ON-LINE APPENDIX

Graph Theoretical Measures

Network Strength. The connectivity strength (S_i) of node i is defined as the sum of weights of the edges that are directly connected to node i:

$$S_i = \sum_{j \in G} w_{ij},$$

where w_{ij} is the edge weight between node i and j. The network strength S_p is defined as the average of the strengths over all nodes in the graph:

$$S_p = \frac{1}{N}\sum_{i \in G} S_i.$$

Clustering Coefficient. This measure reflects functional segregation of brain networks, which is a measure of the propensity of the brain to execute specialized processes within interconnected groups of brain regions or clusters.[20] The clustering coefficient of a node i, C_i, defined as the fraction of node i neighbors that are connected to each other,[21] is calculated as follows:

$$C_i = \frac{2}{k_i(k_i - 1)} \sum_{j,\, k \in G,\, j,\, k \neq i} (w_{ij} w_{jk} w_{ki})^{1/3,}$$

where, k_i is the number of edges linking to node i (ie, the degree of node i) and w is the weight. If node i is either isolated or has only 1 connection (ie, $k_i = 0$ or 1) then $C_i = 0$.

The average clustering coefficient of a graph, C_p, reflects the extent of local interconnectivity in a network, with a high clustering coefficient indicating that the neighbors of a node are directly connected to each other[21]:

$$C_p = \frac{1}{N}\sum_{i \in G} C_i.$$

Characteristic Path Length. A path between 2 nodes, i and j, is a sequence of distinct nodes and links between them that connect the 2 nodes. In a weighted graph, edge length is computed as the reciprocal of edge weight (ie, $1/w_{ij}$) and path length between a pair of nodes is defined as the sum of edge lengths along the path. The shortest path length, L_{ij}, is defined as the length of the path with minimum sum of edge lengths among all the paths between the 2 nodes i and j. The characteristic path length of a weighted graph, L_p, is defined as the mean of the shortest path length between all pairs of nodes:

$$L_p = \frac{1}{N(N-1)} \sum_{i \neq j \in G} L_{ij}.$$

L_p is the most commonly used measure of functional integration and quantifies the ability of the network to propagate information in parallel.[20]

Global Efficiency. Global efficiency is the inverse of the characteristic path length of a weighted network and is another measure of functional integration. It reflects how efficiently information can be exchanged over the whole network, with larger global efficiency indicating a more efficient network:

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

Small-World Parameters. Small-world networks are defined as networks that have a characteristic path length similar to those of random networks but are significantly more clustered than random networks.[21] The degree of "small-worldness" of a network can be assessed by using a normalized clustering coefficient γ and normalized characteristic path length λ, which measures the clustering coefficient and the characteristic path length of real networks relative to random networks. To calculate these 2 parameters, we first binarized the connectivity matrices by setting all connections where at least 1 tract was reconstructed to 1 and all others to zero. We then generated 100 random networks while preserving the number of nodes and edges of each binary connectivity matrix. The clustering coefficient ($C_p{}^{real}$) and characteristic path length ($L_p{}^{real}$) of each subject were then compared with the mean clustering coefficient ($C_p{}^{rand}$) and mean characteristic path length ($L_p{}^{rand}$) of the 100 random networks as follows:

$$\gamma = \frac{C_p^{real}}{C_p^{rand}},\ \lambda = \frac{L_p^{real}}{L_p^{rand}}.$$

The small-worldness of a network can be summarized into a scalar quantitative measurement, which is the ratio of γ/λ. $\sigma > 1$ indicates that the network has small-world property.

Nodal Efficiency. Nodal efficiency is the reciprocal of the harmonic mean of the shortest path length between node i and all other nodes in the network.[22] The nodal efficiency quantifies the importance of the nodes for communication within the network. The nodes with high nodal efficiencies can be categorized as hubs in a network.[22]

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

On-line Table 1: Brain regions with significant nodal efficiency of all patients with epilepsy, frontal lobe epilepsy, and temporal lobe epilepsy relative to controls

	Enodal Controls	Enodal All Epilepsy	Enodal FLE	Enodal TLE
L precentral gyrus	0.0362		0.0352 ($P = .0177$)	
L dorsolateral superior frontal gyrus	0.0391		0.0379 ($P = .0074$)[a]	
L orbital superior frontal gyrus	0.0442	0.0428 ($P = .0344$)	0.0425 ($P = .0266$)	
L middle frontal gyrus	0.0376		0.0364 ($P = .0085$)	
L orbital middle frontal gyrus	0.0403		0.0391 ($P = .0335$)	
R orbital middle frontal gyrus	0.0373	0.036 ($P = .0213$)	0.0357 ($P = .0161$)	
L triangular inferior frontal gyrus	0.0367	0.0357 ($P = .0225$)	0.0354 ($P = .0067$)	
L orbital inferior frontal gyrus	0.0409	0.0392 ($P = .0033$)	0.039 ($P = .0021$)	
R orbital inferior frontal gyrus	0.0369		0.0355 ($P = .0402$)	
L rolandic operculum	0.039		0.0378 ($P = .0448$)	
R rolandic operculum	0.0383	0.0372 ($P = .0268$)	0.0365 ($P = .003$)	
L olfactory cortex	0.0453	0.0431 ($P = .0085$)	0.0429 ($P = .0161$)	0.0431 ($P = .0164$)
R olfactory cortex	0.0459	0.044 ($P = .0111$)	0.0439 ($P = .0295$)	0.0439 ($P = .0164$)
L medial superior frontal gyrus	0.0391	0.038 ($P = .0047$)	0.0376 ($P = .0027$)	
R medial superior frontal gyrus	0.0379	0.0367 ($P = .0044$)	0.0366 ($P = .0045$)	0.0368 ($P = .0377$)
L medial orbital superior frontal gyrus	0.0401		0.0389 ($P = .0487$)	
R medial orbital superior frontal gyrus	0.0405	0.0393 ($P = .0279$)	0.0392 ($P = .0455$)	
L gyrus rectus	0.0486	0.0469 ($P = .0269$)	0.0468 ($P = .0446$)	
L insula	0.0415	0.0402 ($P = .0313$)	0.0401 ($P = .0422$)	
R insula	0.0389		0.0373 ($P = .0266$)	
L anterior cingulate	0.0444	0.043 ($P = .007$)	0.0428 ($P = .0115$)	0.0429 ($P = .0095$)
R anterior cingulate	0.044	0.0424 ($P = .0003$)[a]	0.0424 ($P = .0015$)	0.0423 ($P = .0021$)
L hippocampus	0.028	0.021 ($P = .0001$)[a]	0.0207 ($P = .0013$)	0.0212 ($P = .0119$)
R hippocampus	0.0311	0.0252 ($P = .0001$)[a]	0.025 ($P = .0022$)	0.0257 ($P = .0199$)
L parahippocampal gyrus	0.0465	0.0424 ($P < .0001$)[a]	0.0418 ($P = .0001$)[a]	0.0435 ($P = .0205$)
R parahippocampal gyrus	0.0477	0.0438 ($P < .0001$)[a]	0.0435 ($P = .0001$)[a]	0.044 ($P = .0038$)
L amygdala	0.0375	0.0278 ($P < .0001$)[a]	0.0282 ($P < .0001$)[a]	0.0276 ($P = .0001$)[a]
R amygdala	0.0412	0.0338 ($P < .0001$)[a]	0.0338 ($P < .0001$)[a]	0.0331 ($P = .0001$)[a]
L pericalcarine fissure cortex	0.0543	0.0526 ($P = .019$)	0.0518 ($P = .0027$)	
R pericalcarine fissure cortex	0.0554	0.054 ($P = .0393$)	0.0535 ($P = .0142$)	
L cuneus	0.051		0.0492 ($P = .0274$)	
L lingual gyrus	0.053	0.0513 ($P = .0174$)	0.0505 ($P = .0012$)	
R lingual gyrus	0.0534	0.0517 ($P = .0095$)	0.0511 ($P = .0014$)	
L superior occipital gyrus	0.0472		0.0456 ($P = .0208$)	
L middle occipital gyrus	0.0458		0.0442 ($P = .009$)	
R middle occipital gyrus	0.0432			0.0447 ($P = .0159$)
L inferior occipital gyrus	0.0437		0.0418 ($P = .0016$)	
R inferior occipital gyrus	0.0388		0.0375 ($P = .0103$)	
L fusiform gyrus	0.0524	0.0502 ($P = .0094$)	0.0495 ($P = .0009$)[a]	
R fusiform gyrus	0.0525	0.0502 ($P = .0016$)	0.0497 ($P = .0004$)[a]	
L Heschl gyrus	0.0455		0.0437 ($P = .0121$)	
R Heschl gyrus	0.0451		0.0435 ($P = .0206$)	
L superior temporal gyrus	0.0464		0.0449 ($P = .0225$)	
R superior temporal gyrus	0.0454		0.0438 ($P = .0068$)	
L temporal pole superior temporal gyrus	0.0392	0.0365 ($P = .0006$)[a]	0.0358 ($P = .0004$)[a]	
R temporal pole superior temporal gyrus	0.0382	0.0345 ($P < .0001$)[a]	0.0344 ($P = .0001$)[a]	0.0344 ($P = .0009$)[a]
L middle temporal gyrus	0.0441		0.0427 ($P = .0178$)	
R middle temporal gyrus	0.0423	0.0414 ($P = .0277$)	0.0406 ($P = .0009$)[a]	
L temporal pole middle temporal gyrus	0.0358	0.0341 ($P = .0226$)	0.0334 ($P = .0043$)	
R temporal pole middle temporal gyrus	0.0321	0.0303 ($P = .0035$)	0.0302 ($P = .0088$)	0.0305 ($P = .017$)
L inferior temporal gyrus	0.0447	0.0432 ($P = .014$)	0.0426 ($P = .002$)	
R inferior temporal gyrus	0.043	0.0417 ($P = .0145$)	0.0413 ($P = .0035$)	

Note:—L indicates left; R, right; Enodal, significant nodal efficiency.
[a] $P \leq .001$.

On-line Table 2: **Network-based statistics demonstrating reduced subnetwork connections in patients with epilepsy, frontal lobe epilepsy, and temporal lobe epilepsy relative to controls**

Subnetwork	Patients with Epilepsy	Patients with FLE	Patients with TLE
Frontal-temporal	Right inferior frontal gyrus to left inferior temporal gyrus Left olfactory cortex to left middle temporal gyrus	Left olfactory cortex to left hippocampus Right orbital superior frontal gyrus to left parahippocampal gyrus	Left olfactory cortex to left amygdala Right olfactory cortex to right amygdala Right fusiform gyrus to left paracentral lobule
Insula-temporal	Left insula to left superior temporal gyrus	Left insula to left amygdala	Left insula to left superior temporal gyrus Right insula to right superior temporal gyrus Left insula to left amygdala
Temporal-temporal	Left hippocampus to right fusiform gyrus Left parahippocampal gyrus to right fusiform gyrus Right hippocampus to left superior temporal gyrus Right hippocampus to right middle temporal gyrus Right parahippocampal gyrus to right superior temporal gyrus Right parahippocampal gyrus to left inferior temporal gyrus Left amygdala to left superior temporal gyrus Right amygdala to right superior temporal gyrus Left superior temporal gyrus to left middle temporal gyrus Left fusiform gyrus to right superior temporal gyrus Left middle temporal gyrus to left inferior temporal gyrus	Left hippocampus to right hippocampus Left hippocampus to left parahippocampal gyrus Left hippocampus to left amygdala Right hippocampus to left amygdala Left hippocampus to right amygdala Right hippocampus to right amygdala Left amygdala to left superior temporal gyrus Right amygdala to right superior temporal gyrus Left parahippocampal gyrus to left amygdala Right parahippocampal gyrus to left amygdala Right parahippocampal gyrus to right amygdala Left fusiform gyrus to right superior temporal gyrus	Left hippocampus to left amygdala Left parahippocampal gyrus to left amygdala Right parahippocampal gyrus to right amygdala Left amygdala to left superior temporal gyrus Left hippocampus to right fusiform gyrus Right parahippocampal gyrus to right superior temporal gyrus
Frontal-occipital	Left precentral gyrus to left precuneus Left inferior frontal gyrus to left precuneus Left insula to left precuneus Right superior frontal gyrus to right precuneus Right middle frontal gyrus to right precuneus		
Temporal-occipital	Left lingual gyrus to right fusiform gyrus Left amygdala to left precuneus Right superior occipital gyrus to left superior temporal gyrus Left inferior occipital gyrus to left superior temporal gyrus Right calcarine cortex to right middle temporal gyrus Left inferior occipital gyrus to left inferior temporal gyrus	Left hippocampus to left lingual gyrus Right parahippocampal gyrus to left lingual gyrus Left hippocampus to left inferior occipital gyrus Left inferior occipital gyrus to left superior temporal gyrus	Left hippocampus to left lingual gyrus Right parahippocampal gyrus to left lingual gyrus
Occipital-occipital		Left middle occipital gyrus to left inferior occipital gyrus	
Frontal-occipital			Left olfactory cortex to right lingual gyrus