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Research Highlight

Developmental population neuroscience: emerging from ICHBD

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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

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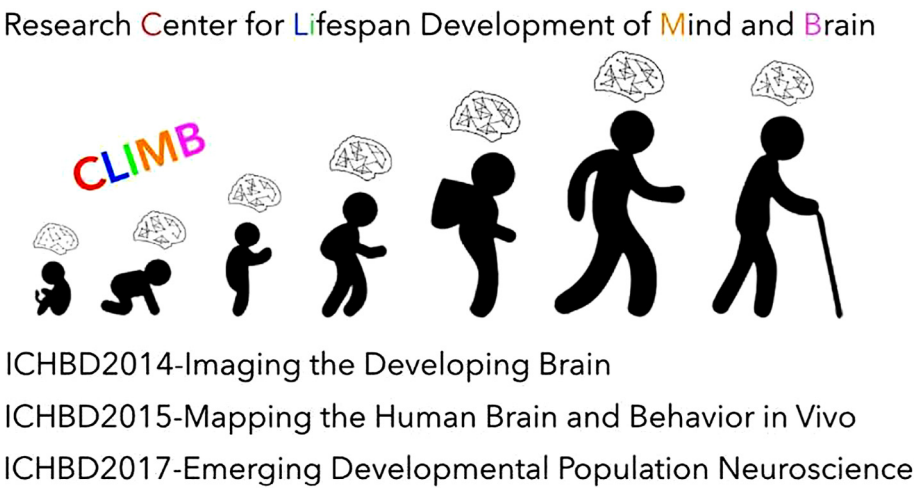

Fig. 1. (Color online) Building CLIMB based on Three ICHBD conferences.

recently developed scientific framework on human lifespan connectomics [19] using DPN approaches, CLIMB aims to unfold the mysterious inner workings of the human brain to determine the synchrony between brain and mind along the steps of the lifespan and how the genes and environment travel this path together. It is our hope in near future that CLIMB might serve as an international research hub to unlock the perplexities underlying the mechanisms of human brain structure and function and to help translate these findings into clinical, engineering and educational settings [20].

Conflict of interest

The authors declare that they have no conflict of interest.

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