# Chinese Color Nest Project (CCNP)i: Growing Up in China Postprint

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**Date:** 2017-10-13T00:00:00+00:00

## Abstract

Abstract: To face the challenges of keeping healthy in increasing population sizes of both ageing and developing people in China, a fundamental request from the public health is the development of lifespan normative trajectories of brain and behavior. This paper introduces the Chinese Color Nest Project (CCNP 2013–2022), a large-scale tenyear program of modeling brain and behavioral trajectories for human lifespan (6–85 years old). We plan to gradually collect the behavioral and brain imaging data at ages across the lifespan on nationwide and depict the normal trajectory of Chinese brain development across the lifespan, based on the accelerated longitudinal design in the coming next 10 years starting at 2013. Various psychiatric disorders have been demonstrated highly relevant to abnormal events during the neurodevelopment regarding their onset ages of first episodes. Therefore, delineation of normative growth curves of brain and cognition in typically developing children is extremely useful for monitoring, early detecting and intervention of various neurodevelopmental disorders. In this paper, we detailed the developing part of CCNP, devCCNP. It tracked 192 healthy children and adolescents (6–18 years old) in Beibei district of Chongqing for the first 5 years of the full CCNP cohort (2013–2017). To demonstrate the feasibility of implementing the longterm follow-up of CCNP, we here comprehensively document devCCNP in terms of its experimental design, sample strategies, data acquisition and storage as well as some preliminary results and data sharing roadmap for future. Specifically, we first describe the accelerated longitudinal sampling design as well as its exact ratio of sample dropping off during the data collection. Second, we present several initial findings such as canonical growth curves of cortical surface areas of a set of well-established large-scale functional networks of the human brain. Finally, together with records generated by many psychological and behavioral tests, we will provide an individual growing-up report for each family participating the program, initiating the potential guidance on the individual academic and social development. The resources introduced in the current work can provide first-hand data for a series of coming Chinese brain development studies, such as Chinese Standard MRI Brain Templates, Normative Growth Curves of Chinese Brain and Cognition as well as Mapping of Language Areas in Chinese Developing Brain. These would not only offer normative references of the atypical brain and cognition development for Chinese population but also serve as a strong force on accelerating the pace of integrating Chinese brain development into the national brain program or Chinese Brain Project.

## Full Text

## Preamble

### Chinese Color Nest Project (CCNP): Growing Up in China

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*This is the translational version of our paper describing the Chinese Color Nest Project, which has been published in Chinese Science Bulletin, 2017, 62: 3008-3022. All coauthors prepared the draft, which has been proof-read by a native English speaker from Child Mind Institute at New York: Dr. Jasmine Escalera.*

## Abstract

To address the public health challenges posed by China' s growing and aging population, there is a fundamental need to develop normative lifespan trajectories of brain and behavior. This paper introduces the Chinese Color Nest Project (CCNP; 2013-2022), a large-scale ten-year program aimed at modeling brain and behavioral trajectories across the human lifespan (6–85 years old). We plan to systematically collect behavioral and brain imaging data from individuals across all ages nationwide and delineate the normative trajectory of Chinese brain development across the lifespan using an accelerated longitudinal design over the coming decade, beginning in 2013. Various psychiatric disorders have been shown to be highly associated with abnormal neurodevelopmental events, particularly regarding the age of first episode onset. Therefore, establishing normative growth curves of brain and cognition in typically developing children is extremely valuable for monitoring, early detection, and intervention of various neurodevelopmental disorders. This paper provides a detailed description of the developmental component of CCNP, known as devCCNP, which has tracked 192 healthy children and adolescents (6–18 years old) in the Beibei district of Chongqing during the first five years of the full CCNP cohort (2013-2017). To demonstrate the feasibility of implementing long-term follow-up within CCNP, we comprehensively document devCCNP in terms of its experimental design, sampling strategies, data acquisition and storage protocols, preliminary results, and future data sharing roadmap. Specifically, we first describe the accelerated longitudinal sampling design and report the exact dropout rates observed during data collection. Second, we present several initial findings, such as canonical growth curves of cortical surface areas for a set of well-established large-scale functional networks of the human brain. Finally, together with data generated from numerous psychological and behavioral tests, we provide an individual growth report for each participating family, offering potential guidance for the child' s academic and social development. The resources introduced in this work can provide first-hand data for a series of upcoming Chinese brain development studies, including Chinese Standard MRI Brain Templates, Normative Growth Curves of Chinese Brain and Cognition, and Mapping of Language Areas in the Chinese Developing Brain. These resources will not only offer normative references for atypical brain and cognitive development in the Chinese population but also serve as a powerful force in accelerating the integration of Chinese brain development research into the national brain program, or Chinese Brain Project.

**Keywords:** brain development, growth curve, Chinese color nest project, brain mapping, connectome

## Introduction

Establishing growth curves based on physiological and psychological measurements across childhood and adolescence, along with their typical developmental characteristics at specific ages, can help identify critical periods of development and determine whether a child is reaching normal developmental milestones. Long-term pediatric practice in public health has demonstrated that growth curves are powerful tools for monitoring developmental processes. One prominent example is the Child Growth Standards launched by the World Health Organization (WHO) in 2006 [**?**, **?**], which shows that the median height for five-year-old boys is 110 cm, with three standard deviations above and below the median corresponding to 123.9 cm and 96.1 cm, respectively. Using this growth curve as a reference, a five-year-old boy falling below 96.1 cm may indicate malnutrition or a developmental abnormality. Therefore, growth charts—comprising sets of growth curves for physiological and psychological measurements—can help identify the need for early intervention and treatment in children with developmental disorders.

As early as the 1970s, WHO released international standards for the growth of children aged 5 to 19 years [**?**] and conducted a multicenter growth reference program (1997-2003) for children under six years of age. This program included a longitudinal study of infants from birth to 24 months and a cross-sectional survey of children from 18 to 71 months [**?**]. In 2007, the existing growth curves were reconstructed using a new statistical model [**?**], and the updated WHO growth reference now includes height, weight, body mass index, head circumference, chest circumference, and other anthropometric measurements. In addition to assessing children's nutritional status, many countries have incorporated these standards into national wellbeing indices and require that public health policies reference them.

In China, supported by national population census initiatives from the Ministry of Health, domestic public health and pediatric institutions have established comprehensive growth curves for height, weight, head circumference, and trace elements in Chinese children and adolescents. These efforts, based on methodological frameworks from WHO and the U.S. National Center for Disease Control (CDC), have significantly contributed to clinical growth monitoring for Chinese youth. The Department of Growth and Development at the Capital Institute of Pediatrics and the Institute of Child and Adolescent Health at Peking University jointly developed standardized growth curves for height and weight in children aged 0 to 18 years [?]. Data for children 0-6 years were derived from the large-scale "National Growth Survey of Children under 7 Years in Nine Cities of China" organized by the Ministry of Health, while data for children and adolescents aged 7-19 years came from the "2005 Chinese Student Physique and Health Survey" organized by the Ministry of Education across nine cities (Beijing, Harbin, Xi' an, Shanghai, Nanjing, Wuhan, Guangzhou, Fuzhou, and Kunming). Children under seven were divided into 22 age groups, with random cluster sampling conducted according to age group intervals, yielding a total of 69,760 healthy children (34,901 males and 34,859 females). Healthy children and adolescents aged 6-19 years were selected through cluster sampling within the nine cities and surrounding areas, with schools determined and stratified by age and classrooms used as units for random cluster sampling, resulting in 24,542 participants (12,188 males and 12,354 females) [?]. In 2010, Li and colleagues used this dataset to construct growth curves for weight, length, and head circumference in newborns from birth to six months at one-month intervals [?]. Beyond anthropometric measures, Jin and colleagues also revised neuropsychological development assessments for children in the Beijing area, reconstructing test items into five domains—gross motor function, fine hand movement, adaptive ability, language, and social behavior—based on child cognitive development theory [?]. They assessed 2,402 children (1,265 males and 1,137 females) aged 0-60 months to establish norms and conduct reliability analyses in the Beijing area [?, ?].

Clinical epidemiological surveys reveal that brain dysfunction imposes enormous social and economic burdens worldwide and can occur at any stage across the lifespan [?, ?]. Fifty percent of individuals with mental disorders are diagnosed before age 14, and this figure rises to 75% when the age of onset is extended to 24 [?, ?]. Research indicates that such disorders can be identified within specific critical time windows: for example, destructive and impulsive behaviors and anxiety tend to emerge in childhood, whereas mood disorders, psychotic disorders, and substance abuse are more likely to onset during adolescence [?]. The National Institute of Mental Health' s (NIMH) Strategic Plan emphasizes that brain and behavioral sciences should prioritize research on the lifelong development of brain function and mental disorders, noting that establishing statistical norms for specified brain circuits will enable researchers to understand the pathophysiology underlying the entire developmental course of psychiatric disorders. Human brain magnetic resonance imaging (MRI) technology has been widely used in fundamental brain development research [?] and is increasingly being applied to studies of brain developmental trajectories in children and adolescents [?]. It is expected to serve as a supportive tool for early detection, objective diagnosis, and course monitoring of various brain functional diseases [?]. However, studies implementing growth curves for brain cognition and child/adolescent behavior remain rare, suggesting that such research has not yet received sufficient attention in basic brain sciences. Recently, with the advancement of brain initiatives in many countries and regions [?, ?], the relationship between human brain structure and psychological behavior has received increasing attention and is becoming a core focus of brain science research. For example, the "Human Connectome Project (HCP: 2009-2015)" launched in the United States, which focuses on macro-scale human brain connectomics and psychological behaviors, has achieved significant advances [?, ?]. Similarly, the U.S. National Institutes of Health (NIH) has deployed three projects—Infant Connectome, Adolescent Brain and Cognitive Development, and Human Brain Lifespan Development—building upon the latest HCP developments [?].

With support from the National Natural Science Foundation, Chinese Academy of Sciences (CAS), Ministry of Science and Technology, and Beijing Municipal Science & Technology Commission, Chinese scientists initiated brain growth curve studies earlier than the U.S. HCP (beginning in 2012) and launched the "Chinese Color Nest Project (CCNP: 2013-2022)," which will nationally collect behavioral and brain imaging data across all ages throughout the human lifespan [?, ?]. CCNP aims to determine the normative trajectory of Chinese brain development over the next decade. As the developmental component of CCNP, devCCNP has been tracking 192 healthy children and adolescents (6–18 years old) in Beibei District, Chongqing for five years, demonstrating the program' s feasibility as a long-term initiative [?, ?]. This paper provides a detailed introduction to devCCNP, covering its experimental design, sampling strategy, data acquisition and storage, preliminary results, data sharing plans, existing challenges, and future research directions.

## Experimental Design and Sample Modeling

Modeling brain development curves requires that the age distribution of the sample span a sufficient range and that longitudinal tracking occurs at regular intervals. Studying individual differences in brain structure also requires an adequate number of subjects at each age to ensure generalizable statistical results. As a lifespan development research program, CCNP adopted a mixed longitudinal and cross-sectional design because purely longitudinal designs are difficult to implement in human subjects, while purely cross-sectional designs cannot accurately characterize within-individual changes [?]. The devCCNP component is committed to modeling growth curves of brain cognition in children and adolescents. Prior to devCCNP, the brain imaging field lacked longitudinal datasets for modeling brain structure and functional growth curves. A few large-scale brain development datasets contained only cross-sectional structural MRI (sMRI), diffusion tensor imaging (dMRI), and resting-state functional MRI (rfMRI) data [?, ?]. The limited nature of these datasets greatly restricts the statistical power and sensitivity of growth curve modeling. To accurately model brain growth curves, we employed a multi-cohort structured longitudinal design [?] to establish a standardized large-scale longitudinal dataset encompassing multimodal brain imaging, cognitive, and behavioral measurements. The advantages of this design include: (1) the multi-cohort longitudinal design can systematically track changes in brain and behavior while effectively controlling for external environmental factors such as season and climate, and ensures that multiple longitudinal measurements cover all ages; (2) the structured design within each cohort ensures that every measurement covers all developmental stages and collects sufficient cross-sectional data to study age-related characteristics and individual differences; (3) the mixed design not only tracks individual brain and behavioral changes systematically but also expands cross-sectional samples, making the fitted normative trajectory more representative of the population; and (4) the multi-cohort structured design mitigates some drawbacks of longitudinal tracking, such as being time-consuming and having high dropout rates.

## Sampling Strategy

The age range of participants at baseline recruitment was 6.0–17.9 years, divided into 12 age groups separated by one-year increments. The longitudinal interval was 15 months for each cohort (to avoid seasonal effects), with each age group containing 16 participants (8 males and 8 females). For each subject, the tracking period was 30 months, including three measurement time points: baseline, follow-up 1 (15 months after baseline), and follow-up 2 (30 months after baseline). Therefore, each subject received three MRI scans and cognitive-behavioral assessments. Figure 1 [Figure 1: see original paper] depicts the detailed sampling strategy.

## Recruitment Strategy

The target sample will be community-ascertained, and we aim to optimize representativeness by encompassing variation across geographic, ethnic, racial, and socioeconomic groups. The pilot project selected communities in Beibei District, Chongqing, and was jointly conducted by the Institute of Psychology, CAS and the Faculty of Psychology at Southwest University. The project included a primary school, a middle school, and a high school, providing access to children from first grade through second year of high school. The program is dedicated to comprehensive growth and development monitoring of these school-age children, providing a five-year physical and mental development report for each child. We held project promotion sessions with parents and schools and conducted outreach activities to educate families about recent advances in brain development science. To avoid temporal confounds, the project team evenly distributed data collection for all subjects throughout the five-year period rather than concentrating sampling within narrow timeframes.

## Exclusions

Exclusion criteria were as follows:
1) **Demographic**: Subjects with inadequately detailed family histories.
2) **Pregnancy, birth, and perinatal history**: Known intrauterine exposures capable of altering brain structure or function (teratogenic medications, illicit drug use, smoking >½ pack per day or >2 alcoholic drinks per week during

pregnancy), hyperbilirubinemia requiring transfusion and/or phototherapy (>2 days), multiple birth, infant resuscitation by chest compression or intubation, birth weight <1500g or >4200g.

3) **Physical/medical or growth**: Current height or weight <3rd percentile, or head circumference <3rd percentile according to National Center for Health Statistics 2000 data; history of significant medical or neurological disorder with CNS implications (e.g., seizure disorder, CNS infection, malignancy, diabetes, systemic rheumatologic illness, muscular dystrophy, migraine or cluster headaches, sickle cell anemia); significant closed head injury with loss of consciousness; malignancy; hearing impairment requiring intervention; visual impairment requiring more than conventional glasses (e.g., strabismus, visual handicap); metal implants; or current positive pregnancy test.

4) **Behavioral/psychiatric**: Current or past treatment for language disorders (simple articulation disorders not exclusionary); lifetime history of Axis I psychiatric disorder ascertained by semi-structured interview (Schedule for Affective Disorders and Schizophrenia for Children-PL), except for simple phobia, adjustment disorder, enuresis, encopresis, or nicotine dependency; any Child Behavior Checklist (CBCL) subscale score 70; Wechsler Intelligence Scale for Children-IV-Chinese Version (WISC-IV) score <80.

5) **Family history**: History of inherited neurological disorder; history of mental retardation due to non-traumatic events in any first-degree relative; any first-degree relatives with lifetime history of schizophrenia, bipolar affective disorder, psychotic disorder, alcohol or other drug dependence, obsessive-compulsive disorder, Tourette' s disorder, major depression, ADHD, or pervasive developmental disorder.

## Phenotypic Assessment and Data Collection

The project assesses routine behavioral and neuropsychological measurements. Our international partners have demonstrated the feasibility of large-scale phenotypic data collection in lifespan developmental neuroimaging studies [**?**]. We have utilized Chinese versions of these measurements in the current project. For each subject, the assessment process proceeded as follows: (1) children' s guardians signed informed consent and completed basic information questionnaires and the CBCL; (2) height, weight, pulse, and blood pressure measurements were obtained; (3) magnetic resonance imaging scans were conducted; and (4) Wechsler intelligence tests, behavioral assessments, and psychological tasks were administered. To prevent physical fatigue and emotional fluctuations from behavioral testing from influencing brain scans, all psychological and behavioral scales and tasks were completed after MRI scanning, either on the same day or a few days later. Table 1 and Table 2 provide detailed information about the psychological-behavioral scales and experimental tasks, respectively. Below is a detailed introduction to the Wechsler Intelligence test and MRI scan-related phenotypic assessments.

Insert <Table 1 Psychological Behavioral Scales> about Here

Insert <Table 2 Psychological Experimental Tasks> about Here

**Wechsler Intelligence Scale**: We adopted the fourth edition of the Wechsler Child Intelligence test (Wechsler Intelligence Scale for Children-IV-Chinese Version, WISC-IV) [?, ?]. This test is applicable to children aged 6–16 years and includes 10 core subtests and 4 supplemental subtests. From these, we derive a Full-Scale IQ (FSIQ) and four index scores: Verbal Comprehension Index, Perceptual Reasoning Index, Working Memory Index, and Processing Speed Index. The ten core subtests include Block Design, Similarities, Digit Span, Picture Concepts, Coding, Vocabulary, Letter-Number Sequencing, Matrix Reasoning, Comprehension, and Symbol Search. Supplemental subtests include Information, Picture Completion, Arithmetic, and Cancellation. These supplemental subtests can serve as alternatives to core subtests and provide a broader sample of cognitive and intellectual functions. The subtests map onto the four indices as follows: Similarities, Vocabulary, Comprehension, and Information constitute the Verbal Comprehension Index; Block Design, Picture Concepts, Matrix Reasoning, and Picture Completion constitute the Perceptual Reasoning Index; Digit Span, Letter-Number Sequencing, and Arithmetic form the Working Memory Index; and Coding, Symbol Search, and Cancellation constitute the Processing Speed Index. The four indices reflect children' s cognitive abilities in different domains, while the FSIQ reflects overall cognitive ability. Raw scores from each subtest can be normalized as scaled scores (mean = 10, SD = ±3) and composite scores (mean = 100, SD = ±15) for the four indices and FSIQ.

The test was administered one-on-one by a certified examiner. The WISC-IV demonstrates high reliability and validity: split-half reliability exceeds 0.71 for each subtest and ranges from 0.87 to 0.97 for composite scores; test-retest reliability over a one-month interval ranges from 0.71 to 0.86 for subtests and exceeds 0.80 for composite scores; inter-rater reliability ranges from 0.96 to 0.99. The WISC-IV shows good convergent and discriminant validity, with higher correlations between functionally similar tests than between functionally different tests. Exploratory factor analysis demonstrates good fit for the four-factor structure, and correlations with WISC-R composite and total scale scores range from 0.60 to 0.74. Studies of gifted children and children with mental disorders and learning disabilities have further validated the Chinese version of WISC-IV [?].

**MRI Scans**: MRI scanning was performed at the brain-imaging center at Southwest University using a 3.0T Siemens Tim Trio MRI scanner equipped with a Siemens 12-channel phased-array head coil and a 32-channel phased array coil. The scanning protocol included two repeated resting-state scans, a T1-weighted image, and a T2-weighted image. The scanning order was: positioning image scan → resting-state scan → T1-weighted anatomical image scan → resting-state scan → T2-weighted anatomical image scan. T2-weighted images were used only for auxiliary diagnosis to exclude brain lesions. No hardware or software upgrades were performed on the scanner during the project.

High-resolution T1-weighted anatomical images were acquired using a 3D Magnetization Prepared Rapid Gradient Echo (MP-RAGE) sequence with the following parameters: Flip Angle (FA) = 8°, time to inversion (TI) = 900 ms, time echo (TE) = 3.02 ms, time repetition (TR) = 2600 ms, Bandwidth per Voxel = 180 Hz, Partial Fourier = 6/8, Number of Slices = 176, slice phase encoding direction from anterior to posterior, slice acquisition order sequential ascending, Slice Thickness = 1 mm, Slice Gap = 0.5 mm, field of view (FOV) = 256 mm, Acquisition Matrix = 256×256, Slice In-Plane Resolution = 1.0×1.0 mm², Scan Duration = 8 minutes 19 seconds.

The resting-state scan used Echo Planar Imaging (EPI) with the following parameters: FA = 8°, TE = 30 ms, TR = 2500 ms, Bandwidth per Voxel = 2240 Hz, Number of Slices = 38, Slice Orientation = Axial, slice phase encoding direction from anterior to posterior, slice acquisition order interleaved ascending, Slice Thickness = 3 mm, Slice Gap = 0.33 mm, FOV = 216 mm, Acquisition Matrix = 72×72, Slice In-Plane Resolution = 3.0×3.0 mm², Number of Measurements = 184, Scan duration = 7 minutes 45 seconds, with fat suppression enabled during scanning.

## Project Progress and Growth Reports

After one year of preparation, we launched CCNP in Beibei District, Chongqing. We held nine rounds of project promotion sessions for students, parents, and teachers at local primary, middle, and high schools. A total of 198 students and their parents volunteered for the first wave (baseline) of data collection, providing informed consent signed by both the students and their guardians. Among all subjects, the following were excluded: 2 subjects for FSIQ below 80; 1 subject for antidepressant medication use; 1 subject for claustrophobia; and 2 subjects for brain cysts. The first wave began in December 2013 and concluded in July 2014. The second wave (first follow-up) was conducted from April to August 2015, with 158 subjects participating, of whom 152 had participated in the first wave, yielding a dropout rate of 20.83%. Additionally, 7 new volunteers joined, though 1 child was excluded due to behavioral problems. The third wave (second follow-up) was carried out from September 2016 to January 2017, with 107 children participating, including 100 subjects for their third time, 5 for their second time, and 2 for their first time, resulting in a dropout rate of 33.54%. Details of subjects' age distribution are listed in Table 3 , and information about phenotypic data collection is provided in Table 4 .

Insert <Table 3 Age Distribution of Sample Size> about Here
Insert <Table 4 Completion of Phenotypic Assessments> about Here

After each wave of data collection, the project team generated individual growth reports for every participant, including those initially excluded. These reports, which provided information about the participant' s physical, psychological, behavioral, and cerebral development, were sent to guardians. To date, we have provided 198 reports for the first wave and 164 for the second wave; reports for the third wave will be completed and delivered to participants' families before December 2017.

Figure 2 [Figure 2: see original paper] illustrates the growth curve of brain network surface area and its individual application. The growth report is a periodic presentation of participants' physical and mental development based on real data, objectively feedback to families. Through appropriate and effective communication, we have helped children and their guardians understand these reports. Each growth report includes five measurement domains: physical indices (height, weight, head circumference, blood pressure, pulse), intelligence quotient, emotional indices (social anxiety, depression, stress, behavioral problems), personality, and brain indices. Brain development measurements comprise total brain volume, subcortical gray matter volume, gray matter volume, white matter volume, cerebrospinal fluid volume, as well as cortical thickness and surface area of seven brain networks [**?**]—visual, somatomotor, dorsal attention, ventral attention, frontoparietal, limbic, and default networks. Referring to the modeling methods used for WHO' s height and weight growth curves [**?**], we plotted group-level growth curves for each measurement, with individual data plotted in each report. Figure 2 shows the development of cortical area in brain functional networks, and a sample growth report in the supplementary material illustrates specific developmental patterns for individual subjects. The second wave reports contained all content from the first wave plus comparisons between waves and suggestions for families. Additionally, we included second-wave scores from the Children' s Depression Inventory and Children' s Loneliness Scale, along with second-wave contrasts, enabling parents to better understand their children' s psychological health.

Figure 3 [Figure 3: see original paper] presents absolute brain volume and tissue relative volumes illustrated as spaghetti plots. After strict quality control, we collected 393 qualified brain images from 179 subjects. A total of 80 subjects (44 females) completed all three waves of scanning, 54 subjects (28 females) completed the first two waves, and 45 subjects (32 females) completed only the baseline scan. We applied volBrain [**?**], an online automatic MRI brain volumetry system, to obtain intracranial volume, gray matter volume, white matter volume, and cerebrospinal fluid volume. Due to individual variance in brain volume, we normalized gray matter, white matter, and cerebrospinal fluid volumes by dividing by intracranial volume to calculate the proportional volumes of these three tissues. Figure 3 shows individual longitudinal scatter plots of absolute brain volume, relative gray matter volume, white matter volume, and cerebrospinal fluid volume.

## Discussion

This paper systematically introduced CCNP and demonstrated the feasibility of implementing this project as a long-term study. CCNP is a longitudinal research program focused on measuring the psychological, behavioral, and neurocognitive characteristics of school-age children. Currently, China has developed specific guidelines for promoting psychological health construction, making it crucial to ensure that every child grows up healthy and happy to enhance national competitiveness. Developed countries have identified the study of mental health disorders as developmental phenomena as a major focus in basic clinical and public health research [?, ?]. In China, research on children' s mental health is developing, but clinical diagnosis and prevention for severe cases such as autism and schizophrenia remain relatively weak and require greater support [?].

A non-negligible problem in MRI research on normal brain development is deviation in brain registration. Due to the scarcity of pediatric MRI data, early studies generally adopted adult brain templates such as MNI152 [?] or the Talairach template [?] for registering children' s MRI images. However, numerous studies have pointed out that because substantial differences exist between children' s and adults' brain shapes, using adult templates can cause non-negligible systematic deviations [?], affecting measurements of brain structures such as gray and white matter proportions [?] and cortical thickness [?]. To address this problem, investigators have begun developing brain templates for different pediatric age cohorts. In America, Sanchez et al. [?, ?] constructed age-specific MRI templates for Western children from 2 weeks to 4 years old and from 4.5 to 19.9 years old at 0.5-year intervals, using data from both 1.5T and 3.0T MRI scanners. However, systematic deviations also occur when registering Chinese MRI data to Western templates, potentially due to racial and environmental differences [?]. To solve this problem, the Medical College of Shandong University and Xuanwu Hospital affiliated with Capital Medical University have constructed brain templates for Chinese adults [?], while Hong Kong University and West China Hospital affiliated with Sichuan University have constructed templates for Chinese children [?, ?]. These pediatric templates were based on small samples and lack testing and validation with longitudinal MRI data. One dataset was based on a single template derived from 53 children aged 5–8 years, ignoring differences in brain structures across age cohorts, while the other included five templates for five age cohorts at 2-year intervals, with 20–39 subjects per cohort. Because these subjects' ages are discrete, the templates cannot depict developmental curves of the brain. Thus, under current circumstances, constructing templates for children from different age cohorts is highly valuable for basic and clinical research in China and can directly impact the measurement of pediatric brain structure and function, as well as the precision and reliability of constructing Chinese brain development norms. CCNP provides fundamental data to address this scientific problem.

It is urgent to promote sharing of Chinese pediatric MRI data. Growth curves and developmental norms generally require support from large samples and big data. As testament to this need, the height and weight development norms constructed by WHO adopted a sample of 8,440 children from six sites [?, ?]. In China, the National Health and Family Planning Commission conducted a research project in 2005 measuring physical development in children under seven years old across nine cities, including 69,760 children, while the Ministry of Education launched a project measuring physique and health in 24,542 Chinese students [?, ?]. Since MRI studies are more complex and costly than physiological measurements, they typically have much smaller sample sizes. Benefiting from international major data sharing projects, researchers can access large amounts of free MRI data publicly shared by different institutes worldwide, which has partially solved the sample-size problem. Notable data sharing projects include the 1000 Functional Connectomes Project (FCP) [?, ?] and Human Connectome Project (HCP) [?, ?] in the USA, and the Consortium for Reliability and Reproducibility (CoRR), the first big data sharing project for brain imaging in China [?]. The brain templates for Western children constructed by Sanchez [?, ?] also benefited from public neuroimaging data from six sites, primarily from the Pediatric MRI Data Repository (NIHPD) funded by NIH and data collected at the McCausland Brain Image Center at the University of South Carolina. In contrast, pediatric MRI data sharing projects are developing rather slowly, with only the CoRR [?] and ADHD-200 [?] initiatives containing pediatric MRI data. This is hindering the construction of developmental norms for children, as small sample sizes and non-representative samples lead to regional biases, and the lack of longitudinal data makes it impossible to construct longitudinal developmental curves. In the future, by relying on national research projects and encouraging different research teams in different regions to publicly share pediatric MRI data, these problems can be solved. Such initiatives will greatly promote research on pediatric brain imaging and deepen our understanding of developmental patterns and pathological mechanisms in Chinese children and adolescents' brains.

Due to the special nature of working with children and adolescents, studies involving these populations encounter additional difficulties in ensuring and effectively communicating safety, recruitment, organization, and implementation. It is equally important to ensure that studies do not delay children' s academic development, which requires cooperation from schools. According to China' s current situation, only projects involving children and adolescents carried out by national ministries (such as the Ministry of Health and Ministry of Education) can cover a wide range of subjects while meeting adequate safety and organizational requirements. For example, the Chinese children' s physiological (height and weight) development project was promoted by the National Health and Family Planning Commission and efficiently organized by the Ministry of Education. Greater attention and support from Chinese national ministries and commissions are needed for imaging studies focused on constructing Chinese brain development curves.

Once the challenges of conducting large-scale research are addressed, such studies can promote progress in understanding Chinese brain development and broader Chinese brain sciences. CCNP has verified the feasibility of collecting data across various regions to compose a human brain development curve. Reflecting on the famous Decade of Brain in the United States at the end of the last century, our greatest achievement would be to depict curves of brain morphological development. Currently, brain projects are being vigorously promoted worldwide. China should seize this opportunity, utilize its advantage of having the world' s largest population, and carry out research programs focused on brain and cognitive growth norms that will enhance China' s influence in related research fields worldwide, while considering the implications for China' s aging society and fertility policies.

## Acknowledgements

This research project was supported by the International Cooperation of the National Natural Science Fund (81220108014), key projects of the Chinese Academy of Sciences (CAS: KSZD-EW-TZ-002), Study on life cycle development trajectory of human brain functional connectome (81171409), and human visual perception data computation and organization (2015CB351702).

The smooth running of the project benefited from strong support from the Faculty of Psychology at Southwestern University and the Institute of Psychology at the Chinese Academy of Sciences, as well as assistance and promotional permissions from participating primary and middle schools in Beibei District, Chongqing. We thank Liu Xun, Cao Xiaoyan, and Li Su for advice on project design, and Chen Bing for video production. During data collection, Hao Lei, Zhou Yafei, Meng Jie, Tian Xue, Yin Shouhang, Liu Ying, Zhai Jing, Wang Kangcheng, Hou Xin, Wei Jiali, Tang Qingting, Hu Jia, Zhang Xing, Ma Yuanxiao, Yang Zhengyu, Mao Yu, Sun Jiangzhou, Hu Na, Liu Xinyi, Yang Bingbing, Zhuang Kaixiang, Shi Liang, Ren Zhiting, Tang Yancheng, Li Hanxiao, Yang Chong, Tang Yan, Lu Dandan, Zhu Wenrong, Guan Jing, Gao Qing, Chen Qunlin, Zhao Yuanfang, Wang Yang, Cao Guoguang, Li Baolin, Dong Debo, Feng Pan, Guo Yiqun, Che Xianwei, Zhao Haichao, Chen Shengdong, Wu Xinran, Deng Xiang, Yang Runlan, and others contributed to the project. We thank Kuang Chen for data digitalization and Ms. Wen Qiong for logistical support.

The two senior international collaborators, Dr. Michael P. Milham and Dr. Olaf Sporns, have been invaluable members of the NSFC and CAS team in supporting this longitudinal brain-behavior project in China.

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**Table 1 Psychological Behavioral Scales**

| Scale | Scope of Application (years) | Measuring Method | No. of Items | Dimensions | Reliability | Validity |
|---|---|---|---|---|---|---|
| Child Behavior Checklist [?, ?] | 4–16 | Guardians' rating | - | - | TRR: 0.77–0.79; ICR: 0.78 | Factor analysis yielded 2 factors that explain the variance of: 63.0% (males of 4–11 years); 60.2% (females of 4–11 years); 73.4% (males of 12–16 years); 67.4% (females of 12–16 years) |

| Scale | Scope of Application (years) | Measuring Method | No. of Items | Dimensions | Reliability | Validity |
|---|---|---|---|---|---|---|
| Perceived Stress Scale [?, ?] | - | Self-evaluation | - | - | TRR: 0.70–0.94; ICR: 0.86; SHR: 0.82 | Factor analysis yielded 2 factors; the loadings of the items were between 0.50–0.78 |
| Adolescent Self-Rating Life Events Checklists [?] | 13–20 | Self-evaluation | - | - | TRR: 0.54–0.84; ICR: 0.79; SHR: 0.81 | Factor analysis yielded 6 factors that explained the variance of 44% |

| Scale | Scope of Application (years) | Measuring Method | No. of Items | Dimensions | Reliability | Validity |
|---|---|---|---|---|---|---|
| Piers-Harris Children's Self-Concept Scale [?] | 6–17 | Self-evaluation | - | - | TRR: 0.84; ICR: 0.91 | The diagnostic sensitivity of abnormal children was 70%, the specificity was 72%, and the consistency was 0.63 when using the ICD-10 as criteria and the 30th percentile of PHCSS score as demarcation point |

| Scale | Scope of Application (years) | Measuring Method | No. of Items | Dimensions | Reliability | Validity |
|---|---|---|---|---|---|---|
| Social Anxiety Scale for Children (SASC) [?] | - | Self-evaluation | - | - | TRR: 0.68 | Factor analysis yielded 2 factors that explained the variance of 49.21% |
| Multidimensional Anxiety Scale | 7-16 | Self-evaluation | - | - | TRR: 0.81; ICR: 0.88 | Factor analysis yielded 4 factors; the fit indices of the items were all above 0.94 |

| Scale | Scope of Application (years) | Measuring Method | No. of Items | Dimensions | Reliability | Validity |
|---|---|---|---|---|---|---|
| State-Trait Anxiety Inventory [?] | 8–19 | Self-evaluation | - | - | ICR: 0.88 | Factor analysis yielded 4 factors that explained the variance of 47.1% |
| Children's Depression Inventory [?] | 7–17 | Self-evaluation | - | - | ICR: >0.77 | Factor analysis yielded 5 factors; the fit indices of the items were all above 0.87 |

| Scale | Scope of Application (years) | Measuring Method | No. of Items | Dimensions | Reliability | Validity |
|---|---|---|---|---|---|---|
| Children's Loneliness Scale [?] | 6–12 | Self-evaluation | - | - | TRR: 0.83; ICR: 0.90 | Confirmatory factor analysis found that the fit indices of the items were all above 0.80 |
| Positive and Negative Affect Scale [?, ?] | - | Self-evaluation | - | - | TRR: 0.58–0.67 (primary school); TRR: 0.61–0.86 (middle school); SHR of subscales: 0.51–0.77; ICR: 0.54–0.78 | Factor analysis yielded 4 factors; the loadings of the items were between 0.45–0.80, the fit indices of the items were all above 0.90 |

| Scale | Scope of Application (years) | Measuring Method | No. of Items | Dimensions | Reliability | Validity |
|---|---|---|---|---|---|---|
| Bar-On Emotional Quotient Inventory [?] | 7–18 | Self-evaluation | - | - | TRR: 0.49–0.81; ICR: 0.40–0.87; SHR: 0.41–0.92 | Factor analysis yielded 4 factors that explained the variance of 41.14% |
| Eysenck Personality Questionnaire (EPQ) [?] | 7–15 | Self-evaluation | - | - | SHR: 0.89 | - |
| Eysenck Personality Questionnaire (EPQ) [?] | - | Self-evaluation | - | - | - | - |
| Torrance Tests of Creative Thinking [?] | - | Self-evaluation | - | - | - | - |

| Scale | Scope of Application (years) | Measuring Method | No. of Items | Dimensions | Reliability | Validity |
|---|---|---|---|---|---|---|
| Williams' Creativity Test [?] | - | Self-evaluation | - | - | - | - |
| Chinese Character Naming [?] | 5–12 | Experimenters' -rating | - | - | - | - |

*TRR: Test-retest reliability; ICR: Internal consistency reliability; SHR: Split-half reliability*

**Table 2 Psychological Experimental Tasks**

| Task | Testing Method | No. of Acquisitions | Introduction of Tasks |
|---|---|---|---|
| Attention Network Test (ANT) [?] | Computer | - | Subjects were asked to judge the direction of the target correctly and quickly: the arrow in the middle was left or right and pressed the corresponding key |
| Task-Switch (TS) [?] | Computer | - | Subjects were asked to convert between two different types of digital classification tasks (1 to determine the number is greater or less than 5; 2 to determine the number is odd and even numbers) |

| Task | Testing Method | No. of Acquisitions | Introduction of Tasks |
|---|---|---|---|
| Working Memory Updating (WM) [?] | Computer | - | N-back paradigm was used with a total of 9 stimuli for the number of 1–9 were shown successively. Subjects were required to judge whether the current stimulus was consistent with the Nth stimuli presented before |

**Table 3 Age Distribution of Sample Size**

| Age Span (years) | Wave 1 | Wave 2 | Wave 3 |
|---|---|---|---|
| 10–11 | - | - | - |
| 11–12 | - | - | - |
| 12–13 | - | - | - |
| 13–14 | - | - | - |
| 14–15 | - | - | - |
| 15–16 | - | - | - |
| 16–17 | - | - | - |
| 17–18 | - | - | - |
| total | - | - | - |

**Table 4 Completion of Phenotypic Assessments**

| Assessment Type | Completion |
|---|---|
| Psychological behavior questionnaire | 157** |
| Psychological experiment tasks | 101*** |
| Physiology | 191* |
| WISC-IV | 157** |
| Feeling | 101*** |
| Handedness | 157** |
| Character naming | 101*** |

- *: 191 (1 uncomfortable);* ***: 157 (1 perencephaly);*** : 101 (6 perencephaly)

*Note: Figure translations are in progress. See original paper for figures.*

*Source: ChinaXiv —Machine translation. Verify with original.*