**Supporting Information for**

Hemispheric functional organization, as revealed by naturalistic neuroimaging, in pediatric epilepsy patients with cortical resections

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Supporting Information

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**Supporting Information Text**

**Subhead.** Type or paste text here. This should be additional explanatory text such as an extended technical description of results, full details of mathematical models, etc. Supporting information text for Brief Reports is limited to extended methods only.

**Heading**

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A circular diagram of a diagram

Description automatically generated with medium confidence

**Figure S1**. Schematic of the organization of the 22 networks from the Glasser atlas in the chord diagrams. The 8 labels on the outside of the circle were labelled by anatomical, functional, or lobar descriptions for visualization purposes. The 22 labels were taken from the HCP atlas.1

A comparison of a diagram

Description automatically generated with medium confidence

**Figure S2**. Edgewise group differences within and between the 7-level Schaefer-defined networks in the preserved (A) LH and (B) RH patients relative to the matched hemisphere of controls. Only group differences that survived multiple comparisons correction are shown. Arcs on the circumference on each circle signal z-ratio contrasts in within-network connections. Chords between arcs signify z-ratio contrasts in between-network connections. For between-network edges, the thickness of an edge represents the relative proportion of the z-ratio difference for that edge compared to the sum of z-ratio differences across all significantly different between-network edges, including those significant before correction. Comparisons were corrected separately for the two hemisphere groups with an FDR < 0.05. The percentage of within- and between-network edges in patients that significantly differed from controls after correction were included below the chord diagrams.

**A diagram of a patient

Description automatically generated**

**Figure S3**. Chord diagrams illustrating the patient group-level edgewise differences for the 7-level Schaefer-defined networks, separately by (A) edges with positive normalized values (i.e., greater than the control mean) and (B) edges with negative normalized values (i.e., lower than the control mean). Arcs on the circumference of each circle signify contrasts in within-network connections. Edges between arcs signify contrasts in between-network connections. For each between-network edge, the thickness represents the relative proportion of the z-ratio difference for that edge relative to the sum of z-ratio differences across all between-network edges that significantly differed across the two patient groups. The color of each edge signifies the absolute normalized mean of the patient group that was further from controls (larger absolute value). Only edges that are significantly different across hemispheres after multiple comparisons correction with an FDR < 0.05 are shown. The percentage of within- and between-network edges in patients that significantly differed from controls after correction were included below the chord diagrams, enumerating how many edges had a greater absolute value, or distance from controls, in each patient group.

**SI References**

1. Glasser, M. F. *et al.* A multi-modal parcellation of human cerebral cortex. *Nature* **536**, 171–178 (2016).

**Table S1**. Additional clinical details of patient cohort.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ID | Years since surgery  at test | Estimated lesion proportion\* | Seizure type(s)† | Cognitive Ability | Visual/auditory impairments | Co-morbidities |
| R1 | 8 | 379,198/ 1,403,236 | generalized; infantile spasms; focal | average | amblyopia, hemianopia | autism, ADHD, PTSD, anxiety |
| R2 | 5 | 11,182/ 1,278,343 | focal; focal with generalization | mildly impaired |  | specific learning disorder with impairments in math |
| R3 | 2 | 191,782/ 1,200,331 | generalized | mildly impaired | hemianopia |  |
| R4 | 1 | 17,148/ 1,622,926 | focal | low average to average |  | ADHD |
| R5 | 2 | 304,941/ 1,261,593 | focal | moderately impaired | strabismus, amblyopia | aphasia, dyscalculia, dysgraphia |
| R6 | 15 | 56,312/ 1,905,747 | focal | slightly above average |  |  |
| R7 | 10 | 30,908/ 1,231,497 | focal, secondary generalization | low average to average |  | ADHD, PTSD, anxiety |
| L1 | 2 | 155,997/ 1,080,147 | unknown | mildly impaired | hemianopia |  |
| L2 | 4 | 201,845/ 1,155,499 | generalized | average | amblyopia, hemianopia, blindness in right eye, nystagmus |  |
| L3 | 1 | 14,427/ 1,374,804 | unknown | average |  | anxiety |
| L4 | 16, 10 | 310,158/ 1,085,098 | unknown | slightly above average | hemianopia; central auditory processing issues |  |
| L5 | 6 | 31,395/ 1,688,373 | febrile and focal | low average to average | left lower quadrantanopia | pervasive developmental disorder NOS; ADHD |
| L6 | 15 | 10,960/ 1,661,863 | focal, secondary generalization | low average |  | ADHD |
| L7 | 9 | 761,794/ 1,622,457 | focal | mildly impaired | hemianopia | dysthymia, mild neurocognitive disorder |

ADHD = attention-deficit/hyperactivity disorder, PTSD = post-traumatic stress disorder, NOS = not otherwise specified

\*Lesion voxels (numerator) were measured by calculating the binary voxels in masks manually drawn in MRICron. Total voxels (denominator) were approximated by counting non-zero voxels of skull-stripped T1-weighted volumes, adding the lesion voxel count, and subtracting any voxels that overlapped.

†Seizures classified as focal, generalized, or unknown; several patients had multiple types of semiologies within these classifications.

**Table S2**. Glasser atlas comparisons of connection type (within/between) and group (patient/control) with separate models for each matched hemisphere analysis (left and right) between patients and control and for the across-hemisphere analysis between the two patient groups after normalization to the control means of each hemisphere. Estimates are estimated marginal means, confidence intervals (CI) were 95th percentile, and p-values from the linear mixed effects models were approximated using the Satterthwaite method. Predictors with p-values below 0.05 were bolded.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Glasser Atlas |  |  |  | |
|  | Left Hemisphere Comparisons | | |
| *Predictors* | *Estimates* | *CI* | *p* | |
| (Intercept) | 0.121 | 0.111 – 0.131 | **<0.001** | |
| Group effect | -0.014 | -0.034 – 0.006 | 0.165 | |
| **Connection Type effect** | 0.113 | 0.112 – 0.114 | **<0.001** | |
| Age, centered | -0.001 | -0.002 – 0.000 | 0.174 | |
| Sex | -0.010 | -0.024 – 0.005 | 0.184 | |
| **Group \* Connection Type** | -0.003 | -0.006 – 0.001 | **0.018** | |
|  |  |  |  | |
|  | Right Hemisphere Comparisons | | |
| *Predictors* | *Estimates* | *CI* | *p* | |
| (Intercept) | 0.131 | 0.123 – 0.138 | **<0.001** | |
| Group effect | -0.011 | -0.026 – 0.004 | 0.137 | |
| **Connection Type effect** | 0.112 | 0.111 – 0.113 | **<0.001** | |
| **Age, centered** | -0.001 | -0.002 – 0.000 | **0.029** | |
| **Sex** | -0.050 | -0.024 – 0.004 | **0.005** | |
| **Group \* Connection Type** | -0.008 | -0.011 – 0.006 | **<0.001** | |
|  |  |  |  | |
|  | Z-score Normalized Hemisphere Comparisons | | |
| *Predictors* | *Estimates* | *CI* | *p* | |
| (Intercept) | -0.130 | -0.698 – 0.437 | 0.652 | |
| Hemisphere effect | 0.053 | -0.545 – 0.650 | 0.863 | |
| Connection Type effect | 0.012 | -0.016 – 0.040 | 0.407 | |
| Age, centered | 0.000 | -0.050 – 0.049 | 0.985 | |
| Sex | -0.227 | -0.868 – 0.414 | 0.488 | |
| **Hemisphere \* Connection Type** | -0.101 | -0.141 – -0.061 | **<0.001** | |

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**Table S3**. Schaefer atlas comparisons of connection type (within/between) and group (patient/control) with separate models for each matched hemisphere analysis (left and right) between patients and control and for the across-hemisphere analysis between the two patient groups after normalization to the control means of each hemisphere. Estimates are estimated marginal means, confidence intervals (CI) were 95th percentile, and p-values from the linear mixed effects models were approximated using the Satterthwaite method. Predictors with p-values below 0.05 were bolded.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Schaefer Atlas |  |  |  | |
|  | Left Hemisphere Comparisons | | | |
| *Predictors* | *Estimates* | *CI* | *p* | |
| (Intercept) | 0.112 | 0.101 – 0.123 | **<0.001** | |
| Group effect | -0.022 | -0.044 – 0.001 | 0.056 | |
| **Connection Type effect** | 0.069 | 0.068 – 0.069 | **<0.001** | |
| **Age, centered** | -0.001 | -0.002 – -0.000 | **0.030** | |
| Sex | -0.013 | -0.029 – 0.003 | 0.122 | |
| **Group \* Connection Type** | -0.015 | -0.016 – -0.014 | **<0.001** | |
|  |  |  |  | |
|  | Right Hemisphere Comparisons | | | | | |
| *Predictors* | *Estimates* | *CI* | | *p* | | |
| (Intercept) | 0.119 | 0.109 – 0.128 | | **<0.001** | |
| Group effect | -0.013 | -0.032 – 0.005 | | 0.162 | |
| **Connection Type effect** | 0.066 | 0.065 – 0.066 | | **<0.001** | |
| **Age, centered** | -0.001 | -0.002 – -0.000 | | **0.010** | |
| **Sex** | -0.016 | -0.029 – -0.003 | | **0.018** | |
| **Group \* Connection Type** | -0.006 | -0.007 – -0.005 | | **<0.001** | |
|  |  |  | |  | |
|  | Z-score Normalized Hemisphere Comparisons | | | |
| *Predictors* | *Estimates* | *CI* | *p* | | | |
| (Intercept) | -0.347 | -0.999 – 0.306 | 0.298 | |
| Hemisphere effect | 0.186 | -0.502 – 0.874 | 0.596 | |
| **Connection Type effect** | -0.109 | -0.123 – -0.096 | **<0.001** | |
| Age, centered | 0.016 | -0.042 – 0.073 | 0.590 | |
| Sex | -0.125 | -0.863 – 0.613 | 0.739 | |
| **Hemisphere \* Connection Type** | 0.059 | 0.040 – 0.079 | **<0.001** | |

**Table S4**. Planned comparisons of connection type (within/between) and group (patient/control) with separate models for each matched hemisphere analysis (left and right) between patients and control and for the across-hemisphere analysis between the two patient groups after normalization to the control means of each hemisphere. EMM is estimated marginal mean, SE is standard error of the mean, and p-values from the linear mixed effects models were approximated using the Satterthwaite method. Predictors with p-values below 0.05 were bolded.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Glasser Atlas |  |  |  |  |  |  |
|  | Left Hemisphere | | | Right Hemisphere | | |
| *Planned Contrasts* | *EMM* | *SE* | *p* | *EMM* | *SE* | *p* |
| Within control – patient | 0.017 | 0.010 | 0.093 | 0.020 | 0.010 | **0.011** |
| Between control – patient | 0.014 | 0.010 | 0.165 | 0.011 | 0.010 | 0.137 |
| **Patient between – within** | -0.110 | 0.0012 | **<0.0001** | -0.104 | 0.0012 | **<0.0001** |
| **Control between – within** | -0.113 | 0.0005 | **<0.0001** | -0.112 | 0.0005 | **<0.0001** |
|  |  |  |  |  |  |  |
|  | Normalized Patients | | |  |  |  |
| *Planned Contrasts* | *EMM* | *SE* | *p* |  |  |  |
| Within left – right | 0.048 | 0.3055 | 0.8741 |  |  |  |
| Between left – right | -0.053 | 0.3049 | 0.8741 |  |  |  |
| Left between – within | -0.012 | 0.0144 | 0.8148 |  |  |  |
| **Right between – within** | 0.089 | 0.0144 | **<0.0001** |  |  |  |
|  |  |  |  |  |  |  |
| Schaefer Atlas |  |  |  |  |  |  |
|  | Left Hemisphere | | | Right Hemisphere | | |
| *Planned Contrasts* | *EMM* | *SE* | *p* | *EMM* | *SE* | *p* |
| **Within control – patient** | 0.037 | 0.011 | **0.001** | 0.020 | 0.010 | **0.041** |
| Between control – patient | 0.022 | 0.011 | 0.056 | 0.013 | 0.010 | 0.162 |
| **Patient between – within** | -0.054 | 0.0006 | **0.001** | -0.059 | 0.0006 | **<0.0001** |
| **Control between – within** | -0.069 | 0.0002 | **<0.0001** | -0.066 | 0.0002 | **<0.0001** |
|  |  |  |  |  |  |  |
|  | Z-score Normalized Patients | | |  |  |  |
| *Planned Contrasts* | *EMM* | *SE* | *p* |  |  |  |
| Within left – right | -0.246 | 0.35112 | 0.5959 |  |  |  |
| Between left – right | -0.186 | 0.35102 | 0.5959 |  |  |  |
| **Left between – within** | 0.109 | 0.00696 | **<0.0001** |  |  |  |
| **Right between – within** | 0.050 | 0.00717 | **<0.0001** |  |  |  |