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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 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	Behavioral experiments were video recorded, and manually scored. Data was organized in Microsoft Excel for further analysis. Electrophysiological recordings were made using Patchmaster software controlling a HEKA EPC10 amplifier.
Data analysis	All data was analyzed using PRISM 8.0V. Supplemental video was edited using iMovie version 10.2.1.

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 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 raw data generated during the current study are available as source data files in the form of excel files packaged with this manuscript. Additional requests should be addressed to the corresponding authors.

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	Power analysis to determine the appropriate size of the behavioral (Figure 5) experimental groups was performed to determine differences between two means and was calculated with a 99% power, using a two group t-test with a 0.05 two-sided significance level. According to the results of the power analysis, for an effect size of 1.5, we need 11-12 animals to detect a significant difference.
Data exclusions	No data was excluded from this article.
Replication	Behavioral experiments (Figure 5) were performed in 3 separate cohorts, as means to provide replication.
Randomization	Animals were randomized to receive either sham or LED implants (Figure 5).
Blinding	Experimenters were blinded to the experimental conditions, during acquisition and analysis when comparisons were made by surgery conditions or genotype.

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
☒	☐ Human research participants
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

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

Animals and other organisms

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research

Laboratory animals	We used both male and female animals (mus musculus), 8-10 weeks old. Mice were generated by crossing a mouse that expressed conditional ChR2 allele (Ai32 mice; Jackson Laboratories, Stock No: 012569) with mice that express Cre recombinase from the nociceptor-specific TRPV1 locus (TRPV1-Cre mice;, Stock No: 017769). Experimental animals were both positive for the conditional allele and Cre recombinase (TrpV1-ChR2), and control mice only expressed the conditional allele but did not express Cre recombinase.
Wild animals	This study did not involve wild animals.
Field-collected samples	This study did not involve field-collected samples.
Ethics oversight	The surgical and experimental procedures presented in this manuscript were approved by the Animal Care and Use Committee of Washington University School of Medicine.

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