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Reporting Summary

Nature Research 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 Research policies, see Authors & Referees 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 (*n*) 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 *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☐	☒	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. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐	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 *d*, Pearson's *r*), 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	Data from wristwatch style monitors used the Parkinsons's KinetiGraph System (PKG) (Global Kinetics Inc.). We wrote custom code to interface with the Summit RC+S (Medtronic Inc.) DBS device and is available at https://openmind-consortium.github.io/.
Data analysis	Data were analyzed using Matlab 2019b (Mathworks Inc.). Code to process and analyze neural data recorded with Summit RC+S is available at https://github.com/openmind-consortium/Analysis-rcs-data and code used to create the figures in this paper is available at https://github.com/roeegilron/rcsAtHome

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/reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research 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 list of figures that have associated raw data
- A description of any restrictions on data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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

Life sciences study design

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

Sample size	The aim of the study is to determine within subject biomarkers, over extensive per subject data recording. Therefore the primary unit of analysis is on-off medication cycles within subject. Given that acute studies have shown on average a 30% reduction in beta off versus on medication, and assuming a relatively large within subject variance (not available from the literature - assuming 50%) we would require 19 repetitions per subject to show an effect (alpha 0.05, power 80%). With 50 - 200 (mainly awake) hours per subject, we captured > 20 cycles per subject (5 cycles per day). Modelled similar to primate studies that collect large volumes of within subject data on low numbers of participants (typically 2-3), our study was repeated over 5 human subjects (10 sides) to assess how reliable this effect was over subjects.
Data exclusions	Field potential recordings may include transients and artifacts that were excluded from analysis. Data which were 2 standard deviations above mean were defined as outliers. In the primary analysis, sleep data was excluded although the complete dataset (including sleep) is reported.
Replication	All data were modelled (within subject) in the primary analysis and 5 fold cross validation, which held back data from the initial modeling, was used in the supervised learning component. The primary within subject analyses were replicated over 5 subjects (10 sides) and was successful.
Randomization	Our study is primarily a physiological study for which randomization is not relevant. The adaptive DBS component was primarily meant as a demonstration of technique.
Blinding	This was an observational study, to develop a technique and was not a definitive clinical outcomes study.

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
☒	☐ Animals and other organisms
☐	☒ Human research participants
☐	☒ Clinical data

Methods

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

Human research participants

Policy information about studies involving human research participants

Population characteristics	See - https://clinicaltrials.gov/ct2/show/NCT03582891
Recruitment	Patients were recruited from a population scheduled to undergo DBS implantation for the treatment of PD. Participants were selected based on pre-defined inclusion and exclusion criteria. Compliance with the protocol necessitates reasonable cognitive ability (Inclusion criteria: MOCA 20) therefore these study results may not extend to patients with advanced cognitive impairment. Results relevant to the specific population of patients that meet clinical criteria for DBS implantation.
Ethics oversight	The study was approved by the UCSF institutional review board (IRB) under a physician sponsored investigational device exemption (IDE), protocol # G180097

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

Clinical data

Policy information about clinical studies

All manuscripts should comply with the ICMJE guidelines for publication of clinical research and a completed CONSORT checklist must be included with all submissions.

Clinical trial registration	NCT03582891 see - https://clinicaltrials.gov/ct2/show/NCT03582891
Study protocol	The full study protocol is available at https://osf.io/ya5jf/
Data collection	Recruitment for this study started in July 2018, data were collected starting July 2019 until January 2020. Data were collected almost entirely at home with remote monitoring and assistance consistent with requirements of the COVID pandemic and study protocol.
Outcomes	Our study investigates brain physiology and novel brain recording techniques. Our reported outcome for adaptive DBS (Figure 6D) had a primary outcome of safety and secondary outcome of preliminary efficacy measured by motor diaries and wearables. These were predefined in our FDA investigational device exemption.

Magnetic resonance imaging

Experimental design

Design type	Structural imaging only
Design specifications	Structural imaging only
Behavioral performance measures	Structural imaging only

Acquisition

Imaging type(s)	Structural imaging
Field strength	3T
Sequence & imaging parameters	Volumetric T1 weighted gradient echo without contrast (GE MRI 3D T1 BRAVO). Axial T2-weighted fast spin echo, interleaved
Area of acquisition	Whole brain,

Diffusion MRI ☐ Used ☒ Not used

Preprocessing

Preprocessing software	None
Normalization	Contact location were evaluated with respect to each individual MRI and not transfered to a common template.
Normalization template	Not applicable - since normalization was not used.
Noise and artifact removal	Structural diagnostic imaging was used to demonstrate lead locations on individual MRIs and no further processing was performed.
Volume censoring	Volume censoring was not needed since we did not need to do motion correction.

Statistical modeling & inference

Model type and settings	Not applicable utilized structural imaging without any task data for which models are typically employed
Effect(s) tested	Not applicable utilized structural imaging without any task data for which models are typically employed

Specify type of analysis: ☒ Whole brain ☐ ROI-based ☐ Both

Statistic type for inference (See Eklund et al. 2016)	Imaging was used only to document lead location without any hypothesis testing.
Correction	No hypothesis testing was performed with MR images.

Models & analysis

n/a	Involved in the study
☒	☐ Functional and/or effective connectivity
☒	☐ Graph analysis
☒	☐ Multivariate modeling or predictive analysis