**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*) | $$L=\frac{1}{N(N-1)} \sum\_{i=1}^{N}\sum\_{j\ne i}^{N}d\_{ij}^{w}$$ | Here$, d\_{ij }^{w}$is the shortest weighted path length between node *i* and node *j* in a weighted network.  |
| Clustering coefficient (*C*) | $$C=\frac{1}{N}\sum\_{i=1}^{N}\frac{\sum\_{j,h=1}^{N}\left(w\_{ij}w\_{ih}w\_{jh}\right)^{^{1}/\_{3}}}{k\_{i}^{w}(k\_{i}^{w}-1)}$$ | Here, $w\_{ij }$is the weight between node *i* and *j*. $k\_{i}^{w} i$s the degree of node *i* (the sum of weight between node *i* and its neighbors).  |
| Global efficiency (*GE*) | $$GE=\frac{1}{N(N-1)}\sum\_{i=1}^{N}\sum\_{j\ne i}^{N}(d\_{ij}^{w})^{-1}$$ | The definition of $d\_{ij}^{w} $is the same as aforementioned.  |
| Small-worldness (*SW*) | $$SW=\frac{{C}/{C\_{rand}}}{{L}/{L\_{rand}}}$$ | 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*) | $$bc\_{i}=\frac{1}{(n-1)(n-2)}\sum\_{\begin{array}{c}h,j\in N\\h\ne j,h\ne i,\\j\ne i\end{array}}^{}\frac{ρ\_{hj}^{(i)}}{ρ\_{hj}}$$ | The *bc*i is the betweenness centrality of node *i*. Here, $ρ\_{hj}$ is the number of shortest paths between node *h* and *j*, and $ρ\_{hj}^{(i)}$ is the number of shortest paths between h and j that passes through node *i*. |
| Modularity (*Q*) | $$Q=\frac{1}{l^{w}}\sum\_{i,j=1}^{N}\left[w\_{ij}-\frac{k\_{i}^{w}k\_{j}^{w}}{l^{w}}\right]δ\_{m\_{i}, m\_{j}}$$ | $l^{w} $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, $w\_{ij }$is the weight between node *i* and *j* while $k\_{i}^{w} i$s the degree of node *i* (the sum of weight between node *i* and its neighbors). $ m\_{i} $is the module where node *i* belongs to. If *mi* equals to *mj*, set $δ\_{m\_{i}, m\_{j}}$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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