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Corresponding author(s): Stefanos Stagkourakis & Christian Broberger

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.

Statistical parameters

When statistical analyses are reported, confirm that the following items are present in the relevant location (e.g. 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
☐	☒	An indication of 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 statistics 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
☐	☒	Clearly defined error bars *State explicitly what error bars represent (e.g. SD, SE, CI)*

Our web collection on statistics for biologists may be useful.

Software and code

Policy information about availability of computer code

Data collection	In vitro electrophysiology data were collected in Clampex 10.8. Behavioural data were collected using IC capture cameras from imaging source, recording both top and side view. Confocal images were taken using the ZEN software from ZEISS.
Data analysis	In vitro electrophysiology data were analyzed in Clampfit 10.8, OriginPro 8.5 and Matlab using the signal processing toolbox. Behavioural data were scored with Ethovision XT 10. Statistical tests on data sets were performed with GraphPad Prism 6.

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 upon request. 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

All materials used are readily available from standard commercial sources. Sources are specified in the method sections.

Field-specific reporting

Please select 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/authors/policies/ReportingSummary-flat.pdf

Life sciences study design

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

Sample size	Sample sizes are estimated based on previous physiological studies using similar animal models to guarantee statistical relevance. Considering the typical variance of mouse social behaviour, we estimated that an n=10-20 animals per group allows for at least 80% statistical power when using the appropriate statistical test. Histological quantitative analyses was performed on similar group sizes to previous studies, typically with an n=10. Electrophysiological data for individual groups were collected from a minimum of n=3 mice. No further sample size calculation was performed.
Data exclusions	Animals injected with AAV and part of the behavioural optogenetics experiments, showing no detectable viral expression in the target region and/or ectopic fiber placement upon post-hoc histological examination were excluded from analysis. In electrophysiology whole-cell patch clamp recordings, access resistance was monitored throughout the experiments, and neurons in which the series resistance exceeded 15 MΩ or changed ≥20% were excluded from the statistics.
Replication	Behavioral experimental findings were reproduced in duplicates or triplicates and among individuals of a group. Electrophysiology and anatomy findings were replicable within groups.
Randomization	Randomization was performed in the majority of experimental designs in the current study. Randomization was performed during behavioral data collection. Male mice from the same litter were allocated in different experimental groups. Randomization was performed during electrophysiology data collection presented in Figure 1.
Blinding	Behavioural data collection and analysis was performed blind to experimental conditions. Anatomy data analysis but not tissue collection was blinded. Electrophysiological data sampling and analysis was not blinded, with the exception of all whole-cell patch clamp datasets presented in Figure 1.

Reporting for specific materials, systems and methods

Materials & experimental systems

n/a	Involved in the study
☐	☒ Unique biological materials
☐	☒ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology
☐	☒ Animals and other organisms
☒	☐ Human research participants

Methods

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

Unique biological materials

Policy information about availability of materials

Obtaining unique materials	No restrictions on availability of reagents used in the present study apply.

Antibodies

Antibodies used	1. rabbit anti-NeuN (1:500; Cell Signalling, D4G40) 2. rabbit anti-NUCB1 (1:1,000; Dr M. Wendel lab; Petersson et al., 2004) 3. rabbit anti-c-fos antibody (1:200; sc-52 LotG1108, Santa Cruz Biotechnology) 4. chicken anti-GFP (1:500; Aves Labs, GFP-1020) 5. rabbit anti-ERα (1:200; Santa Cruz Biotechnology, sc-542) 6. rat anti-DAT (1:1000; Millipore, MAB369)

Validation

1. rabbit anti-NeuN (1:500; Cell Signalling, D4G40)
NeuN (D4G4O) XP® Rabbit mAb recognizes endogenous levels of total NeuN protein. This monoclonal antibody was produced by immunizing animals with recombinant protein specific to the amino terminus of human NeuN protein (RNA binding protein fox-1 homolog 3). PMID: 28848607, 28429775, 28423319, 27008987

2. rabbit anti-NUCB1 (1:1000; Dr M. Wendel lab)
The antibody was produced by immunizing rabbits with the peptide KVPEQPPELPQLDSQHL, corresponding to amino acids 439-455 in the C-terminal region of mouse NUCB1. Specificity of the antibody was validated by western blot and immunohistochemical analysis. PMID: 15193541, 26666627

3. Rabbit anti-c-fos antibody sc-52 LotG1108
This antibody was produced by immunizing rabbits with the N-terminus of c-Fos of human origin. The specificity of the AbI was validated in several mouse brain areas following open field ,object recognition and CPP test and in particular in the bilateral barrel field of the primary somatosensory cortex following whisker stimulation. In the last study, the specificity of the AbI was confirmed using another anti-c-Fos antibody (SC-253) that yielded similar results. PMID: 26136670, 25870909, 20463958

4. chicken anti-GFP (1:500; Aves Labs, GFP-1020)
Anti-GFP (Green Fluorescent Protein) was produced by immunization of chickens with purified recombinant green fluorescent protein (GFP) emulsified in Freund's adjuvant. The antibody was analyzed by western blot analysis and immunohistochemistry using transgenic mice expressing the GFP gene product. PMID: 28957379, 28885975, 28694334

5. rabbit anti-ERα
(1:200; Santa Cruz Biotechnology, sc-542) ERα Antibody (MC-20) is a rabbit polyclonal IgG recognizing the C-terminus of Estrogen receptor of mouse origin. PMID:29456719, 28938159, 28499383

6. rat anti-DAT (1:1000; Millipore, MAB369)
Rat were immunized with N-terminus of human dopamine transporter fused to Glutathione S-transferase. The AbI was validated in our and other laboratories as well by staining several mouse brain regions expressing DAT (i.e. Arcuate, ventral tegmental area, substantia nigra, Striatum, etc). Immunolocalization of DAT on sections of human brain using MAB369 shows dense punctate staining throughout the caudate, putamen and accumbens. DAT signal with this AbI is absent in the DAT-KO mouse and shows no cross reactivity to the closely related serotonin and norepinephrine transporters. PMID: 28417953, 29263318, 29038581, 28367951

Animals and other organisms

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

Laboratory animals	Male C57BL/6J dopamine transporter (DAT)-Cre mice (Ekstrand et al., 2006) were used to genetically label and manipulate the DAT expressing neurons in the ventral premammillary nucleus. In addition to viral mediated labelling, to tag DAT+ PMv neurons DAT-Cre mice were crossed with Rosa26-lox-stop-lox-TdTomato (Ai14) reporter (The Jackson Laboratory stock 007905). Wild-type C57BL/6J (JAX mice strain) and BALB/c mice (BALB/cAnNCrl, strain code: 028, Charles River) were used in behavioural experiments.
Wild animals	No wild animals were used in the present study.
Field-collected samples	No field collected samples were used in the present study.