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	In vivo electrophysiological data was collected chronically with custom micro-electrode and eCube Server (White Matter LLC). Animal behavior was monitored with 15 or 30 fps video recording with WatchTower (White Matter LLC).
Data analysis	Spike unit activities were sorted using SpikeInterface and MountainSort4. Animal locomotion activities were analyzed from video using DeepLabCut. All other code (Python) required for analyses in the manuscript is available publicly at https://github.com/hengenlab/Sleep_restores_criticality and github.com/hengenlab. Python 3.10.0, Scipy 1.9.3, sklearn 1.2.0, xgboost 1.7.2, statsmodels 0.13.5, mrestimator 0.1.8, deeplabcut 2.2

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

Source data has been provided with the manuscript. The raw datasets generated and/or analyzed in this study constitute >10 terabytes of raw neural broadband. The data are stored in a cost efficient manner not immediately accessible to the internet. Data are available upon request.

Human research participants

Policy information about studies involving human research participants and Sex and Gender in Research.

Reporting on sex and gender	n/a
Population characteristics	n/a
Recruitment	n/a
Ethics oversight	n/a

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	Sample sizes for this study are similar to those generally employed in the field (PMID: 31601510, 28947577, 24139038, 26997481).
Data exclusions	Single units were included if they met standard spike sorting criteria such as high amplitude spiking, stable spike amplitude over time, consistent waveform shapes, and little to no refractory period contamination. Criticality analysis (DCC) were excluded if the size or duration distribution of neural avalanches failed to pass the power-law test. See methods.
Replication	All experiments were performed with sufficient biological replicates across studied subjects. Additionally, experimental approaches are documented with sufficient detail for precise replication. We conducted experiments in a total of 8 animals - all 8 were included here (none excluded). Each of the 8 animals showed the main effects reported here (We employed linear mixed effects model for the majority of statistics). In addition, subsequent work in the lab has replicated these findings in mice.
Randomization	Subjects within each group were randomly selected before surgical procedures, and were randomized by sex. Where applicable, analyses were randomized, for example, in the train/test splitting of data for training XGBoost models and logistic regression (Fig. 2).
Blinding	Blinding was performed during preprocessing steps (e.g. selection of parameters for neural avalanches analysis, XGBoost model for behavior prediction, identification of increasing and decreasing DCC sequences) such that knowledge of behavior states was not considered. Experimenters were blinded where relevant, such as in the selection of increasing/decreasing sequences of DCC (Fig. 6).

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

Animals and other research organisms

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research, and Sex and Gender in Research

Laboratory animals	We used 8 Long-Evans rats (Charles River). All rats were at P21 at the time of surgery and P24 at the beginning of data collection.
Wild animals	No wild animals were used in this study.
Reporting on sex	Animals from both sexes were used in each condition. Results were not seen to differ qualitatively by any individual animal (linear mixed effect test), and thus aren't explained by sex difference.
Field-collected samples	No field-collected samples were used in this study.
Ethics oversight	All procedures involving rats were performed in accordance with protocols approved by the Washington University in Saint Louis Institutional Animal Care and Use Committee, following guidelines described in the US National Institutes of Health Guide for the Care and Use of Laboratory Animals.

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