Table S1

The list of the 90 anatomical regions used to construct the brain networks

Index	Regions	Abbreviation	Index	Regions	Abbreviation
1, 2	Precentral gyrus	PreCG	47, 48	Lingual gyrus	LING
3, 4	Superior frontal gyrus (dorsal)	SFGdor	49, 50	Superior occipital gyrus	SOG
5, 6	Orbital frontal cortex (superior)	ORBsup	51, 52	Middle occipital gyrus	MOG
7, 8	Middle frontal gyrus	MFG	53, 54	Inferior occipital gyrus	IOG
9, 10	Orbital frontal cortex (middle)	ORBmid	55, 56	Fusiform gyrus	FFG
11, 12	Inferior frontal gyrus (opercula)	IFGoperc	57, 58	Postcentral gyrus	PoCG
13, 14	Inferior frontal gyrus (triangular)	IFGtriang	59, 60	Superior parietal gyrus	SPG
15, 16	Orbital frontal cortex (inferior)	ORBinf	61, 62	Inferior parietal lobule	IPL
17, 18	Rolandic operculum	ROL	63, 64	Supramarginal gyrus	SMG
19, 20	Supplymentary motor area	SMA	65, 66	Angular gyrus	ANG
21, 22	Olfactory	OLF	67, 68	Precuneus	PCUN
23, 24	Superior frontal gyrus (Medial)	SFGmed	69, 70	Paracentral lobule	PCL
25, 26	Orbital frontal cortex (Medial)	ORBmed	71, 72	Caudate	CAU
27, 28	Rectus gyrus	REC	73, 74	Putamen	PUT
29, 30	Insular	INS	75, 76	Pallidum	PAL
31, 32	Anterior cingulum gyrus	ACG	77, 78	Thalamus	THA
33, 34	Middle cingulum gyrus	MCG	79, 80	Heschl gyrus	HES
35, 36	Posterior cingulum gyrus	PCG	81, 82	Superior temporal gyrus	STG
37, 38	Hippocampus	HIP	83, 84	Temporal pole (superior)	TPOsup
39, 40	Parahippocampal gyrus	PHG	85, 86	Middle temporal gyrus	MTG
41, 42	Amygdala	AMYG	87, 88	Temporal pole (middle)	TPOmid
43, 44	Calcarine cortex	CAL	89, 90	Inferior temporal gyrus	ITG
45, 46	Cuneus	CUN			

90 ROIs are obtained from the Automated Anatomical Labeling (AAL) brain atlas (Tzourio-Mazoyer et al. , 2002). Odd numbers of index refer to regions in the left hemisphere, and even numbers of index refer to the regions in the right hemisphere.

Table S2

Details of measures by HAMD in MDD patients

Case	Total score	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Helplessness item	Hopelessness item	Worthlessness item
1	23	5	0	2	1	7	2	5	3	1	1
2	27	6	1	1	2	9	3	4	2	1	1
3	23	3	1	1	1	7	4	2	1	0	1
4	34	8	2	3	2	9	2	9	4	2	3
5	33	6	0	7	1	9	3	6	4	1	1
6	35	8	1	2	2	8	6	8	4	1	3
7	22	3	1	6	1	6	3	3	2	0	1
8	37	8	2	4	1	11	6	3	2	0	1
9	37	9	2	5	1	10	5	4	2	1	1
10	20	3	1	4	1	6	3	3	2	0	1
11	34	8	2	7	0	7	5	5	3	1	1
12	49	11	2	9	1	9	6	10	4	2	4
13	34	6	2	4	2	9	6	4	2	0	2
14	36	8	2	3	2	9	2	9	4	2	3
15	26	2	0	6	2	8	3	4	2	1	1
16	24	3	2	1	1	7	4	5	3	0	2

The total score is based on 24-item version of Hamilton Depression Scale (HAMD), which measures the illness severity. The HAMD scale is consisted of seven factors, which measure seven symptom groups, e.g., factor 1 - anxiety/somatization, factor 2 - change of weight, factor 3 - cognitive dysfunction, factor 4 - atypical circadian rhythm, factor 5 - retardation, factor 6 - sleep disorder, and factor 7 - desperation. And, the factor desperation includes three items, helplessness, hopelessness, and worthlessness (Zhang, 1998).

Table S3

List of impaired connections in the sub-network, detected by NBS in MDD group, compared to control group

Region A	Region B	Regional correlation (*r*, mean)		Significance (*p*)
		MDD	Control	
SMA.L	OLF.R	0.1105	0.2769	0.0027
INS.L	HIP.L	0.2273	0.3805	0.0041
SMA.L	CUN.L	0.1948	0.4058	0.0007
INS.L	SOG.L	0.1803	0.3412	0.0019
IFGoperc.L	SOG.R	0.1084	0.2847	0.0019
SMA.L	SOG.R	0.1863	0.3575	0.0023
INS.L	SOG.R	0.1992	0.3693	0.0022
INS.R	SOG.R	0.1990	0.3746	0.0015
ORBsup.R	SMG.R	0.1818	0.3466	0.0003
ORBmid.R	SMG.R	0.2556	0.4456	0.0036
OLF.L	SMG.R	0.1093	0.2604	0.0020
OLF.R	SMG.R	0.1282	0.2931	0.0008
AMYG.R	SMG.R	0.1552	0.3486	0.0016
ORBmid.R	ANG.R	0.3437	0.5639	0.0021
ORBmid.L	PUT.L	0.2235	0.4209	0.0035
AMYG.R	PUT.L	0.4695	0.7023	0.0017
SMG.R	PUT.L	0.2215	0.4156	0.0021
ORBmid.L	PUT.R	0.2296	0.4156	0.0028
IPL.R	PUT.R	0.1382	0.3268	0.0031
SMG.R	PAL.R	0.2035	0.4004	0.0025
SMA.L	THA.R	0.2410	0.4356	0.0034
SMG.R	TPOsup.L	0.2458	0.4364	0.0007
AMG.L	ITG.R	0.2093	0.3722	0.0028
PUT.R	ITG.R	0.2153	0.4161	0.0023

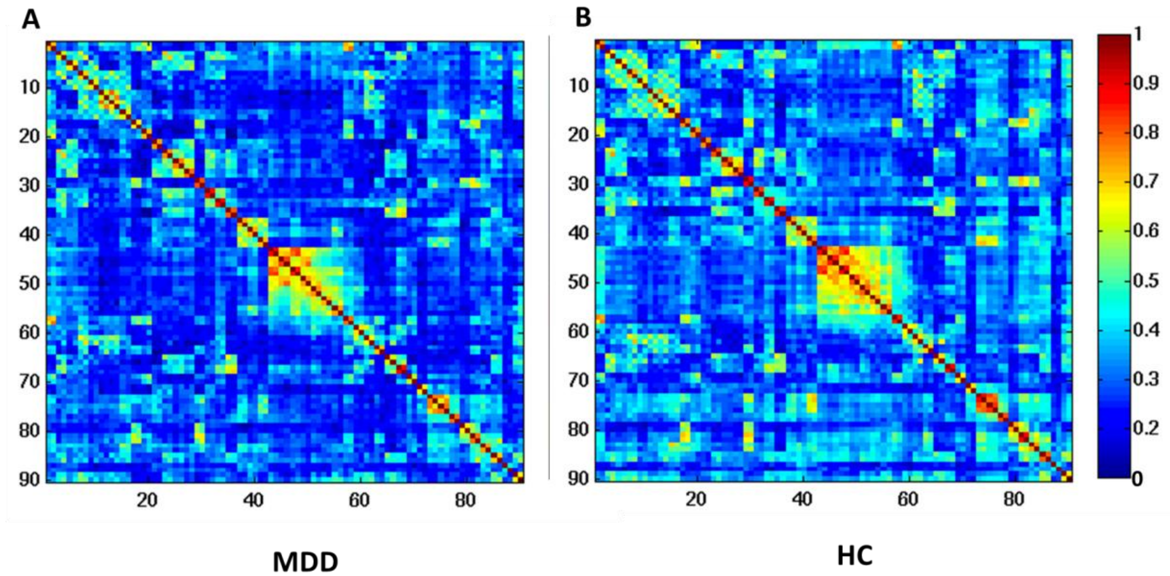

Fig. S1. The illustration of mean correlation matrices of both major depression disorder (MDD) and health control (HC) groups.

Functional network construction based on wavelet

The maximal overlap discrete wavelet transform method was first employed to decompose each individual regional-mean fMRI time series into 4 wavelet scales: scale 1, 0.125–0.250 Hz; scale 2, 0.060–0.125 Hz; scale 3, 0.030–0.060 Hz; and scale 4, 0.015–0.030 Hz(Percival and Walden, 2006). As initial analysis found that the significant group difference of wavelet correlation is mainly observed in scale 2(Lynall et al. , 2010), the scale 2 was used in the subsequent analysis. Then, the Pearson correlation coefficients between all pairs of 90 brain regions were calculated based on the wavelet coefficients (Wang et al. , 2013). The brain correlation matrices were obtained in the native space. After registering a brain template to each individual brain, we will have brain regions defined in individual native space. From that, we calculate the correlation matrices for each subject in native space. Finally, a 90×90 correlation matrix was obtained for each subject (with the matrix figure shown in Fig. S1).

Small-world Analysis

Individual correlation matrices were transformed to binary format at a wide range of network sparsity levels for further evaluation. The criteria we adopted is that, at the smallest sparsity, the average number of connections linked to each node is larger than 2xlog(*N*), where N = 90(Zhang et al. , 2011). At the highest sparsity, the small-worldness scalar is larger than 1.6. Finally, the sparsity range between 0.11 and 0.38 was determined as the small-world regime with an interval of 0.01.

Both clustering coefficient C_p and characteristic path length L_p were used to measure the properties of small-worldness (Watts and Strogatz, 1998). The clustering coefficient C_i mesures the ratio of the number of existing connections among the *i*-th node's neighbors and all their possible connections. C_p is the average of clustering coefficients over all nodes in a network. L_p is the shortest path length transferring from one node to another among all pairs of nodes in a network, which indicates the overall routing efficiency in the network (Watts and Strogatz, 1998).

Based on Latora and Marchiori's model (Latora and Marchiori, 2001), the global efficiency of the graph *G* with *N* nodes and *K* edges is defined as follows:

$$E_{glob}(G) = \frac{1}{N(N-1)} \sum_{i \neq j \in G} \frac{1}{d_{ij}},$$

where d_{ij} is the shortest path length between node *i* and node *j* in *G*.

The following equation computes the local efficiency of a network *G*:

$$E_{loc}(G) = \frac{1}{N}\sum E_{glob}(G_i),$$

where $E_{glob}(G_i)$ is the global efficiency of G_i, a sub-graph of the neighbors of node *i*.

Network Modularity Analysis

The property of modularity in a network is proposed by Newman and Girvan (Newman and Girvan, 2004). The maximum network modularity *Q*(*m*) is defined as below:

$$Q(m) = \sum_{s=1}^{n_m}\left[\frac{h_s}{L} - \left(\frac{T_s}{2L}\right)^2\right],$$

where *m* is the configuration of modular organization with n_m modules, h_s is the sum of the edge weights between nodes in module *s*, *L* is the total weight of edges of this graph, T_s is the sum of the weights of nodes in module *s*. The node weight is defined as the sum of edge weights connecting the node. An optimum network partition *m* is determined by assigning the nodes into a number of modules that achieve the maximum network modularity *Q*(*m*).

The participation coefficient (PC) and intra-module degree (MD) for each node are used as indices for inter- and intra-module connection densities, respectively (Guimera and Nunes Amaral, 2005). For a node *i* in module *s*, the participation coefficient, PC_i, is measured by the regional inter-module connectivity of node *i*. The PC of node *i* will be close to 0 if all weights are largely intramodular. The PC_i is defined as:

$$PC_i = 1 - \sum_{s=1}^{N_M} (w_{is}/w_i),$$

where N_M is the number of modules; w_{is} is the sum of edge weights between the node *i* and module *s*; w_i is the total weight of node *i* in the network. And, its intra-module degree, MD_i, is measured by its regional intra-module connectivity w_i, scaled by the average and standard deviation of intra-modular degree for all nodes in the module. The MD_i is defined by the equation:

$MD_i = (w_i - \overline{W_s})/\sigma_s$, where w_i is the regional intra-module connectivity; the $\overline{W_s}$ and σ_s are the average and standard deviation, respectively (Rubinov and Sporns, 2010).

Network Based Statistic Analysis

The network based statistic (NBS) approach was used to localize any sub-network with multiple pairwise regional correlations significantly altered in the major depressive disorder (MDD), compared to health controls (Zalesky et al. , 2010). To promote normality, Fisher's *r*-to-*z* transform was first applied to individual correlation matrices in an element-by-element manner (Press et al. , 1992). Then, a set of suprathreshold links were tested by the *t*-statistic (two-sample one-tailed *t*-tests), and thresholding with $p < 0.05$ (corrected). Any connected components and their size (e.g., the number of links) were detected within the set of suprathreshold links. The significance of a component was assessed based on its size. Specifically, for a connected component of size M, the corrected *p*-value was determined by finding the proportion of the 5000 permutations for which the maximal connected component was larger than M (Zalesky and Fornito, 2010).

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