**Atypical hemispheric lateralization of brain function and structure in autism: a comprehensive meta-analysis study**

Qingqing Li, Wei Zhao, Lena Palaniyappan, Shuixia Guo

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# Supplementary Methods

## Imaging data acquisition

For subjects from NYU, imaging data were acquired using a Siemens Allegra 3T scanner (New York University Center for Brain Imaging). Data acquisition included: (1) T1-weighted magnetization-prepared gradient-echo image: repetition time (TR) = 2,530ms, inversion time (TI) = 1100ms, echo time (TE) =3.25ms, flip angle (FA) =7°, voxel size = 1 × 1 × 1 mm3, 160 slices, FOV = 256 × 256mm. (2) resting-state function MRI using a multi-echo echo-planar imaging sequence: TR=2000ms, TE=30ms, FA=90°, voxel size = 3 × 3 × 3 mm3, 128 slices with interleaved acquisition, FOV = 256×256mm.

For subjects from GU, functional images were acquired on a 3T Siemens Trio scanner using a T2\*-sensitive gradient echo pulse sequence. Data acquisition included: (1) T1-weighted magnetization-prepared gradient-echo image: TR = 2,000ms, TI = 900ms, TE =2.52ms, FA =90°, voxel size = 1 × 1 × 1 mm3, 176 slices, FOV = 256 × 256mm. (2) resting-state function MRI using a multi-echo echo-planar imaging sequence: TR=2000ms, TE=31ms, FA=90°, voxel size = 3 × 3 × 3 mm3, 154 slices with interleaved acquisition, FOV = 256×256mm. Seven children (5 TDC) received an alternate sequence: TR=2000ms, TE=30ms, FA=90°, voxel size = 3 × 3 × 3 mm3, 37 slices with interleaved acquisition, FOV = 192×192mm.

For subjects from OHSU, MR data were collected during a single session for each subject using a Siemens Tim Trio 3T Scanner with a 12-channel head coil. Data acquisition included: (1) T1-weighted magnetization-prepared gradient-echo image: TR = 2,300ms, TI = 900ms, TE =3.58ms, FA =10°,voxel size = 1×1×1 mm3, 160 slices, FOV = 240 × 256mm. (2) resting-state function MRI using a gradient- echo echo-planar imaging sequence: TR=2500ms, TE=30ms, FA=90°, voxel size =1.56×1.56×1.56 mm3, 36 slices with interleaved acquisition, FOV = 240×240mm.

For subjects from UCLA, all resting-state fMRI and DTI scans were acquired on a Siemens 3T Trio at UCLA. Data acquisition included: (1) T1-weighted magnetization-prepared gradient-echo image: TR = 3,000ms, TI = 900ms, TE =28ms, FA =90°,voxel size = 3×3×3 mm3, 364 slices, FOV = 256× 256mm. (2) resting-state function MRI using a gradient- echo echo-planar imaging sequence: TR=5,000ms, TE=34ms, FA=90°, voxel size =1.5×1.5×1.5 mm3, 36 slices with interleaved acquisition, FOV = 240×240mm.

For subjects from UM1, MRI scanning occurred at the University of Michigan’s 3 Tesla GE Signa MRI machine. Data acquisition included: (1) T1-weighted magnetization-prepared gradient-echo image: TR = 2,000ms, TI = 900ms, TE =30ms, FA =90°,voxel size = 3×3×3 mm3, 124 slices, FOV = 256× 256mm. (2) resting-state function MRI using a gradient- echo echo-planar imaging sequence: TR=890ms, TE=18ms, FA=15°, voxel size =1.5×1.5×1.5 mm3, 124 slices, FOV = 240×240mm.

For subjects from USM, images were acquired on Siemens 3 Tesla Trio scanner. Data acquisition included: (1) T1-weighted magnetization-prepared gradient-echo image: TR = 2,000ms, TI = 900ms, TE =30ms, FA =90°, voxel size = 3×3×3 mm3, 240 slices, FOV = 256× 256mm. (2) resting-state function MRI using a gradient- echo echo-planar imaging sequence: TR=2,000ms, TE=28ms, FA=90°, voxel size =1×1×1 mm3, 240 slices, FOV = 240×240mm.

For subjects from KKI, scans were acquired on one of two Philips 3T scanners using either an 8-channel (Subjects number =155) or a 32-channel (Subjects number =55) phased array head coil. Data acquisition included: (1)T1-weighted magnetization-prepared gradient-echo image of 155 subjects: TR = 8.0ms, TI = 9ms, TE =3.7ms, FA =8°,voxel size = 1×1×1 mm3, 200 slices, FOV = 256× 256mm. T1-weighted magnetization-prepared gradient-echo image of 55 subjects: TR = 8.0ms, TI = 9ms, TE =3.7ms, FA =8°,voxel size = 1×1×1 mm3, 150 slices, FOV = 256× 256mm. (2) resting-state function MRI using a gradient- echo echo-planar imaging sequence: TR=2,500ms, TE=30ms, FA=75°, voxel size = 3×3×3 mm3, 47 slices, FOV = 256×256mm.

## Calculation of fALFF and ReHo

For the preprocessed fMRI data, the average fALFF of each ROI was extracted as follows: Firstly, fast Fourier transform (FFT) was used to transform the filtered time series of each voxel into the frequency domain and obtain the power spectrum. Then calculate the average of the square root of the power spectrum in the frequency range of 0.01-0.1 Hz(Y. F. Zang et al., 2007) to obtain the fALFF of the corresponding voxel. Finally, the fALFF based on the above AAL2 atlas was obtained by averaging the fALFF of all the voxels in the region. ReHo was calculated as follows: First, for a voxel, the preprocessed but unsmoothed functional MRI data were used to calculate Kendall’s coefficient of concordance (KKC, Kendall, 1957) of the time series of a given voxel and those of its nearest neighbors in a cluster (Y. Zang et al., 2004)：

 . (1)

Where  is the KKC among given  voxels, here, =27 and ; is the number of times point in the time series of a voxel.  is the sum of ranks of the th time point and ; and are the variance and the maximum possible variance of , respectively. The regional ReHo was extracted based on the above AAL2 atlas. Finally, the regional ReHo was obtained by averaging the ReHo of all the voxels in the region.

## statistics and statistics

According to the Cochrane Handbook for Systematic Reviews of Interventions, the various differences between different studies in the meta-analysis were called heterogeneity (or inconsistency), commonly used  statistics and  statistics to measure (Cochran, 1954; Freeman et al., 1986; Higgins et al., 2003). The calculation of thestatistics was as follows,

 (2)

The  statistic obeyed the  distribution with  degrees of freedom. Here,  was the number of sites,  was the effect size of the -th site,  was the pooled effect size,  was the weight of the site. The greater the , the greater the heterogeneity between different sites. The calculation of  was based on  as follows,

. (3)

## Correlation analysis

Ordinary Pearson correlation coefficient was calculated to study the following three kinds of relationships: (1) The relationship between pooled SMD and pooled SD was studied by calculating the correlation coefficient between the effect size of the SMD meta and the effect size of the SD meta. (2) The relationship between structural and functional lateralization. Specifically, for each of three regional cortical measures, we firstly calculated the mean of the absolute values of AI across all brain regions in individual subjects. Then, regressed the effect of the site by using a linear regression model, and used residual vectors of the linear regression model to calculate Pearson correlation coefficients between residual vectors of any pair of cortical measures (i.e., GMV, fALFF, ReHo) in all patients with autism as well as all non-autistic controls (NAC). (3) The relationship between the hemisphere lateralization and the autism symptom measures. Six of the seven datasets were accompanied by phenotypic information that included autism symptom (that is, ADI-A, ADI-B and ADI-C) measures. We first standardized autism symptoms by minus the mean divided by the standard deviation for all patients with autism to eliminate errors caused by different measurement standards. Subsequently, for regions that have both brain structural and functional lateralization effects, after regressing the effects of the site, we calculated Pearson correlation coefficients between the absolute AIs of each cortical measure and standardized autism symptoms.

# Supplementary Tables

## TableS1.The anatomical regions defined in each hemisphere and their label in the automated anatomical labelling atlas AAL3.

|  |  |
| --- | --- |
| **ROIs** | **Abbreviations** |
| Precentral gyrus | Precentral\_L(R) |
| Superior frontal gyrus, dorsolateral | Frontal\_Sup\_2\_L(R) |
| Middle frontal gyrus | Frontal\_Mid\_2\_L(R) |
| Inferior frontal gyrus, opercular part | Frontal\_Inf\_Oper\_L(R) |
| Inferior frontal gyrus, triangular part | Frontal\_Inf\_Tri\_L(R) |
| Inferior frontal gyrus, orbital part | Frontal\_Inf\_Orb\_2\_L(R) |
| Rolandic operculum | Rolandic\_Oper\_L(R) |
| Supplementary motor area | Supp\_Motor\_Area\_L(R) |
| Olfactory cortex | Olfactory\_L(R) |
| Superior frontal gyrus, medial | Frontal\_Sup\_Medial\_L(R) |
| Middle frontal gyrus, orbital part | Frontal\_Med\_Orb\_L(R) |
| Rectus | Rectus\_L(R) |
| Median orbitofrontal cortex | OFCmed\_L(R) |
| Anterior orbitofrontal cortex | OFCant\_L(R) |
| Posterior orbitofrontal cortex | OFCpost\_L(R) |
| Lateral orbitofrontal cortex | OFClat\_L(R) |
| Insular lobe | Insula\_L(R) |
| Anterior cingulate and paracingulate gyri | Cingulate\_Ant\_L(R) |
| Median cingulate and paracingulate gyri | Cingulate\_Mid\_L(R) |
| Posterior cingulate gyrus | Cingulate\_Post\_L(R) |
| Hippocampus | Hippocampus\_L(R) |
| Parahippocampal gyrus | ParaHippocampal\_L(R) |
| Amygdala | Amygdala\_L(R) |
| Calcarine fissure and surrounding cortex | Calcarine\_L(R) |
| Cuneus | Cuneus\_L(R) |
| Lingual gyrus | Lingual\_L(R) |
| Superior occipital gyrus | Occipital\_Sup\_L(R) |
| Middle occipital gyrus | Occipital\_Mid\_L(R) |
| Inferior occipital gyrus | Occipital\_Inf\_L(R) |
| Fusiform gyrus | Fusiform\_L(R) |
| Postcentral gyrus | Postcentral\_L(R) |
| Superior parietal gyrus | Parietal\_Sup\_L(R) |
| Inferior parietal gyrus | Parietal\_Inf\_L(R) |
| Supramarginal gyrus | SupraMarginal\_L(R) |
| Angular gyrus | Angular\_L(R) |
| Precuneus | Precuneus\_L(R) |
| Paracentral lobule | Paracentral lobule\_L(R) |
| Caudate nucleus | Caudate\_L(R) |
| Lenticular nucleus, putamen | Putamen\_L(R) |
| Lenticular nucleus, pallidum | Pallidum\_L(R) |
| Thalamus | Thalamus\_L(R) |
| Heschl gyrus | Heschl\_L(R) |
| Superior temporal gyrus | Temporal\_Sup\_L(R) |
| Temporal pole: superior temporal gyrus | Temporal\_Pole\_Sup\_L(R) |
| Middle temporal gyrus | Temporal\_Mid\_L(R) |
| Temporal pole: middle temporal gyrus | Temporal\_Pole\_Mid\_L(R) |
| Inferior temporal gyrus | Temporal\_Inf\_L(R) |
| Cerebellum Crus1 | Cerebellum\_Crus1\_L(R) |
| Cerebellum Crus2 | Cerebellum\_Crus2\_L(R) |
| Cerebellum 3 | Cerebellum\_3\_L(R) |
| Cerebellum 4\_5 | Cerebellum\_4\_5\_L(R) |
| Cerebellum 6 | Cerebellum\_6\_L(R) |
| Cerebellum 7b | Cerebellum\_7b\_L(R) |
| Cerebellum 8 | Cerebellum\_8\_L(R) |
| Cerebellum 9 | Cerebellum\_9\_L(R) |
| Cerebellum 10 | Cerebellum\_10\_L(R) |
| Cerebellum vermis 1\_2 | Vermis\_1\_2 |
| Cerebellum vermis 3 | Vermis\_3 |
| Cerebellum vermis 4\_5 | Vermis\_4\_5 |
| Cerebellum vermis 6 | Vermis\_6 |
| Cerebellum vermis 7 | Vermis\_7 |
| Cerebellum vermis 8 | Vermis\_8 |
| Cerebellum vermis 9 | Vermis\_9 |
| Cerebellum vermis 10 | Vermis\_10 |

**TableS2**.The scores of subdomains of the ADI-Rin six sites.

|  |  |  |  |
| --- | --- | --- | --- |
|  | ADI-A | ADI-B | ADI-C |
| GU |  |  |  |
| NYU |  |  |  |
| OHSU |  |  |  |
| UCLA |  |  |  |
| UM1 |  |  |  |
| KKI |  |  |  |

Note. ADI-A: Differences in reciprocal social interaction score; ADI-B: Differences in communication score; ADI-C: Restricted, repetitive and stereotyped patterns of behavior score. The data in the table are the “mean standard deviation” of symptom scores.

## TableS3.The ROIs and pooled effect size with atypical lateralization measured by GMV.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | ROI |  |  |  |  |  |
|  | Cerebellum\_9 | 2.72 | <0.001 | 3.08 | 0.80 | 1.28% |
| Cerebellum\_Crus2 | 2.04 | <0.001 | 5.21 | 0.52 | 0.34% |
| Caudate | 1.99 | <0.001 | 15.08 | 0.02 | 0.54% |
| Cerebellum\_10 | 1.98 | <0.001 | 1.03 | 0.98 | 5.81% |
| Cerebellum\_8 | 1.36 | <0.001 | 4.75 | 0.58 | 0.47% |
| Cerebellum\_7b | 1.29 | <0.001 | 1.83 | 0.93 | 2.82% |
| Cingulate\_Post | 1.17 | <0.001 | 3.20 | 0.78 | 1.19% |
| Putamen | 1.15 | <0.001 | 6.85 | 0.33 | 0.02% |
| Precuneus | 0.95 | <0.001 | 2.65 | 0.85 | 1.64% |
| OFCpost | 0.79 | <0.001 | 2.19 | 0.90 | 2.20% |
| Frontal\_Sup\_2 | 0.68 | <0.001 | 0.56 | 1.00 | 11.50% |
| SupraMarginal | 0.66 | <0.001 | 2.47 | 0.87 | 1.83% |
| Angular | 0.52 | <0.001 | 1.79 | 0.94 | 2.92% |
| Cerebellum\_Crus1 | 0.51 | <0.001 | 0.64 | 1.00 | 9.92% |
| Frontal\_Inf\_Orb\_2 | 0.44 | <0.001 | 1.61 | 0.95 | 3.35% |
| Rectus | 0.43 | <0.001 | 1.69 | 0.95 | 3.15% |
| Cuneus | 0.40 | <0.001 | 1.18 | 0.98 | 4.95% |
|  | Cingulate\_Ant | -3.94 | <0.001 | 6.58 | 0.36 | 0.06% |
| Temporal\_Inf | -2.71 | <0.001 | 3.90 | 0.69 | 0.80% |
| Cingulate\_Mid | -2.42 | <0.001 | 4.48 | 0.61 | 0.56% |
| OFClat | -2.24 | <0.001 | 12.88 | 0.05 | 0.46% |
| Temporal\_Pole\_Sup | -1.98 | <0.001 | 2.81 | 0.83 | 1.49% |
| Fusiform | -1.80 | <0.001 | 0.87 | 0.99 | 7.02% |
| Hippocampus | -1.73 | <0.001 | 2.83 | 0.83 | 1.47% |
| Supp\_Motor\_Area | -1.64 | <0.001 | 3.11 | 0.80 | 1.25% |
| ParaHippocampal | -1.64 | <0.001 | 1.88 | 0.93 | 2.72% |
| Insula | -1.52 | <0.001 | 4.18 | 0.65 | 0.67% |
| Rolandic\_Oper | -1.50 | <0.001 | 1.51 | 0.96 | 3.65% |
| Temporal\_Pole\_Mid | -1.44 | <0.001 | 5.89 | 0.44 | 0.19% |
| Heschl | -1.31 | <0.001 | 4.34 | 0.63 | 0.61% |
| Temporal\_Sup | -1.24 | <0.001 | 4.66 | 0.59 | 0.50% |
| Calcarine | -1.18 | <0.001 | 1.13 | 0.98 | 5.17% |
| Thalamus | -1.07 | <0.001 | 2.38 | 0.88 | 1.94% |
| Olfactory | -0.83 | <0.001 | 1.63 | 0.95 | 3.30% |
| Occipital\_Mid | -0.78 | <0.001 | 1.54 | 0.96 | 3.55% |
| Cerebellum\_4\_5 | -0.72 | <0.001 | 2.60 | 0.86 | 1.69% |
| Parietal\_Inf | -0.64 | <0.001 | 2.53 | 0.87 | 1.77% |
| Frontal\_Sup\_Media | -0.58 | <0.001 | 1.37 | 0.97 | 4.12% |
| Occipital\_Inf | -0.57 | <0.001 | 0.90 | 0.99 | 6.77% |
| Pallidum | -0.54 | <0.001 | 2.37 | 0.88 | 1.95% |
| Precentral | -0.52 | <0.001 | 0.35 | 1.00 | 19.04% |
| Temporal\_Mid | -0.50 | <0.001 | 2.46 | 0.87 | 1.84% |
| Frontal\_Inf\_Tri | -0.47 | <0.001 | 0.79 | 0.99 | 7.86% |
| Occipital\_Sup | -0.40 | <0.001 | 1.93 | 0.93 | 2.62% |
| OFCmed | -0.35 | <0.001 | 4.17 | 0.65 | 0.68% |
| Postcentral | -0.28 | 0.02 | 1.42 | 0.96 | 3.92% |
| Cerebellum\_3 | -0.27 | 0.02 | 0.66 | 1.00 | 9.54% |
| Parietal\_Sup | -0.24 | 0.05 | 2.77 | 0.84 | 1.53% |

## TableS4.The ROIs and pooled effect size with atypical lateralization measured by fALFF.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | ROIs |  |  |  |  |  |
|  | Frontal\_Inf\_Oper | 2.34 | <0.001 | 10.83 | 0.09 | 0.35% |
| Temporal\_Sup | 2.02 | <0.001 | 8.99 | 0.17 | 0.22% |
| Frontal\_Inf\_Orb\_2 | 1.71 | <0.001 | 4.36 | 0.63 | 0.61% |
| Angular | 1.69 | <0.001 | 2.86 | 0.83 | 1.45% |
| Precentral | 1.54 | <0.001 | 5.41 | 0.49 | 0.29% |
| Frontal\_Sup\_2 | 1.50 | <0.001 | 2.42 | 0.88 | 1.89% |
| Temporal\_Mid | 1.07 | <0.001 | 2.97 | 0.81 | 1.36% |
| Occipital\_Inf | 0.98 | <0.001 | 4.25 | 0.64 | 0.65% |
| Parietal\_Sup | 0.85 | <0.001 | 2.61 | 0.86 | 1.68% |
| Olfactory | 0.66 | <0.001 | 1.85 | 0.93 | 2.79% |
| Rectus | 0.60 | <0.001 | 2.71 | 0.84 | 1.59% |
| Frontal\_Inf\_Tri | 0.34 | 0.01 | 2.60 | 0.86 | 1.70% |
| Cerebellum\_9 | 0.28 | 0.03 | 0.75 | 0.99 | 8.30% |
| Frontal\_Sup\_Medial | 0.26 | 0.05 | 1.53 | 0.96 | 3.58% |
| Postcentral | 0.26 | 0.05 | 1.01 | 0.99 | 5.93% |
|  | Temporal\_Pole\_Sup | -1.81 | <0.001 | 11.48 | 0.07 | 0.39% |
| Temporal\_Inf | -1.53 | <0.001 | 9.67 | 0.14 | 0.28% |
| Cerebellum\_8 | -1.51 | <0.001 | 2.67 | 0.85 | 1.63% |
| Supp\_Motor\_Area | -1.48 | <0.001 | 8.56 | 0.20 | 0.18% |
| Fusiform | -1.20 | <0.001 | 5.75 | 0.45 | 0.22% |
| Cerebellum\_6 | -0.73 | <0.001 | 0.62 | 1.00 | 10.21% |
| Cerebellum\_3 | -0.67 | <0.001 | 1.14 | 0.98 | 5.13% |
| Parietal\_Inf | -0.51 | <0.001 | 1.66 | 0.95 | 3.22% |
| Occipital\_Mid | -0.47 | <0.001 | 0.97 | 0.99 | 6.18% |
| ParaHippocampal | -0.39 | <0.001 | 3.51 | 0.74 | 0.99% |
| OFClat | -0.38 | <0.001 | 1.69 | 0.95 | 3.15% |
| Cerebellum\_4\_5 | -0.38 | <0.001 | 0.89 | 0.99 | 6.90% |
| Frontal\_Mid\_2 | -0.33 | 0.01 | 1.79 | 0.94 | 2.90% |

## TableS5.The ROIs and pooled effect size with atypical lateralization measured by ReHo.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | ROIs |  |  |  |  |  |
|  | Frontal\_Inf\_Oper | 0.94 | <0.001 | 8.70 | 0.19 | 0.20% |
| Cerebellum\_9 | 0.62 | <0.001 | 2.64 | 0.85 | 1.65% |
| Frontal\_Inf\_Orb\_2 | 0.56 | <0.001 | 4.52 | 0.61 | 0.55% |
| Angular | 0.55 | <0.001 | 4.00 | 0.68 | 0.75% |
| Precentral | 0.53 | <0.001 | 2.35 | 0.88 | 1.97% |
| Temporal\_Sup | 0.44 | <0.001 | 4.77 | 0.57 | 0.47% |
| Frontal\_Sup\_2 | 0.41 | <0.001 | 1.47 | 0.96 | 3.77% |
| Temporal\_Mid | 0.40 | <0.001 | 3.61 | 0.73 | 0.94% |
| Putamen | 0.28 | 0.03 | 1.20 | 0.98 | 4.85% |
| Parietal\_Sup | 0.27 | 0.04 | 1.54 | 0.96 | 3.56% |
| Postcentral | 0.26 | 0.04 | 1.32 | 0.97 | 4.30% |
|  | Temporal\_Inf | -1.02 | <0.001 | 9.19 | 0.16 | 0.24% |
| Cingulate\_Ant | -1.00 | <0.001 | 9.83 | 0.13 | 0.29% |
| ParaHippocampal | -0.66 | <0.001 | 8.65 | 0.19 | 0.19% |
| Cerebellum\_6 | -0.65 | <0.001 | 3.75 | 0.71 | 0.87% |
| Temporal\_Pole\_Sup | -0.63 | <0.001 | 4.72 | 0.58 | 0.48% |
| Parietal\_Inf | -0.49 | <0.001 | 3.59 | 0.73 | 0.95% |
| Cerebellum | -0.48 | <0.001 | 2.77 | 0.84 | 1.53% |
| OFClat | -0.47 | <0.001 | 6.52 | 0.37 | 0.07% |
| Cerebellum\_8 | -0.46 | <0.001 | 0.92 | 0.99 | 6.62% |
| Frontal\_Sup\_Medial\_ | -0.45 | <0.001 | 5.05 | 0.54 | 0.39% |
| OFCant | -0.40 | <0.001 | 4.52 | 0.61 | 0.55% |
| Cerebellum\_4\_5 | -0.39 | <0.001 | 3.07 | 0.80 | 1.28% |
| OFCmed | -0.37 | <0.001 | 6.70 | 0.35 | 0.05% |
| Cerebellum\_Crus2 | -0.36 | <0.001 | 3.02 | 0.81 | 1.32% |
| Fusiform | -0.35 | 0.01 | 3.16 | 0.79 | 1.21% |
| Thalamus | -0.35 | 0.01 | 2.51 | 0.87 | 1.79% |
| Occipital\_Mid | -0.33 | 0.01 | 1.65 | 0.95 | 3.24% |
| Cerebellum\_Crus1 | -0.27 | 0.03 | 1.14 | 0.98 | 5.12% |

## TableS6.Results of heterogeneity test of meta-analysis based on SD.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | GMV | | | fALFF | | | ReHo | | |
| ROI |  |  |  |  |  |  |  |  |  |
| Precentral | 127.65 | <0.001 | 94.25% | 356.78 | <0.001 | 97.80% | 81.42 | <0.001 | 90.78% |
| Frontal\_Sup | 49.51 | <0.001 | 84.96% | 233.12 | <0.001 | 96.62% | 38.29 | <0.001 | 81.95% |
| Frontal\_Mid | 177.27 | <0.001 | 95.53% | 183.65 | <0.001 | 96.73% | 82.04 | <0.001 | 92.77% |
| Frontal\_Inf\_Oper | 87.60 | <0.001 | 91.36% | 465.32 | <0.001 | 98.31% | 92.51 | <0.001 | 91.94% |
| Frontal\_Inf\_Tri | 59.39 | <0.001 | 87.86% | 375.47 | <0.001 | 98.15% | 87.38 | <0.001 | 92.86% |
| Frontal\_Inf\_Orb | 50.73 | <0.001 | 85.67% | 350.88 | <0.001 | 97.74% | 54.44 | <0.001 | 86.02% |
| Rolandic\_Oper | 74.23 | <0.001 | 89.57% | 447.20 | <0.001 | 98.21% | 85.23 | <0.001 | 91.36% |
| Supp\_Motor\_Area | 154.31 | <0.001 | 94.95% | 82.22 | <0.001 | 92.72% | 63.52 | <0.001 | 90.66% |
| Olfactory | 105.50 | <0.001 | 92.74% | 130.23 | <0.001 | 94.35% | 50.89 | <0.001 | 86.01% |
| Frontal\_Sup\_Medial | **2.81** | **0.83** | **0.00%** | **3.62** | **0.73** | **0.00%** | **8.17** | **0.23** | **31.96%** |
| Frontal\_Med\_Orb | 206.87 | <0.001 | 96.23% | 33.89 | <0.001 | 80.79% | **1.48** | **0.96** | **0.00%** |
| Rectus | **5.02** | **0.54** | **0.00%** | **7.24** | **0.30** | **20.87%** | 14.69 | 0.02 | 59.26% |
| OFCmed | 138.49 | <0.001 | 94.66% | 18.68 | <0.001 | 68.58% | 54.15 | <0.001 | 89.55% |
| OFCant | 105.62 | <0.001 | 92.86% | 178.87 | <0.001 | 96.13% | 69.60 | <0.001 | 91.29% |
| OFCpost | 201.23 | <0.001 | 96.21% | 159.84 | <0.001 | 95.29% | 50.99 | <0.001 | 86.35% |
| OFClat | 80.59 | <0.001 | 90.90% | **5.40** | **0.49** | **0.99%** | **9.01** | **0.17** | **37.17%** |
| Insula | 214.71 | <0.001 | 96.37% | 13.31 | 0.04 | 55.39% | 16.13 | 0.01 | 61.62% |
| Cingulate\_Ant | 118.52 | <0.001 | 93.60% | **11.85** | **0.07** | **49.24%** | **10.57** | **0.10** | **38.56%** |
| Cingulate\_Mid | 181.72 | <0.001 | 95.66% | 168.54 | <0.001 | 95.23% | 38.33 | <0.001 | 81.13% |
| Cingulate\_Post | 133.49 | <0.001 | 94.31% | 382.27 | <0.001 | 97.93% | 33.12 | <0.001 | 78.33% |
| Hippocampus | 212.27 | <0.001 | 96.26% | 248.18 | <0.001 | 96.74% | 37.08 | <0.001 | 82.97% |
| Para-Hippocampal | 138.11 | <0.001 | 94.57% | **4.11** | **0.66** | **0.00%** | 19.93 | <0.001 | 71.30% |
| Amygdala | 79.12 | <0.001 | 90.61% | 233.75 | <0.001 | 96.59% | 97.22 | <0.001 | 92.01% |
| Calcarine | 206.11 | <0.001 | 96.08% | 180.61 | <0.001 | 95.82% | 96.51 | <0.001 | 91.99% |
| Cuneus | 76.10 | <0.001 | 89.89% | 113.27 | <0.001 | 93.33% | 78.48 | <0.001 | 90.45% |
| Lingual | 61.31 | <0.001 | 88.34% | 37.31 | <0.001 | 81.26% | 33.23 | <0.001 | 78.91% |
| Occipital\_Sup | 60.65 | <0.001 | 87.95% | 13.49 | 0.04 | 54.32% | 24.24 | <0.001 | 73.16% |
| Occipital\_Mid | 156.44 | <0.001 | 95.17% | 82.12 | <0.001 | 91.59% | 77.04 | <0.001 | 89.95% |
| Occipital\_Inf\_ | 64.02 | <0.001 | 88.71% | 388.68 | <0.001 | 97.97% | 94.58 | <0.001 | 91.93% |
| Fusiform | 71.34 | <0.001 | 89.24% | 459.70 | <0.001 | 98.23% | 109.25 | <0.001 | 92.90% |
| Postcentral | 81.96 | <0.001 | 90.84% | 427.30 | <0.001 | 98.11% | 96.84 | <0.001 | 92.20% |
| Parietal\_Sup | 79.99 | <0.001 | 90.73% | 128.56 | <0.001 | 93.96% | 63.48 | <0.001 | 88.12% |
| Parietal\_Inf | 44.34 | <0.001 | 84.27% | 130.50 | <0.001 | 94.34% | 83.21 | <0.001 | 91.01% |
| Supra-Marginal | 154.67 | <0.001 | 94.76% | 211.06 | <0.001 | 96.28% | 31.66 | <0.001 | 77.92% |
| Angular | 39.64 | <0.001 | 81.47% | 14.03 | 0.03 | 57.45% | **9.24** | **0.16** | **37.47%** |
| Precuneus | 258.17 | <0.001 | 97.02% | **8.03** | **0.24** | **22.17%** | **7.38** | **0.29** | **15.15%** |
| Paracentral- lobule | 233.29 | <0.001 | 96.62% | 40.07 | <0.001 | 83.56% | 17.16 | 0.01 | 64.92% |
| Caudate | 88.66 | <0.001 | 91.36% | 42.25 | <0.001 | 84.79% | **4.63** | **0.59** | **0.00%** |
| Putamen | 164.83 | <0.001 | 95.32% | 13.67 | 0.03 | 55.17% | **6.30** | **0.39** | **0.12%** |
| Pallidum | 92.37 | <0.001 | 91.91% | 19.49 | <0.001 | 68.19% | 14.86 | 0.02 | 59.79% |
| Thalamus | 119.76 | <0.001 | 93.70% | 33.73 | <0.001 | 83.07% | 21.31 | <0.001 | 73.23% |
| Heschl | 142.34 | <0.001 | 94.58% | 95.19 | <0.001 | 93.39% | 30.66 | <0.001 | 81.44% |
| Temporal\_Sup | 169.87 | <0.001 | 95.55% | 18.06 | <0.001 | 65.50% | **12.47** | **0.05** | **51.56%** |
| Temporal\_Pole\_Sup | 115.89 | <0.001 | 93.65% | 187.21 | <0.001 | 96.70% | 11.94 | 0.04 | 57.77% |
| Temporal\_Mid | 138.70 | <0.001 | 94.35% | 25.26 | <0.001 | 76.94% | 59.58 | <0.001 | 90.11% |
| Temporal\_Pole\_Mid | 237.10 | <0.001 | 96.75% | 293.89 | <0.001 | 97.55% | 78.16 | <0.001 | 91.72% |
| Temporal\_Inf | 202.23 | <0.001 | 96.12% | 313.36 | <0.001 | 98.29% | 18.94 | <0.001 | 72.83% |
| Cerebellum\_Crus1 | 111.90 | <0.001 | 93.18% | 282.58 | <0.001 | 97.19% | 31.78 | <0.001 | 79.17% |
| Cerebellum\_Crus2 | 206.75 | <0.001 | 96.15% | 324.83 | <0.001 | 97.59% | 31.81 | <0.001 | 77.87% |
| Cerebellum\_3 | 238.63 | <0.001 | 96.59% | 180.52 | <0.001 | 95.27% | 88.93 | <0.001 | 90.79% |
| Cerebellum\_4\_5 | 211.08 | <0.001 | 96.28% | 79.33 | <0.001 | 94.69% | **2.13** | **0.55** | **0.00%** |
| Cerebellum\_6 | 261.87 | <0.001 | 97.01% | 68.11 | <0.001 | 93.50% | 10.00 | 0.04 | 59.66% |
| Cerebellum\_7b | 12.31 | 0.03 | 60.26% | 200.94 | <0.001 | 97.04% | 27.31 | <0.001 | 84.10% |
| Cerebellum\_8 | 56.34 | <0.001 | 87.20% | 100.61 | <0.001 | 94.54% | **6.55** | **0.16** | **36.11%** |
| Cerebellum\_9 | 114.90 | <0.001 | 93.59% | 162.55 | <0.001 | 95.11% | **7.73** | **0.26** | **27.91%** |
| Cerebellum\_10 | 171.24 | <0.001 | 95.37% | **8.88** | **0.18** | **31.82%** | **6.92** | **0.33** | **11.41%** |

## Table S7. Function annotation based on SMD and SD.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Functional terms |  | (permutation) |
| Function annotation based on SMD | illusion | <0.001 | <0.001 |
| motion | <0.001 | <0.001 |
| moving | <0.001 | <0.001 |
| percept | <0.001 | <0.001 |
| speech sounds | 0.04 | 0.001 |
| Function annotation based on SD | auditory visual | <0.001 | <0.001 |
| communication | <0.001 | <0.001 |
| emotion | <0.001 | <0.001 |
| object recognition | <0.001 | <0.001 |
| perception | <0.001 | <0.001 |
| memory | <0.001 | <0.001 |
| language | <0.001 | <0.001 |

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