nature portfolio

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Last updated by author(s): Sep 9, 2024

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	Cheetah 5.7.4 (Neuralynx), Inperstudio Alpha 8.2 (Inper), Patchmaster v2x73 (HEKA)
Data analysis	SpikeSort3D 2.5.2.0 (Neuralynx), NeuroExplorer 5.312(Nex Technologies), Igor Pro 4.03 (WaveMatrics), Mini Analysis Program 6.0 (Synaptosoft), SigmaPlot 14.0 (Systat Software), Matlab 2021a (Mathworks), GraphPad prism 8.0 (GraphPad Software), IBM SPSS Statistics 25 (IBM)

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

All data generated in this study are provided within the article, Supplementary Information and Source Data file. Further information regarding to the findings in the present study are available from the corresponding authors upon request. Source data are provided with this paper.

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	Human participants were not involved in this study.
Reporting on race, ethnicity, or other socially relevant groupings	No information about socially relevant groupings was collected in this study.
Population characteristics	No information about population characteristics was collected in this study.
Recruitment	No human participants were recruited in this study.
Ethics oversight	No organization(s) for study approval were involved in this study.

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 were not pre-determined by statistical calculation and were indicated in the figure legends or figures in each experiment. Target sample sizes were based on similar studies (e.g. PMID:30361367and PMID:28591796). We used similar sample sizes for different animal groups.
Data exclusions	For experiments involving stereotaxic AAV-virus injection,fiber placement and electrode placement, data from animal samples with missed placements were excluded. Only animals with correct placement were included.
Replication	All experiments include multiple animals and individual data points. Each experiment was successfully repeated for at least three times.
Randomization	Mice were randomly assigned to control or treatment groups, with no significant difference of phenotypes observed between groups prior to experiments.
Blinding	Behavior tests were done by people blind to treatment group. During experiments, unique ID numbers were used to represent each mice. Virus expression, fiber placements ,electrode placement and treatment groups were unblinded at the end of the data analyses in order for comparisons, graphing, and statistics. Data collectors and analysts were blind to group allocation of animals belonging to treatment or 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

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	Wild-type C57BL/6J mice (8-12 weeks old) were provided by the Laboratory Animal Center at the Army Medical University.
Wild animals	Study did not involve wild animals
Reporting on sex	The experiments involved the use of male mice for multi-channel single-unit and Ca2+ signal recordings, behavioral tests including the spatial memory test with optogenetic manipulation of RE-MEC pathway, as well as morphological experiment
Field-collected samples	This study did not involve field-collected samples.
Ethics oversight	The experiments conducted adhered to the ethical requirements for animal care and use as set by the Army Medical University, with all procedures receiving approval from the university's ethics committee.

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

Plants

Seed stocks	No seed stocks were involved in this study
Novel plant genotypes	No novel plant genotypes were produced in this study
Authentication	There is no authentication for seed stock or novel plant genotypes in this study