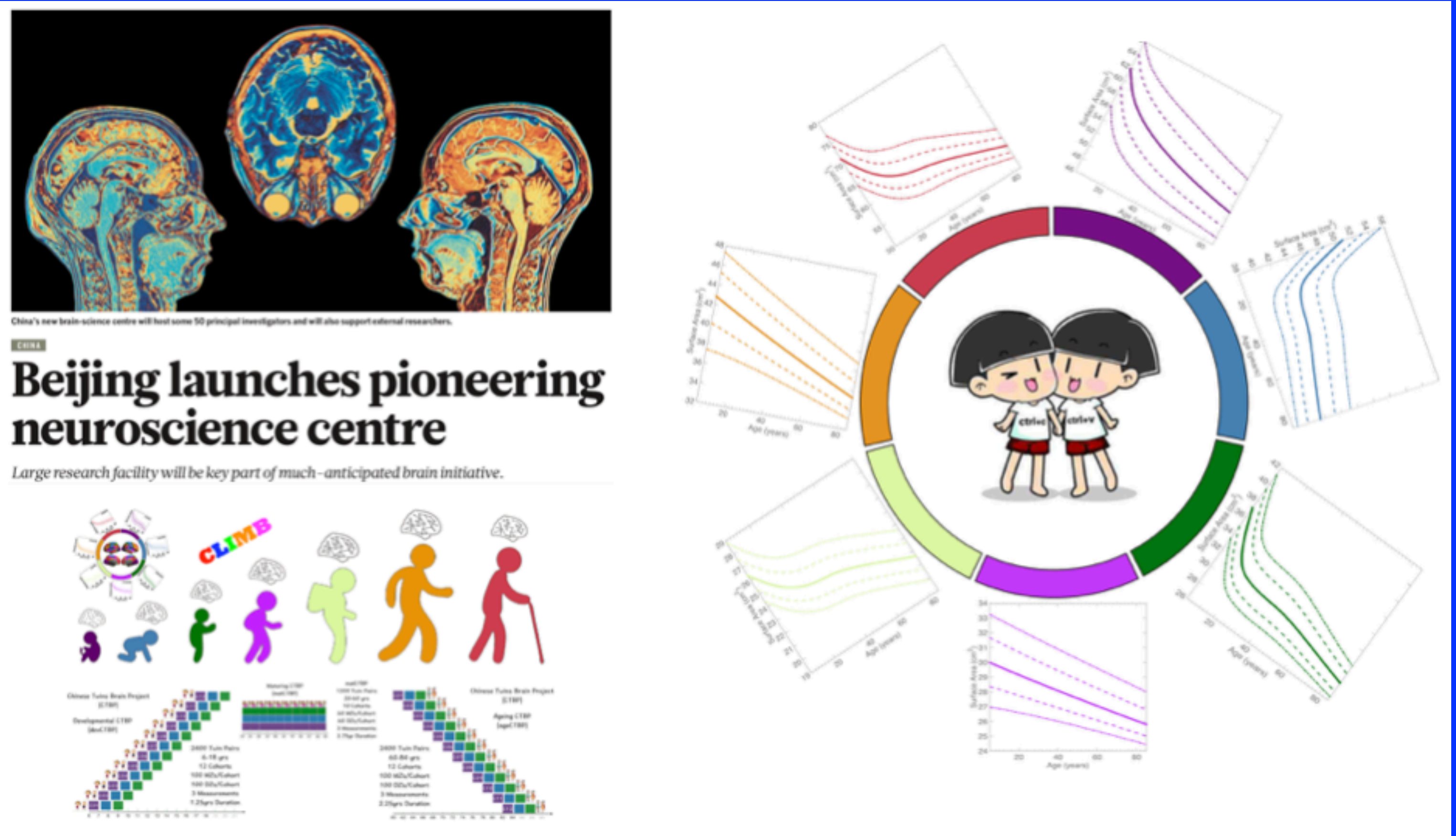
志愿者：阚煜 18645999222　　黄睿思 18706013627

大数据与脑智科学 组织者：左西年　主持人：左西年		
编号	作者	报告题目
1	臧玉峰	持续注意与 ADHD 功能磁共振研究
2	周丽丽　张会娟　胡理	基于多模态大数据的疼痛评估—问题与展望
3	薛贵	脑智大数据与认知促进
4	翁旭初	儿童阅读能力发展的大数据联合研究
5	左西年	开放式脑智科学与数据共享
6	于春水	中国人影像遗传学计划

大数据-人脑连接组毕生发展



大数据-人脑连接组毕生发展



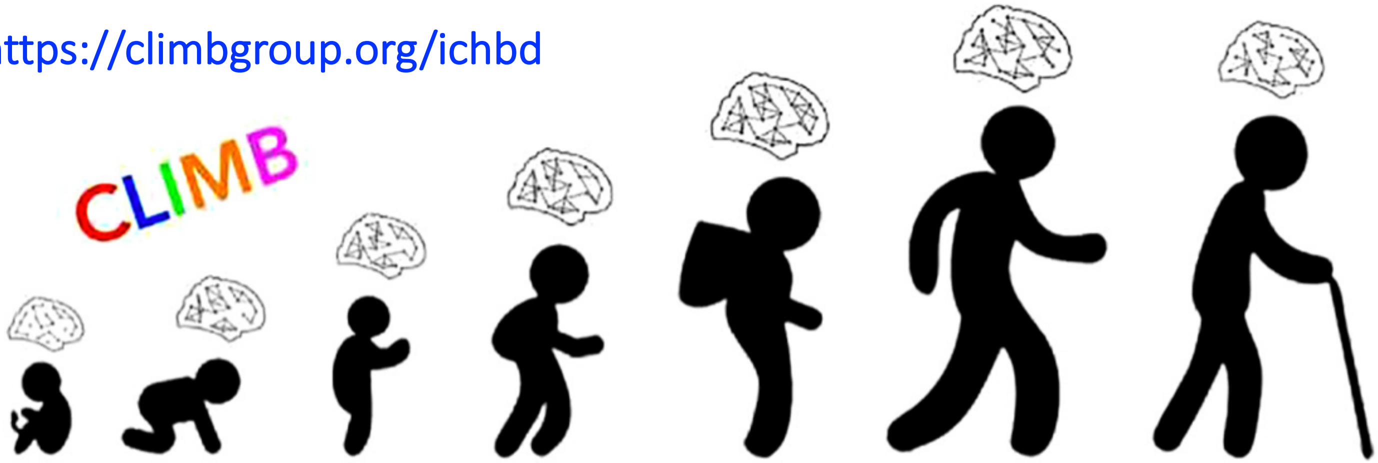
Similar Design as CCNP but for 6000 Pairs of Twins across 12 National Sites

遗传和环境如何调控和塑造人类终身发展？

大数据-人脑连接组毕生发展

Research Center for Lifespan Development of Mind and Brain

https://climbgroup.org/ichbd



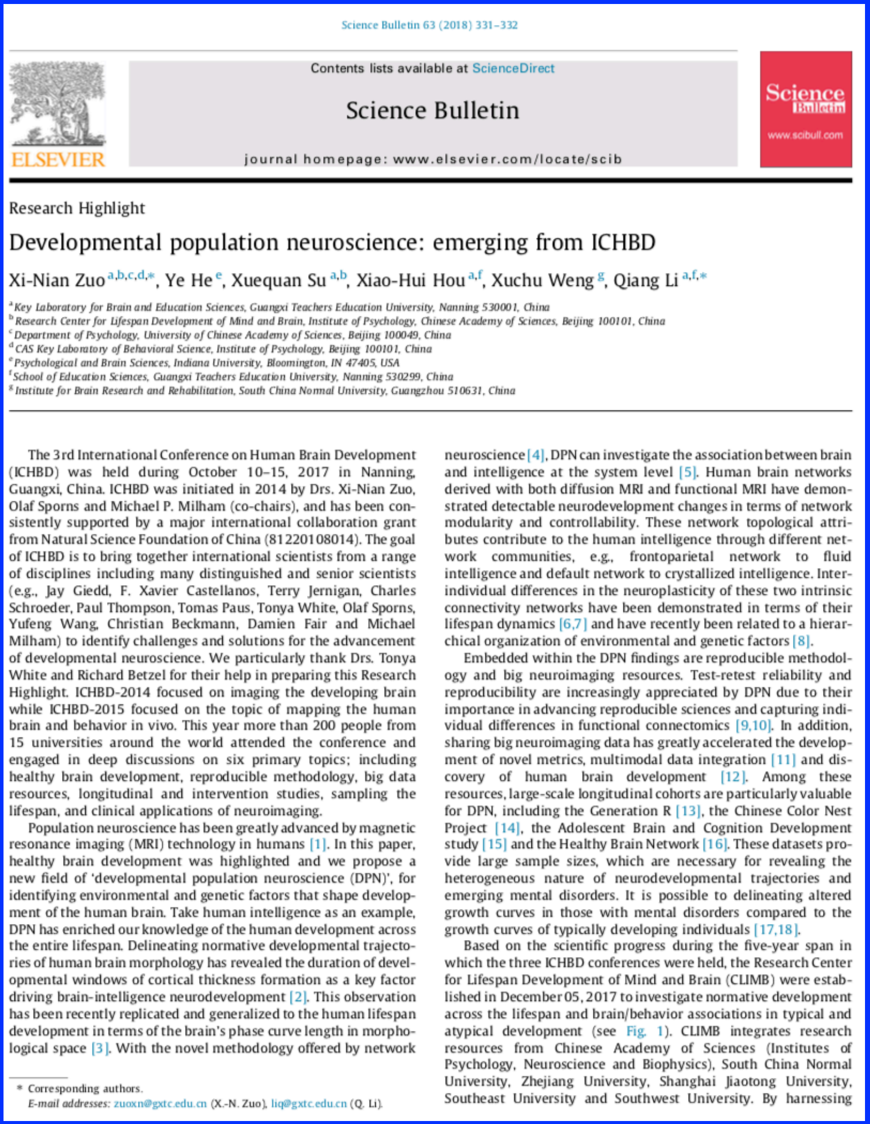
ICHBD2014-Imaging the Developing Brain

ICHBD2015-Mapping the Human Brain and Behavior in Vivo

ICHBD2017-Emerging Developmental Population Neuroscience

Zuo et al., 2018, *Sci Bull*

参考资料



Science Bulletin 63 (2018) 331–332

Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/scib

Research Highlight

Developmental population neuroscience: emerging from ICHBD

Xi-Nian Zuo [a,b,c,d,*], Ye He [e], Xuequan Su [a,b], Xiao-Hui Hou [a,f], Xuchu Weng [g], Qiang Li [a,f,*]

[a] Key Laboratory for Brain and Education Sciences, Guangxi Teachers Education University, Nanning 530001, China
[b] Research Center for Lifespan Development of Mind and Brain, Institute of Psychology, Chinese Academy of Sciences, Beijing 100101, China
[c] Department of Psychology, University of Chinese Academy of Sciences, Beijing 100049, China
[d] CAS Key Laboratory of Behavioral Science, Institute of Psychology, Beijing 100101, China
[e] Psychological and Brain Sciences, Indiana University, Bloomington, IN 47405, USA
[f] School of Education Sciences, Guangxi Teachers Education University, Nanning 530299, China
[g] Institute for Brain Research and Rehabilitation, South China Normal University, Guangzhou 510631, China

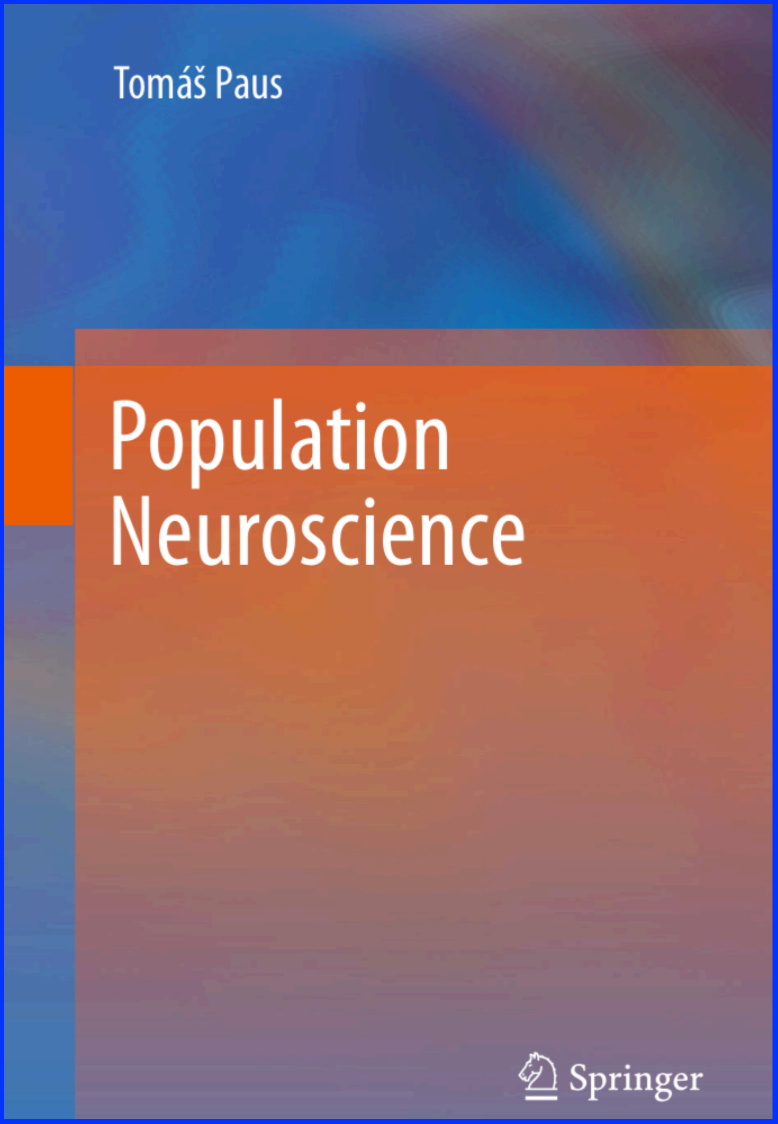
The 3rd International Conference on Human Brain Development (ICHBD) was held during October 10–15, 2017 in Nanning, Guangxi, China. ICHBD was initiated in 2014 by Drs. Xi-Nian Zuo, Olaf Sporns and Michael P. Milham (co-chairs), and has been consistently supported by a major international collaboration grant from Natural Science Foundation of China (81220108014). The goal of ICHBD is to bring together international scientists from a range of disciplines including many distinguished and senior scientists (e.g., Jay Giedd, F. Xavier Castellanos, Terry Jernigan, Charles Schroeder, Paul Thompson, Tomas Paus, Tonya White, Olaf Sporns, Yufeng Wang, Christian Beckmann, Damien Fair and Michael Milham) to identify challenges and solutions for the advancement of developmental neuroscience. We particularly thank Drs. Tonya White and Richard Betzel for their help in preparing this Research Highlight. ICHBD-2014 focused on imaging the developing brain while ICHBD-2015 focused on the topic of mapping the human brain and behavior in vivo. This year more than 200 people from 15 universities around the world attended the conference and engaged in deep discussions on six primary topics; including healthy brain development, reproducible methodology, big data resources, longitudinal and intervention studies, sampling the lifespan, and clinical applications of neuroimaging.

Population neuroscience has been greatly advanced by magnetic resonance imaging (MRI) technology in humans [1]. In this paper, healthy brain development was highlighted and we propose a new field of 'developmental population neuroscience (DPN)', for identifying environmental and genetic factors that shape development of the human brain. Take human intelligence as an example, DPN has enriched our knowledge of the human development across the entire lifespan. Delineating normative developmental trajectories of human brain morphology has revealed the duration of developmental windows of cortical thickness formation as a key factor driving brain-intelligence neurodevelopment [2]. This observation has been recently replicated and generalized to the human lifespan development in terms of the brain's phase curve length in morphological space [3]. With the novel methodology offered by network neuroscience [4], DPN can investigate the association between brain and intelligence at the system level [5]. Human brain networks derived with both diffusion MRI and functional MRI have demonstrated detectable neurodevelopment changes in terms of network modularity and controllability. These network topological attributes contribute to the human intelligence through different network communities, e.g., frontoparietal network to fluid intelligence and default network to crystallized intelligence. Inter-individual differences in the neuroplasticity of these two intrinsic connectivity networks have been demonstrated in terms of their lifespan dynamics [6,7] and have recently been related to a hierarchical organization of environmental and genetic factors [8].

Embedded within the DPN findings are reproducible methodology and big neuroimaging resources. Test-retest reliability and reproducibility are increasingly appreciated by DPN due to their importance in advancing reproducible sciences and capturing individual differences in functional connectomics [9,10]. In addition, sharing big neuroimaging data has greatly accelerated the development of novel metrics, multimodal data integration [11] and discovery of human brain development [12]. Among these resources, large-scale longitudinal cohorts are particularly valuable for DPN, including the Generation R [13], the Chinese Color Nest Project [14], the Adolescent Brain and Cognition Development study [15] and the Healthy Brain Network [16]. These datasets provide large sample sizes, which are necessary for revealing the heterogeneous nature of neurodevelopmental trajectories and emerging mental disorders. It is possible to delineating altered growth curves in those with mental disorders compared to the growth curves of typically developing individuals [17,18].

Based on the scientific progress during the five-year span in which the three ICHBD conferences were held, the Research Center for Lifespan Development of Mind and Brain (CLIMB) were established in December 05, 2017 to investigate normative development across the lifespan and brain/behavior associations in typical and atypical development (see Fig. 1). CLIMB integrates research resources from Chinese Academy of Sciences (Institutes of Psychology, Neuroscience and Biophysics), South China Normal University, Zhejiang University, Shanghai Jiaotong University, Southeast University and Southwest University. By harnessing

* Corresponding authors.
E-mail addresses: zuoxn@gxtc.edu.cn (X.-N. Zuo), liq@gxtc.edu.cn (Q. Li).



致谢

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