Comparison of Brain Development Trajectory between Chinese and U.S. Children and Adolescents and the Construction of Age-specific MRI Brain/Head Templates for Chinese Children and Adolescents

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Brain Development Study

Is there a universal pattern of brain of brain development?

- Structural MRI research contributes to understanding of trajectories of brain development throughout childhood and early adulthood[1]
- The current knowledge about brain structural development is limited to North American and Western European subjects
- Adult structural MRIs reveal morphometric and volumetric brain differences between Asian and North American adults[2,3]
- No study has directly compared the brain development patterns and brain anatomical features between Asian and American child populations.
- Our project explored differences in brain development trajectories and anatomical features between CN and US children and adolescents.

Results

FIGURE 1 | Brain morphology develops as a function of age and nationality

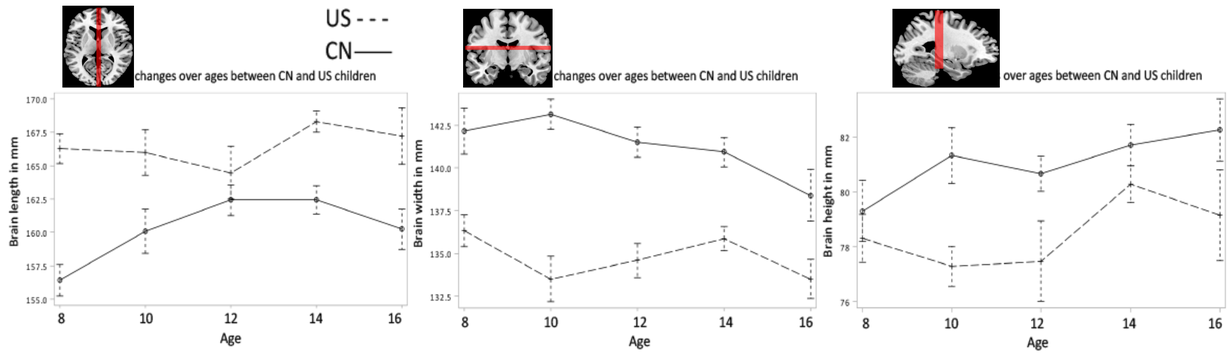
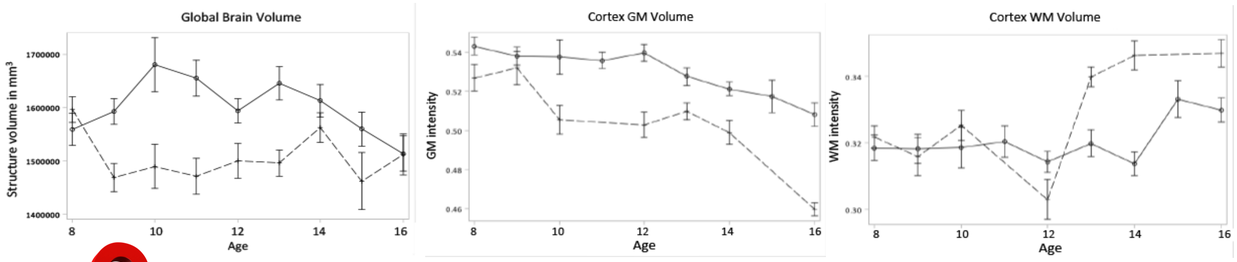
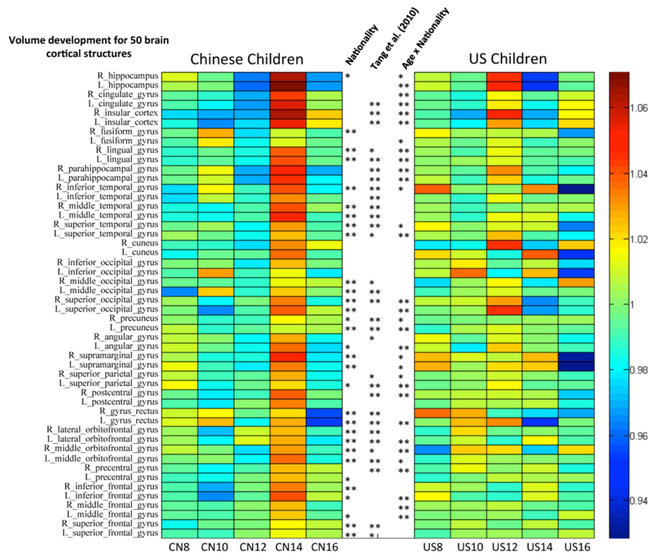


FIGURE 2 | Global cerebral, cortical GM, and WM volume change as a function of age and nationality



For more results & discussion, see Xie et al.[5]

FIGURE 3 | The development of brain volumes for 50 cortical structures



R: right; L: left; **p<0.01; *p<0.05

Methods

Participants

Age group (years)	Nationality	Gender (#Male)	Total N
8	CN	12	16
	US	11	19
9-10	CN	20	22
	US	13	24
11-12	CN	23	36
	US	17	27
13-14	CN	19	39
	US	32	59
15-16	CN	9	20
	US	10	20
Total	CN	83	133
	US	83	149

MRI Acquisition, File Preparation, and Analysis

— The CN scans were collected with two 3.0 T MRI scanners in the Huaxi MR Research Center[A], US Childres Scans were from the USC-MCBI[B] and ABIDE[C] databases.

— FSL computer programs[4] was used for brain extraction and segmentation. So later we could measure brain volumes for regions.

— Two atlases (LPBA40 and manual lobar atlas) were constructed on the individual MRIs.

— Brain and head morphometric measurement was performed with the MRIcron program and scripts in Matlab.

— Gray matter (GM), while matter (WM), and regional MRI volume were calculated with FSL programs.

— The development of these brain features were analyzed and compared between CN and US participants.

— For more details regarding the methods, see Xie et al. [5]

Brain Templates Study

Introduction

Do we need population-specific brain templates ?

- Adult templates do not fit well to child MRIs[6]; North American templates do not fit well to Asian MRIs[2,3].
- Differences in brain features have been shown between CN and US children[5]
- Population-specific templates are needed for Asian children.

Results

FIGURE 1 | Sagittal slices for the Chinese children brain and head templates

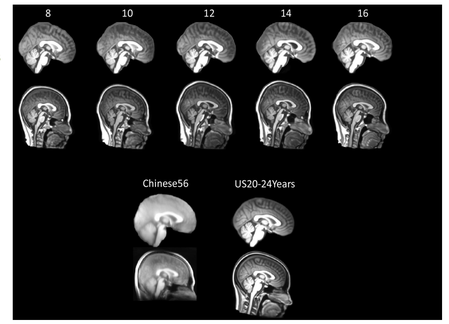


TABLE 1 | External test: comparison of brain morphological differences between original and registered images into different templates using a 12-parameter transformation

Measurements	Original Images (OIs) N=20 (M±S.D.)	Registered to Chinese children templates (Diff to OIs, *p value*)	Registered to U.S. children templates (Diff to OIs, *F value*)	Registered to the Chinese56 (Diff to OIs, *F value*)	Registered to the US20-24 (Diff to OIs)
Length	166.35 ± 5.97	**3.15***	**12.00*****	**17.75*****	**10.30*****
Width	144.25 ± 5.23	1.95	**-8.40*****	**11.25*****	**-9.15*****
Height	140.75 ± 4.94	1.1	**-4.10****	2.4	**-7.70*****
W/L	0.87 ± 0.04	-0.01	**-0.11*****	**-0.03***	**-0.11*****
H/L	0.85 ± 0.03	-0.01	**-0.08*****	**-0.07*****	**-0.10*****
H/W	0.98 ± 0.04	-0.01	**0.03*****	**-0.06*****	0.01

Significant differences are bolded. * p < 0.05, ** p < 0.01, *** p < 0.001

References

1. Gied et al., *Brain development during childhood and adolescence: a longitudinal MRI study.* Nat Neurosci, 1999. **2**(10): p. 861-3. Lentroot et al., 2007
2. Lee et al., *Development of Korean standard brain templates.* J Korean Med Sci, 2005. **20**(3): p. 483-8.
3. Tang, Y.C., et al., *The construction of a Chinese MRI brain atlas: A morphometric comparison study between Chinese and Caucasian cohorts.* Neuroimage, 2010. **51**(1): p. 33-41.
4. Jenkinson, M., et al., *Fsl.* Neuroimage, 2012. **62**(2): p. 782-90.
5. Xie et. al., *Comparison of the Brain Development Trajectory between Chinese and U.S. Children and Adolescents*. Frontiers in Sys Neuroscience, 2014, **8.**
6. Yoon et al., *The effect of template choice on morphometric analysis of pediatric brain data* , NeuroImage, **45**(3): p.769 – 777.

Footnotes

A. West China Hospital of Sichuan University, China
B. U of South Carolina-McCausland Center for Brain Imaging
C. Autism Brain Imaging Data Exchange. The data we used were from their normal controls.