nature portfolio

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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 (*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	Neural data were collected through the Central API (7.0.5, Blackrock Neurotech), whereas other data were collected through custom software made with a combination of Python 3+, Matlab 2019+ and C++.
Data analysis	Data were analysed using Matlab 2019a or newer. Code for the analyses and for figure generation is available on GitHub at https://github.com/CorticalBionics/StableAndPreciseICMS.

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 de-identified data generated in this study are available from the Data Archive BRAIN Initiative (DABI) under the project code GU5A5IO8LRXE (https://

dabi.loni.usc.edu/dsi/GU5A5IO8LRXE). Because of participant privacy, the data are available under restricted access, and access can be obtained on request to the study PIs by an investigator who is prepared to securely handle data resulting from human research.

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	All four participants were male, which is consistent with the represented patient population (spinal cord injury, SCI) being approximately 80% male.
Reporting on race, ethnicity, or other socially relevant groupings	Participants were not recruited with respect to their race, ethnicity or any other social grouping. There were no attempts to make comparisons between participants based on any of these factors.
Population characteristics	Two participants were 28 years old at time of implant, the third was 57 years old, and the fourth was 27 years old. No effects of age were expected or found. All four participants had been diagnosed with a cervical spinal cord injury (SCI), as required by the inclusion criteria.
Recruitment	Participants were recruited through voluntary research registries for people with SCI. Any selection bias is not expected to influence the results.
Ethics oversight	The study was conducted under two IDEs. One from the FDA and with approval from the IRBs at the University of Chicago and at the University of Pittsburgh, and another from the FDA with approval from the IRB at Case Western Reserve University.

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

Life sciences study design

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

Sample size	We used 4 particpants. The number of participants in brain–computer Interface (BCI) studies in humans are limited owing to the necessity of surgery and the limited size of the eligible population. Most studies in this area only include 1 or 2 participants.
Data exclusions	No data were excluded.
Replication	Experiments were replicated in up to 4 volunteers across 3 study sites. All experiments that were repeated were consistent across subjects. Not all experiments could be completed in each participant, owing to differences in evoked sensation.
Randomization	No randomization was possible given the required surgery to implant the electrodes.
Blinding	Blinding was not applicable, as there was no control group.

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
☒	☐ Plants

Methods

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

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	NCT01894802
Study protocol	The trial protocol is unavailable, as it is part of an ongoing study (IDE G130082).
Data collection	Data were collected in research laboratories set up for the BCI trial at the Universities of Chicago and Pittsburgh, and a separate study at Case Western Reserve University. Data were collected 1 year, 1 year, 6 years and 2 years after device implantation for C1, P3, P2, and R1 respectively.
Outcomes	The results reported in this study are are tangential to the primary and secondary outcomes of the clinical trial. Interim publication has been approved by the DSMB.