**Permutation test for the non-random modularity of the group-level networks**

Similar with previous studies (He, Chen, & Evans, 2008; Wu et al., 2012; Yao et al., 2010), a permutation test was applied to the null hypothesis that modularity (denoted as Q) of community structure achieved in a group-level network is higher than that obtained by chance. We randomly reallocated the edges of a group-level network, redetected its community structure, and recomputed the Q value. This randomization procedure was repeated 999 times and get 999 randomized Q values. Along with the original Q value, the 1000 values were sorted in a descending order and if the original Q falls into the top 5%, the null hypothesis was accepted with a probability of type I error of 0.05. The procedure was repeated at each sparsity of the brain networks.



**FIGURE S1 |** Number of isolated ROIs in the individual networks when network sparsity varied from 5% to 50%. The central line represents the group mean, while the envelope represents mean plus standard error for MCI and mean minus standard error for NC, for clarity.

**Table S1|** Definitions and descriptions of network topological metrics used in this study (Rubinov & Sporns, 2010). Here, weighted and undirected network was used.

|  |  |  |
| --- | --- | --- |
| Metrics | Definition | Discription |
| Characteristic path length (*L*) |  | Hereis the shortest weighted path length between node *i* and node *j* in a weighted network. |
| Clustering coefficient (*C*) |  | Here, is the weight between node *i* and *j*. s the degree of node *i* (the sum of weight between node *i* and its neighbors). |
| Global efficiency (*GE*) |  | The definition of is the same as aforementioned. |
| Small-worldness (*SW*) |  | For the calculation the SW of a network, we need to shuffle the edges in the network randomly for *n* times, leading to *n* random networks (in the present study, *n* was set as 1000). *Crand* and *Lrand* represent for the averaged clustering coefficient and characteristic path length, respectively. Meanwhile, *C* and *L* represent for the clustering coefficient and characteristic path length of the original network. |
| Betweenness centrality (*bc*) |  | The *bc*i is the betweenness centrality of node *i*. Here, is the number of shortest paths between node *h* and *j*, and is the number of shortest paths between h and j that passes through node *i*. |
| Modularity (*Q*) |  | is the total degree of the network (the sum of weight of all the edges in the network). Moreover, as same as with the definition of clustering coefficient, is the weight between node *i* and *j* while s the degree of node *i* (the sum of weight between node *i* and its neighbors). is the module where node *i* belongs to. If *mi* equals to *mj*, set as 1 and 0 otherwise. |

**Table S2**| List of the Anatomical Regions of Interest defined in Each Hemisphere (Tzourio-Mazoyer et al., 2002) (Rolls, Huang, Lin, Feng, & Joliot, 2020) and their abbreviations used in the present study.

|  |  |
| --- | --- |
| Anatomical description | Abbreviations |
| Central region | |
| Precentral gyrus | PreCG |
| Postcentral gyrus | PoCG |
| Rolandic operculum | ROL |
| Frontal lobe | |
| Lateral surface | |
| Superior frontal gyrus, dorsolateral | SFGdor |
| Middle frontal gyrus | MFG |
| Inferior frontal gyrus, opercular part | IFGoperc |
| Inferior frontal gyrus, triangular part | IFGtriang |
| Medial surface | |
| Superior frontal gyrus, medial | SFGmed |
| Supplementary motor area | SMA |
| Paracentral lobule | PCL |
| Orbital surface | |
| Superior frontal gyrus, orbital part | ORBsup |
| Superior frontal gyrus, medial orbital | ORBsupmed |
| Middle frontal gyrus, orbital part | ORBmid |
| Inferior frontal gyrus, orbital part | ORBinf |
| Gyrus rectus | REC |
| Olfactory cortex | OLF |
| Temporal lobe | |
| Lateral surface | |
| Superior temporal gyrus | STG |
| Heschl gyrus | HES |
| Middle temporal gyrus | MTG |
| Inferior temporal gyrus | ITG |
| Parietal lobe | |
| Lateral surface | |
| Superior parietal gyrus | SPG |
| Inferior parietal, but supramarginal and angular gyri | IPL |
| Angular gyrus | ANG |
| Supramarginal gyrus | SMG |
| Medial surface | |
| Precuneus | PCUN |
| Occipital lobe | |
| Lateral surface | |
| Superior occipital gyrus | SOG |
| Middle occipital gyrus | MOG |
| Inferior occipital gyrus | IOG |
| Medial and inferior surfaces | |
| Cuneus | CUN |
| Calcarine fissure and surrounding cortex | CAL |
| Lingual gyrus | LING |
| Fusiform gyrus | FFG |
| Limbic lobe | |
| Temporal pole: superior temporal gyrus | TPOsup |
| Temporal pole: middle temporal gyrus | TPOmid |
| Anterior cingulate and paracingulate gyri | ACG |
| Median cingulate and paracingulate gyri | MCG |
| Posterior cingulate gyrus | PCG |
| Hippocampus | HIP |
| Parahippocampal gyrus | PHG |
| Insula | INS |
| Sub cortical gray nuclei | |
| Amygdala | AMYG |
| Caudate nucleus | CAU |
| Lenticular nucleus, putamen | PUT |
| Lenticular nucleus, pallidum | PAL |
| Thalamus | THA |
| Cerebellum | |
| Crus I of cerebellar hemisphere | CERCRU1 |
| Crus II of cerebellar hemisphere | CERCRU2 |
| Lobule III of cerebellar hemisphere | CER3 |
| Lobule IV, V of cerebellar hemisphere | CER4\_5 |
| Lobule VI of cerebellar hemisphere | CER6 |
| Lobule VIIB of cerebellar hemisphere | CER7b |
| Lobule VIII of cerebellar hemisphere | CER8 |
| Lobule IX of cerebellar hemisphere | CER9 |
| Lobule X of cerebellar hemisphere | CER10 |
| Lobule I, II of vermis | VER1\_2 |
| Lobule III of vermis | VER3 |
| Lobule IV, V of vermis | VER4\_5 |
| Lobule VI of vermis | VER6 |
| Lobule VII of vermis | VER7 |
| Lobule VIII of vermis | VER8 |
| Lobule IX of vermis | VER9 |
| Lobule X of vermis | VER10 |

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