

Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our [Editorial Policies](#) and the [Editorial Policy Checklist](#).

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed
☐	☒ The exact sample size (<i>n</i>) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒ A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒ The statistical test(s) used AND whether they are one- or two-sided <i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i>
☐	☒ A description of all covariates tested
☐	☒ A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒ A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒ For null hypothesis testing, the test statistic (e.g. <i>F</i> , <i>t</i> , <i>r</i>) with confidence intervals, effect sizes, degrees of freedom and <i>P</i> value noted <i>Give P values as exact values whenever suitable.</i>
☒	☐ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☒	☐ Estimates of effect sizes (e.g. Cohen's <i>d</i> , Pearson's <i>r</i>), indicating how they were calculated

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection	Intracranial EEG (iEEG) was recorded both intraoperatively and during epilepsy monitoring at various institutes. Biosignal amplifiers, including Natus Quantum, Nihon Kohden, and gHIAmp/Gtec , along with their corresponding software, were used to sample neural data at a rate of at least 2 kHz.
Data analysis	The iEEG data analysis was performed using MATLAB 2019b. The kSVD toolbox by Ron Rubinstein: https://csaws.cs.technion.ac.il/~ronrubin/software.html was used in dictionary learning. For references: [1] M. Aharon, M. Elad, and A.M. Bruckstein, "The K-SVD: An Algorithm for Designing of Overcomplete Dictionaries for Sparse Representation", the IEEE Trans. On Signal Processing, Vol. 54, no 11, pp. 4311-4322, November 2006. [2] M. Elad, R. Rubinstein, and M. Zibulevsky, "Efficient Implementation of the K-SVD Algorithm using Batch Orthogonal Matching Pursuit", Technical Report - CS, Technion, April 2008. Random Forest classification was implemented using the toolbox Erogol 2021 Random Forests (GitHub) available at https://github.com/erogol/Random_Forests Implemented codes are accessible on GitHub upon request at https://github.com/InceLab/

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

The data that support the findings of this study will be openly available at the following URL/DOI: <https://doi.org/10.18120/heco-nn69>

Human research participants

Policy information about [studies involving human research participants and Sex and Gender in Research](#).

Reporting on sex and gender	In total 16 males and 13 females participated in the study. The recruitment and findings were not biased towards a single sex or gender.
Population characteristics	In this study, patients with drug-resistant epilepsy who underwent intracranial electrode implantation surgery for prolonged neural monitoring were included. Since epilepsy affects not only adults but also pediatric population, the study included 15 adults and 14 children (under the age of 18).
Recruitment	Patients diagnosed with refractory epilepsy, eligible for intracranial monitoring, were enrolled in this study. Inclusion criteria were broad, encompassing individuals of all genders, races, nationalities, religions, educational backgrounds, and socioeconomic statuses. Given that epilepsy affects both adults and children, participants included individuals from pediatric age groups as well. The study aimed for gender parity, with 16 male and 13 female subjects recruited. Among them, 14 were children and 15 were adults, ensuring representation across the lifespan.
Ethics oversight	The study protocol received approval from the institutional review boards at multiple recording sites, including the University of Minnesota Fairview Hospital (MN, USA), St. Luke's Hospital, and Texas Children's Hospitals (TX, USA) affiliated with Baylor College of Medicine (BCM), as well as from the Mayo Clinic and the University of Houston.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☒ Life sciences ☐ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	In order to estimate the efficacy of the computational methods to detect relevant patterns (i.e., HFOs) and correlations within the clinically defined SOZ we included a cohort of 29 cases.
Data exclusions	No data excluded from the study.
Replication	The iEEG dataset (available at https://doi.org/10.18120/heco-nn69) along with the necessary code (accessible via https://github.com/InceLab/) will be provided to facilitate the replication of these results.
Randomization	The aim is to analyze High-Frequency Oscillations (HFOs) in intracranial EEG (iEEG) data from patients with drug-refractory epilepsy who have undergone surgical therapy, with the goal of determining the feasibility for identifying the seizure-generating area based on detected HFOs from the brief IOM recordings. The study primarily examines inherent variations within patient data rather than comparing controlled interventions across randomly assigned groups. Therefore, we compared the distribution of HFOs within the resection volume between two groups with favorable outcomes (Engel Class I and II) and poor surgical outcomes (Engel Class II-III).
Blinding	Blinding was not applicable to our study because the experimental parameters were not customized for each subject. However, the entire data analysis was conducted independently of any clinical findings.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging