nature research

Corresponding author(s): Greg S.B. Suh & Dayu Lin

Last updated by author(s): Jan 10, 2019

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	We listed all softwares used in the experiments and for analysis in the Methods section. We used a custom TDT program, OpenEx (Tucker-Davis Technologies) to collect the fiberphotometry signal and StreamPix6 (Norpix) for multiple camera recording. We used EthoVisionXT 8.5/14 (Noldus) to track movement of mice and send a trigger signal to the pulse generator for optogenetics. Confocal images were captured with Zen program from LSM 780 (Zeiss). Differential interference contrast imaging to obtain the whole-cell recording (Nikon Eclipse FN-S2N equipped with a fixed stage and a QImaging optiMOS CMOS camera). Electrophysiological signals were recorded using an Axopatch 700B amplifier (Molecular Devices).
Data analysis	We listed all softwares used in the experiments and for analysis in the Methods section. We used customized code written in MATLAB 2013 to annotate behavior of animals (https://github.com/pdollar/toolbox/tree/master/videos) and further analyze the time-locked photometry signal by a customized code. We used EthoVisionXT 8.5/14 to analyze and visualize the locomotor of the mice. Confocal microscopic imaging data were analyzed by ZEN2009 Light Edition and ImageJ 1.51k with custom settings. Whole-cell patch clamp data were analyzed with pCLAMP 10 programs (Molecular Devices). All statistical analysis were performed using GraphPad Prism 7. The custom codes will be available from corresponding authors upon reasonable request.

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	There is no appropriate precedent to predetermine sample size, but our sample sizes in the data are similar with previous works in this field.
Data exclusions	In behavioral experiments, eight mice with poor virus expression (<5%) or fiber implantation outside (>500um) of the PVN region as described in a mouse brain atlas (Franklin & Paxinos) were excluded. The exclusion criteria were established prior to collecting and analyzing the final sets of data.
Replication	All experiments were conducted at least with 2 cohorts of animals. All mice with sufficient viral expression (>5% of PVN neurons) and correct fiber placement (within 500 um of PVN) showed qualitatively similar responses under the same behavioral test.
Randomization	Littermates were randomly assigned as control or experimental groups in behavior testing used in the study. The order of behavior tests with varied stimulus presentations was randomized in the experimental groups.
Blinding	The experiments were not done blindly in the study, since the experimental conditions (control vs experimental groups) were obvious to experimenters and the analyses were carried out is was done objectively by using a (tracking system) and not subjective to human bias. During annotation and cell counting, the experimenter iswas blind to the GCaMP6 signal or behavioral responses.

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

Antibodies

Antibodies used	We listed all antibodies used with their catalog number in Methods section of "Immunohistochemistry". Primary antibodies : Rabbit anti-CRF (PBL rC68, Paul E.Sawchenko lab;former W. Vale lab, Salk Institute) and Goat anti-cFos (sc-52-G, Santa Cruz). Secondary antibodies: Donkey anti-rabbit Alexa 647 (A21207, Life Technologies) or Donkey anti-goat Alexa 488/647 (A11055/ A21447, Life Technologies).
Validation	Primary antibodies used in this study are listed on the JCN Antibody Database. rC68 was produced in rabbit using human/rat CRF coupled to human a-globulins as immunogen. Paul E.Sawchenko lab noted that rC68 and the characterized and extensively publihsed rC70 were produced in parallel with the same dose of the identical immunogen. Reference for validation of rC70

(PMID:18067140). Information for sc-52-g (rabbit polyclonal IgG): https://www.scbt.com/scbt/product/c-fos-antibody-4?requestFrom=search

Animals and other organisms

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

Laboratory animals	We described the subjects in Methods section (Subjects). CRF-ires-Cre mice (B6(Cg)-Crhtm1(cre)Zjh/J; Jackson Laboratory, stock no: 012704), Ai14 (B6(Cg)- Gt(ROSA)26Sortm14(CAG-tdTomato)Hze/J; Jackson Laboratory, stock no: 007914) mice both female and male (8-16weeks old) housed individually under a 12-hr light/dark cycle (7 am to 7 pm light), with food and water available ad libitum unless specified. CD-1 mice (Charles River Laboratory), aged over 3months, were used for a behavior testing with an aggressive intruder. Behavioral experiments were conducted 3–4 weeks after injection of the viral expression constructs.
Wild animals	The study did not involve wild animals.
Field-collected samples	The study did not involve samples collected from the field.
Ethics oversight	All animal experiments were performed according to protocols approved by NYU and KAIST IACUC protocols for the care and use of laboratory animals. We complied with all pertinent ethical regulations.

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