Supplementary Information: A longitudinal resource for population neuroscience of school-age children and adolescents in China

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[*]LBCC is an international consortium and has aggregated 123,984 MRI scans, across more than 100 primary studies, from 101,457 human participants between 115 days post-conception to 100 years of age, and built brain charts to identify previously unreported neurodevelopmental milestones. More information are available at https://github.com/brainchart/lifespan.

[**]CCNP is a long-term effort (2013-2032) to build the lifespan brain-mind development cohort in China, and more consortium information are available at http://deepneuro.bnu.edu.cn/?p=163.

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ABSTRACT

During the past decade, cognitive neuroscience has been calling for population diversity to address the challenge of validity and generalizability, ushering in a new era of population neuroscience. The developing Chinese Color Nest Project (devCCNP, 2013–2022), the first ten-year stage of the lifespan CCNP (2013–2032), is a two-stages project focusing on brain-mind development. The project aims to create and share a large-scale, longitudinal and multimodal dataset of typically developing children and adolescents (ages 6.0–17.9 at enrolment) in the Chinese population. The devCCNP houses not only phenotypes measured by demographic, biophysical, psychological and behavioural, cognitive, affective, and ocular-tracking assessments but also neurotypes measured with magnetic resonance imaging (MRI) of brain morphometry, resting-state function, naturalistic viewing function and diffusion structure. This Data Descriptor introduces the first data release of devCCNP including a total of 864 visits from 479 participants. Herein, we provided details of the experimental design, sampling strategies, and technical validation of the devCCNP resource. We demonstrate and discuss the potential of a multicohort longitudinal design to depict normative brain growth curves from the perspective of developmental population neuroscience. The devCCNP resource is shared as part of the "Chinese Data-sharing Warehouse for *In-vivo* Imaging Brain" in the *Chinese Color Nest Project (CCNP) – Lifespan Brain-Mind Development Data Community* (https://ccnp.scidb.cn) at the Science Data Bank.

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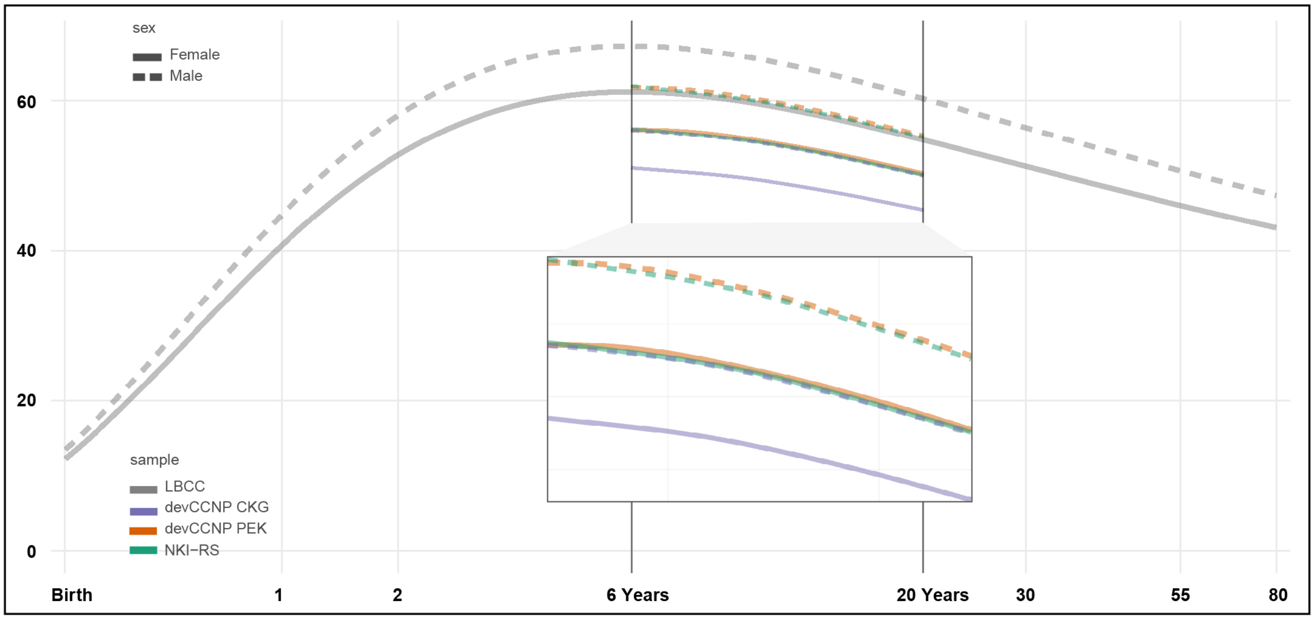

Figure S1. **Site/sex-specific brain charts of grey matter volume (GMV)**

The sex-specific lifespan brain charts of GMV (LBCC, light gray) were adjusted by leveraging the school-aged (6–18 years old) samples for three sites (devCCNP-CKG, purple; devCCNP-PEK, orange; NKI-RS, green), with male (dashed lines) and female (solid lines) respectively. unit: $10ml$ or $10,000mm^3$.

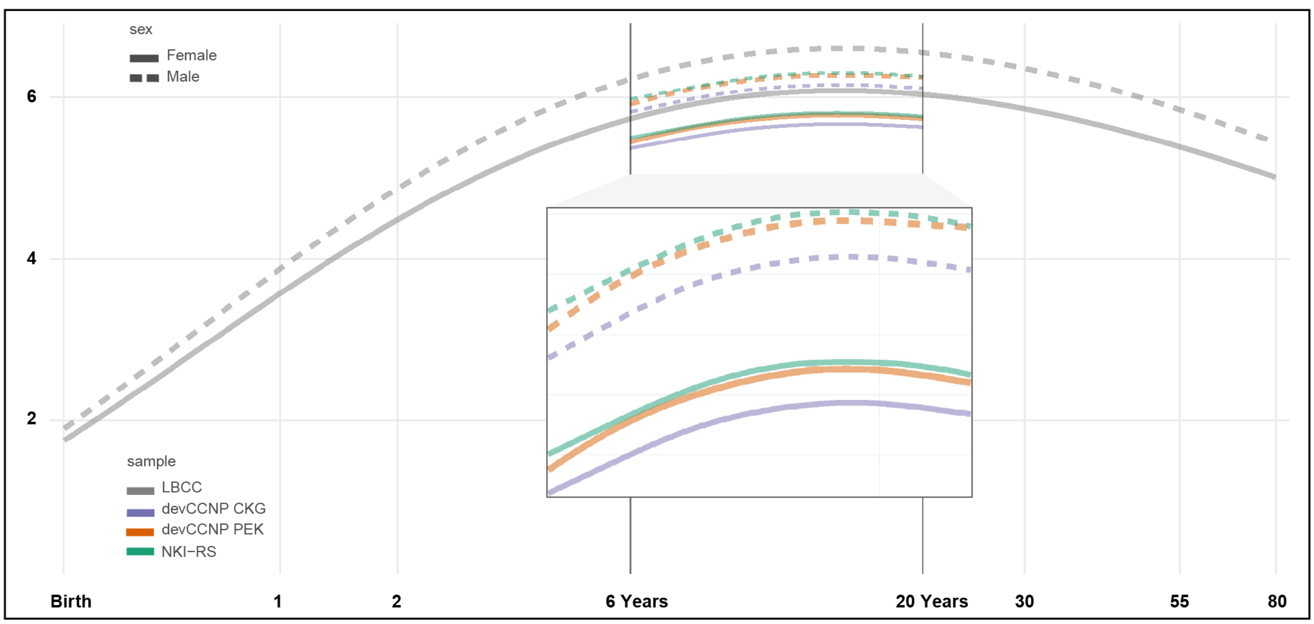

Figure S2. **Site/sex-specific brain charts of subcortical grey matter volume (sGMV)**

The sex-specific lifespan brain charts of sGMV (LBCC, light gray) were adjusted by leveraging the school-aged (6–18 years old) samples for three sites (devCCNP-CKG, purple; devCCNP-PEK, orange; NKI-RS, green), with male (dashed lines) and female (solid lines) respectively. unit: $10ml$ or $10,000mm^3$.

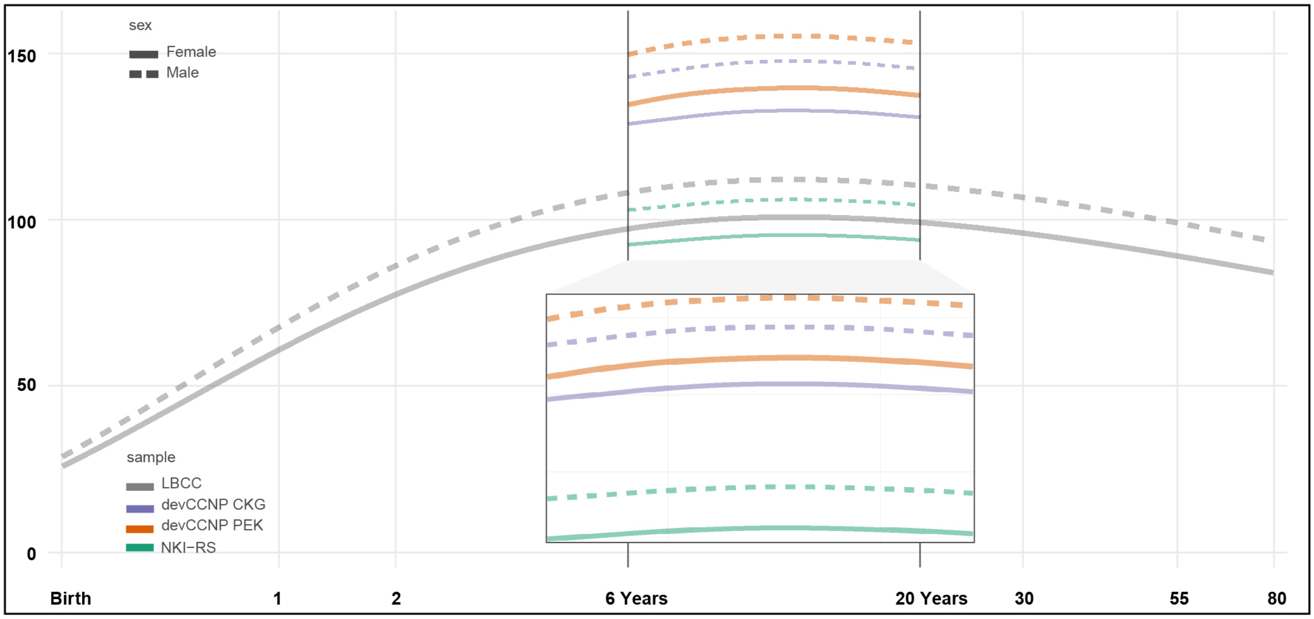

Figure S3. **Site/sex-specific brain charts of total cerebrum volume (TCV)**

The sex-specific lifespan brain charts of TCV (LBCC, light gray) were adjusted by leveraging the school-aged (6–18 years old) samples for three sites (devCCNP-CKG, purple; devCCNP-PEK, orange; NKI-RS, green), with male (dashed lines) and female (solid lines) respectively. unit: $10ml$ or $10,000mm^3$.

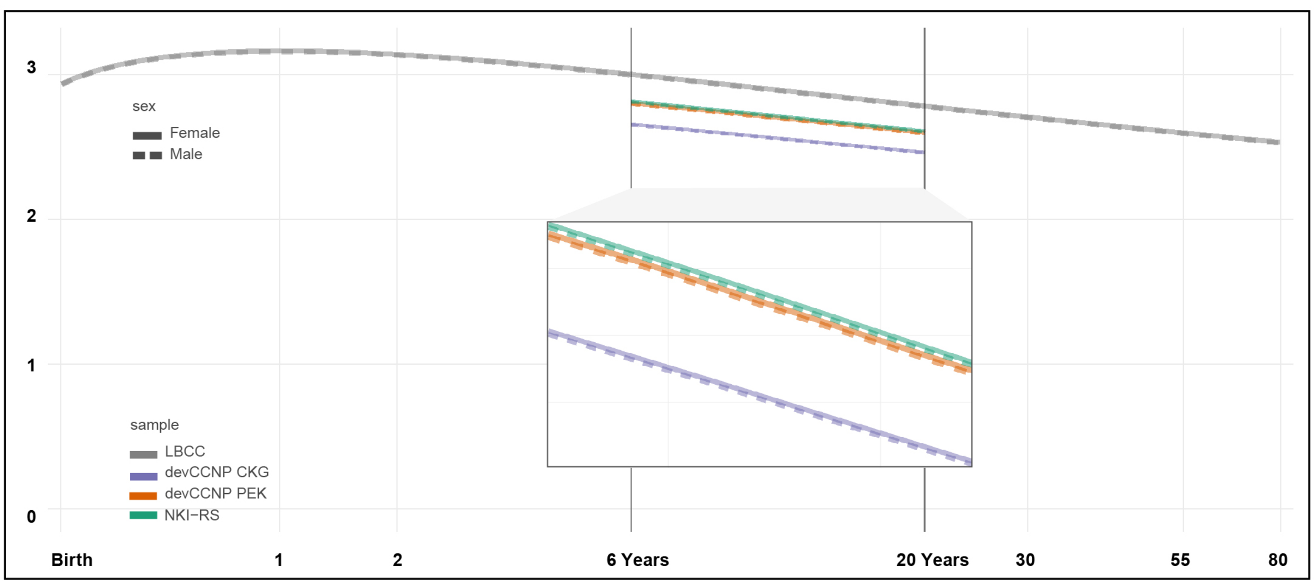

Figure S4. **Site/sex-specific brain charts of mean cortical thickness (CT)**

The sex-specific lifespan brain charts of mean CT (LBCC, light gray) were adjusted by leveraging the school-aged (6–18 years old) samples for three sites (devCCNP-CKG, purple; devCCNP-PEK, orange; NKI-RS, green), with male (dashed lines) and female (solid lines) respectively. unit: *mm*.

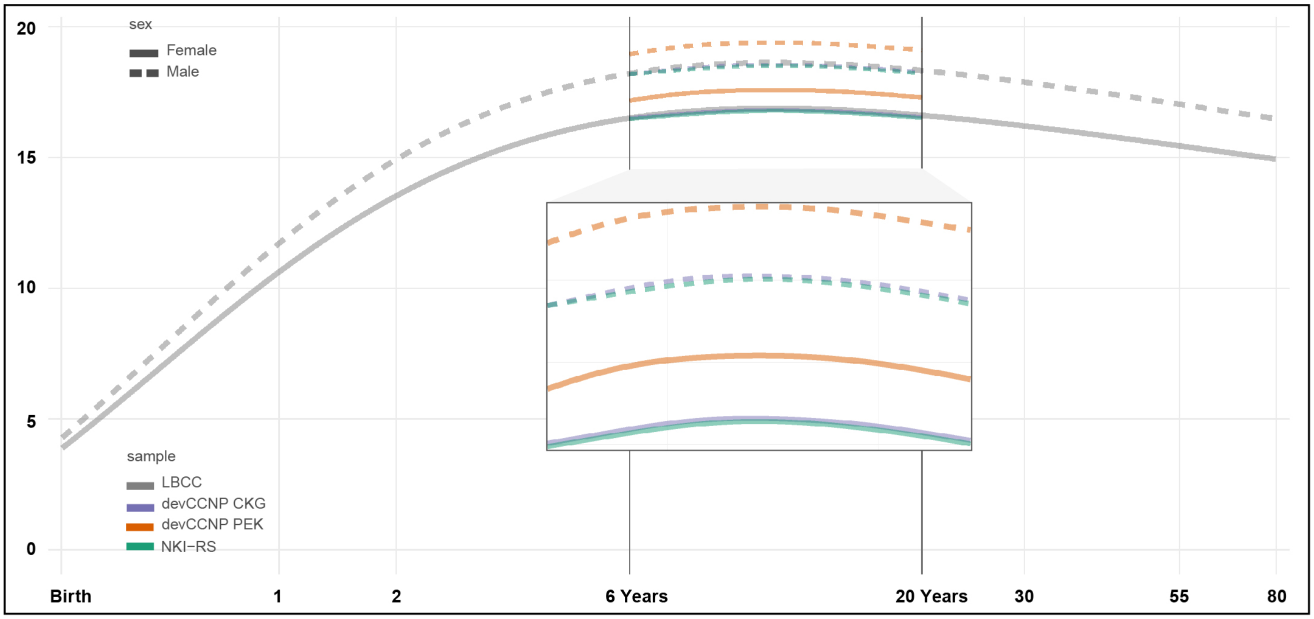

Figure S5. **Site/sex-specific brain charts of total surface area (TSA)**

The sex-specific lifespan brain charts of TSA (LBCC, light gray) were adjusted by leveraging the school-aged (6–18 years old) samples for three sites (devCCNP-CKG, purple; devCCNP-PEK, orange; NKI-RS, green), with male (dashed lines) and female (solid lines) respectively. unit: $10,000mm^2$.

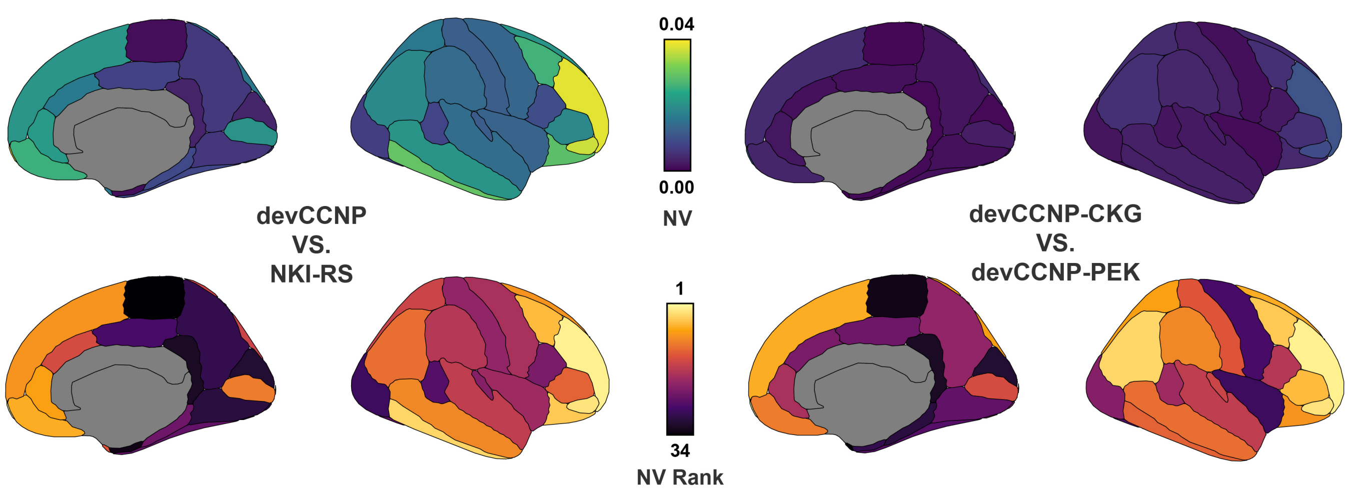

Figure S6. **Similarities of brain growth curves between male participants in devCCNP and NKI-RS**

NV values of the similarity between the United States and China (top, left) and two Samples within devCCNP (top, right) are presented through 34 gyral-based neuroanatomical regions. NV rank of these parcels are presented respectively bottom) from highest (order 1) to lowest (order 34).

	Age of Implementation	CKG Sample	PEK Sample	Duration (minutes)
Demographics				
Sex, date of birth, race, birth weight, gestational age at birth	All, Parental	✓	✓	~ 3
Handedness[1,2]	All	✓	✓	
Participant Characteristic				
Education level, academic performance	All, Parental	✓	✓	~ 15
Music Training History Questionnaire for Children[3,4]	All, Parental		✓	
Child Behaviour CheckList, CBCL[5,6]	6–18, Parental	✓	✓	
Family Characteristics				
Area (urban/rural), number of children	All, Parental	✓	✓	~ 3
Education level, careers and industries of parents	All, Parental	✓	✓	
Subjective social status (Self-designed)	All, Parental		✓	
Biophysical Measures				
Height, weight, head circumference, cardiovascular (blood pressure, pulse)	All	✓	✓	~ 3
Visual acuity, pure tone audiometry[7]	6–18		✓	~ 10
Physical Fitness Measures				
Grip strength[8], standing broad jump[9], 15-meter shuttle run[10]	6–18		✓	~ 15
Rating of Perceived Exertion, RPE[11]	6–18		✓	~ 1
Intelligence Quotient Measure				
Wechsler Intelligence Scale for Children-IV-Chinese Version, WISC-IV[12]	≥ 6	✓	✓	~ 100
Chinese Version of Wechsler Adult Intelligence Scale, WAIS-IV[13]				
Neuroimaging				
Mock scan[14]	All		✓	~ 30
Magnetic resonance imaging, MRI	All	✓	✓	~ 50
Psychological Behaviour Questionnaires				
Self-reported Pubertal Development Scale (Chinese Version), C-PDS[15,16]	≥ 6		✓	
Pittsburgh Sleep Quality Index, PSQI[17,18]	≥ 6		✓	
Torrance Test of Creative Thinking, TTCT[19,20]	≥ 6	✓		
Williams Creativity Assessment Packet, CAP[20,21]	≥ 6	✓		
Eysenck Personality Questionnaire (Children's Version), EPQ[22,23]	≥ 7	✓	✓	
Eysenck Personality Questionnaire (Audlt's Version), EPQ[22,24]				
Piers-Harris Children's Self-concept Scale, PHCSS[23,25]	6–17	✓	✓	
Social Anxiety Scale for Children, SASC[26,27]	7–16	✓	✓	
Multidimensional Anxiety Scale for Children, MASC[28,29]	8–19	✓	✓	
State-Trait Anxiety Inventory (FormY), STAI-FormY[30,31]	≥ 6	✓	✓	
Chinese Perceived Stress Scale, CPSS[32,33]	> 10	✓	✓	
Positive Affect and Negative Affect Scale, PANAS[34,35]	≥ 6	✓	✓	
Social Value Orientation, SVO[36,37]	≥ 6		✓	
Engagement, Perseverance, Optimism, Connectedness and Happiness Measure (Chinese Version), EPOCH[38,39]	6–18		✓	

~ 90

Positive Emotion, Engagement, Relationships , Meaning and Accomplishment Profiler, PERMA Profiler[40,41]	≥ 6		✓	
Children's Loneliness Scale, CLS[27,42]	6–12	✓	✓	
Chinese version of Children's Depression Inventory, CDI-C[43,44]	7–17	✓	✓	
Chinese version of the Bar-On Emotional Quotient Inventory: Youth Version, Bar-On EQ-I:YV[45,46]	7–18	✓		
Emotion Regulation Scale, ERS[47,48]	12–18		✓	
Sensation Seeking Scale, SS[49,50]	12–18		✓	
Resilience Scale for Chinese Adolescents, RSCA[51,52]	12–18		✓	
Domain Specific Risk-taking Scale, DOSPERT[53,54]	12–18		✓	
Rosenberg's Self-Esteem Scale, RSES[27,55,56]	12–18		✓	
Social Support Scale, SSS[57,58]	12–18		✓	
Prosocial Tendencies Measure, PTM[59,60]	12–18		✓	
Revised version of Inventory of Parent and Peer Attachment, IPPA-R[61,62]	12–18		✓	
Egna Minnen av Barndoms Uppfostran, EMBU[6,23,63]	12–18		✓	
Adolescent Self-Rating Life Events Checklist, ASLEC[64,65]	13–20	✓	✓	
Psychological behaviour tasks/tests				
Attention Network Test[66]	6–18	✓	✓	~ 15
Singleton Stroop Task[67]	≥ 7		✓	~ 15
Task-Switch Paradigm[68]	12–18	✓	✓	~ 5
Digit *N*-back Task[69]	12–18	✓	✓	~ 5
Prisoner's Dilemma[70,71]	7–18		✓	~ 10
Ultimatum Game[72,73]	≥ 7		✓	~ 10
Delay Discounting Task[74]	7–18		✓	~ 5
Risky Decision Task[75,76]	≥ 7		✓	~ 20
Chinese Character Reading Test: Chinese Character Naming Task[77]	6–12	✓	✓	~ 5
Lexical Identification[78,79]	6–18		✓	~ 40
Audiovisual Integration of Words[80,81]	6–18		✓	~ 5
Brief Affect Recognition Test[82,83]	≥ 6		✓	~ 30
Temporal Bisection Paradigm[84,85]	≥ 6		✓	~ 20
Ebbinghaus Illusion[86,87]	≥ 6		✓	~ 15
Binocular Rivalry[88,89]	≥ 6		✓	~ 10
Ocular-tracking Test[90–94]	≥ 6		✓	~ 50
Dichotic Digit Test[95,96]	6–18		✓	~ 5
Competing Sentences[96]	6–18		✓	~ 10
Mandarin Hearing in Noise Test for Children[97]	6–18		✓	~ 20
Verbal Fluency[98,99]	6–18		✓	~ 10

Table S1. Complete protocol

Table S2. **NV among female participants in devCCNP and NKI-RS**

NV Rank	Region	Network	NV
1	Rostral middle frontal gyrus	Default, Language, Cont, SalVenAttn	0.0443
2	Pars orbitalis	Default, Language, Cont	0.0429
3	Inferior temporal gyrus	Default, Language, Cont, SalVenAttn, DorsAttn, Visual	0.0354
4	Lateral orbital frontal cortex	Default, Cont, SalVenAttn	0.0338
5	Caudal middle frontal gyrus	Default, Language, Cont, SalVenAttn, DorsAttn, Visual	0.0310
6	Medial orbital frontal cortex	Default, Cont	0.0299
7	Rostral anterior cingulate cortex	Default, Cont	0.0263
8	Superior frontal gyrus	Default, Language, Cont, SalVenAttn, DorsAttn, SomMot	0.0251
9	Middle temporal gyrus	Default, Language, Cont, SalVenAttn, DorsAttn, Aud, Visual	0.0249
10	Pericalcarine cortex	Visual	0.0230
11	Pars triangularis	Default, Language, Cont, SalVenAttn	0.0224
12	Inferior parietal cortex	Default, Cont, SalVenAttn, DorsAttn, Aud, Visual	0.0223
13	Caudal anterior-cingulate cortex	Cont, SalVenAttn	0.0197
14	Temporal pole	Default	0.0188
15	Superior parietal cortex	Cont, DorsAttn, SomMot, Visual	0.0181
16	Superior temporal gyrus	Default, Language, SalVenAttn, Aud	0.0171
17	Supramarginal gyrus	Cont, SalVenAttn, DorsAttn, SomMot, Aud	0.0167
18	Precentral gyrus	Language, SalVenAttn, DorsAttn, SomMot, Visual	0.0158
19	Postcentral gyrus	SalVenAttn, DorsAttn, SomMot	0.0140
20	Transverse temporal cortex	Aud	0.0137
21	Pars opercularis	Language, Cont, SalVenAttn, DorsAttn	0.0114
22	Parahippocampal gyrus	Default, Cont, DorsAttn, Visual	0.0104
23	Fusiform gyrus	Default, Language, SalVenAttn, DorsAttn, Visual	0.0101
24	Banks superior temporal sulcus	Default, Language, SalVenAttn, Aud	0.0096
25	Posterior-cingulate cortex	Default, Cont, SalVenAttn, SomMot	0.0089
26	Lateral occipital cortex	Visual	0.0084
27	Precuneus cortex	Default, Cont, SalVenAttn, DorsAttn, SomMot, Visual	0.0072
28	Lingual gyrus	Cont, Visual	0.0071
29	Cuneus cortex	Visual	0.0042
30	Isthmus–cingulate cortex	Default, Cont	0.0039
31	Entorhinal cortex	Default, DorsAttn	0.0011
32	Paracentral lobule	SalVenAttn, SomMot, Visual	0.0009

[1] As explained in the manual delineation procedure of Desikon-Killiany parcellation, the region frontal pole was not actually designed as a measure of the frontal pole itself. Other frontal lobe regions were first designated and the remaining portion was called the frontal pole, which was also proven to be unreliable. The region corpus callosum was introduced to better define the regions around it. Therefore, the NV of these two regions is not shown. Note this table only refer to female participants. The text color corresponding to the large-scale network illustrated in Figure 5.)

Table S3. **NV among female participants in devCCNP-PEK and devCCNP-CKG**

NV Rank	Region	Network	NV
1	Rostral middle frontal gyrus	Default, Language, Cont, SalVenAttn	0.0114
2	Pars orbitalis	Default, Language, Cont	0.0101
3	Caudal middle frontal gyrus	Default, Language, Cont, SalVenAttn, DorsAttn, Visual	0.0056
4	Pars triangularis	Default, Language, Cont, SalVenAttn	0.0055
5	Inferior parietal cortex	Default, Cont, SalVenAttn, DorsAttn, Aud, Visual	0.0054
6	Superior frontal gyrus	Default, Language, Cont, SalVenAttn, DorsAttn, SomMot	0.0051
7	Lateral orbital frontal cortex	Default, Cont, SalVenAttn	0.0045
8	Superior parietal cortex	Cont, DorsAttn, SomMot, Visual	0.0045
9	Supramarginal gyrus	Cont, SalVenAttn, DorsAttn, SomMot, Aud	0.0039
10	Medial orbital frontal cortex	Default, Cont	0.0039
11	Middle temporal gyrus	Default, Language, Cont, SalVenAttn, DorsAttn, Aud, Visual	0.0036
12	Inferior temporal gyrus	Default, Language, Cont, SalVenAttn, DorsAttn, Visual	0.0036
13	Postcentral gyrus	SalVenAttn, DorsAttn, SomMot	0.0029
14	Superior temporal gyrus	Default, Language, SalVenAttn, Aud	0.0026
15	Pericalcarine cortex	Visual	0.0026
16	Transverse temporal cortex	Aud	0.0026
17	Pars opercularis	Language, Cont, SalVenAttn, DorsAttn	0.0025
18	Rostral anterior cingulate cortex	Default, Cont	0.0024
19	Banks superior temporal sulcus	Default, Language, SalVenAttn, Aud	0.0020
20	Caudal anterior-cingulate cortex	Cont, SalVenAttn	0.0019
21	Precentral gyrus	Language, SalVenAttn, DorsAttn, SomMot, Visual	0.0018
22	Lateral occipital cortex	Visual	0.0017
23	Fusiform gyrus	Default, Language, SalVenAttn, DorsAttn, Visual	0.0017
24	Precuneus cortex	Default, Cont, SalVenAttn, DorsAttn, SomMot, Visual	0.0015
25	Posterior-cingulate cortex	Default, Cont, SalVenAttn, SomMot	0.0014
26	Parahippocampal gyrus	Default, Cont, DorsAttn, Visual	0.0013
27	Lingual gyrus	Cont, Visual	0.0011
28	Entorhinal cortex	Default, DorsAttn	0.0011
29	Paracentral lobule	SalVenAttn, SomMot, Visual	0.0008
30	Isthmus–cingulate cortex	Default, Cont	0.0006
31	Cuneus cortex	Visual	0.0005
32	Temporal pole	Default	0.0003

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