

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

Microscopy images were collected using NIS Elements AR 5.02.00 software from Nikon and BZ-X800 Viewer software from Keyence. Electrophysiology data were acquired with PClamp 10 and Igor Pro 5.0.5.7 (Wavemetrics). Behavior data were collected with MED-PC IV. Photometry data were acquired using Synapse version 92-41665P software from Tucker-Davis Technologies

Data analysis

Anatomical data were analyzed in ImageJ 1.53r or 1.54r. Electrophysiology data were analyzed with Minianalysis 6.0.7 (Synaptosoft). Statistical analysis for all data were done with Graphpad Prism 10.6.1 or R 4.1.2.

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](#)

RNAseq data analyzed in Supplementary Fig. 1 were generated in reference 22 and are available on FigShare at the following link: https://figshare.com/projects/Continuous_and_discrete_neuron_types_of_the_adult_murine_striatum/69080. All other data in the paper are available on Zenodo: [10.5281/zenodo.18332283](https://zenodo.org/record/18332283).

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

Use the terms sex (biological attribute) and gender (shaped by social and cultural circumstances) carefully in order to avoid confusing both terms. Indicate if findings apply to only one sex or gender; describe whether sex and gender were considered in study design; whether sex and/or gender was determined based on self-reporting or assigned and methods used. Provide in the source data disaggregated sex and gender data, where this information has been collected, and if consent has been obtained for sharing of individual-level data; provide overall numbers in this Reporting Summary. Please state if this information has not been collected. Report sex- and gender-based analyses where performed, justify reasons for lack of sex- and gender-based analysis.

Reporting on race, ethnicity, or other socially relevant groupings

Please specify the socially constructed or socially relevant categorization variable(s) used in your manuscript and explain why they were used. Please note that such variables should not be used as proxies for other socially constructed/relevant variables (for example, race or ethnicity should not be used as a proxy for socioeconomic status). Provide clear definitions of the relevant terms used, how they were provided (by the participants/respondents, the researchers, or third parties), and the method(s) used to classify people into the different categories (e.g. self-report, census or administrative data, social media data, etc.) Please provide details about how you controlled for confounding variables in your analyses.

Population characteristics

Describe the covariate-relevant population characteristics of the human research participants (e.g. age, genotypic information, past and current diagnosis and treatment categories). If you filled out the behavioural & social sciences study design questions and have nothing to add here, write "See above."

Recruitment

Describe how participants were recruited. Outline any potential self-selection bias or other biases that may be present and how these are likely to impact results.

Ethics oversight

Identify the organization(s) that approved the study protocol.

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](https://www.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

No statistical methods were used to predetermine sample sizes. Instead, sample sizes of >3 mice for anatomy experiments, >10 cells for electrophysiology experiments, and >6 mice for behavior experiments were chosen based on prior studies performing similar analyses to investigate the contributions of other neural circuits to reward learning (e.g. Steinberg et al. Neuron, 2020). In all experiments, efforts were made to include approximately equal numbers of male and female mice in each group, however we did not perform tests for sex differences owing to the limited sample sizes.

Data exclusions

For in situ hybridization experiments mapping serotonin receptor distribution, each image of a striatal hemisphere was checked for anteroposterior coordinate (samples posterior to ~0.74 mm from bregma or anterior to ~1.70 mm from bregma were excluded), tissue integrity (samples with large tears or damage from overdigestion were excluded), adequate image acquisition (out of focus samples were excluded), and successful thresholding. For cfos analysis following intra-NAC drug infusions, samples were checked for tissue integrity (n=3 saline treated brains with extensive tissue damage in the NAC medSh from the drug infusion procedure were excluded). Electrophysiology recordings with seal resistance < 1 gigaOhm were excluded.

Replication	For all experiments, efforts were made to collect several technical replicates for each biological replicate wherever possible. For in situ hybridization mapping of serotonin receptor expression, we imaged 3-6 hemispheres from each of 8-9 mice per experiment (except for one mouse in the Htr2c mapping experiment for which one hemisphere was used). For axon tracing experiments, we analyzed 6-8 hemispheres for each of 5 mice. For cfos experiments, we imaged 6-8 hemispheres for each of 5 mice per group. For electrophysiology experiments, we recorded from 12-36 cells across 4-9 mice per experiment. Qualitatively similar results that were obtained which were then pooled for the analyses presented in the paper.
Randomization	For in situ hybridization and axon tracing experiments, no randomization could be used because all mice received the same treatment. For electrophysiology experiments, mice were randomly assigned to dopamine and serotonin treated groups. For cfos experiments, mice were randomly assigned to saline and escitalopram treated groups. For behavior experiments, mice were randomly assigned to the D1-sgRosa, D2-sgRosa, D1-Htr2c, and D2-Htr2c groups
Blinding	For anatomical experiments, blinding was not possible because all mice/samples in a given experiment received the same treatment. For electrophysiology experiments, blinding was not done because the Drd1-TdTom and Drd2-eGFP mouse lines used differently colored fluorescent proteins to label D1- and D2-MSNs respectively. Behavioral experiments in Fig 3 were performed blind to experimental condition.

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

Antibodies

Antibodies used	rabbit anti-cfos, Sysy #226008; chicken anti-GFP, Aves #GFP-1020; rat anti-mCherry, Invitrogen #M11217
Validation	The rabbit anti-cfos, Sysy #226008 antibody has 82 references for immunohistochemistry applications documented on the manufacturer's website, and has been validated by the manufacturer to bind to mouse cfos protein. The chicken anti-GFP, Aves #GFP-1020 antibody has over 700 citations in the literature. The manufacturer's website states "Quality control: Antibodies were analyzed by western blot analysis (1:5000 dilution) and immunohistochemistry (1:500 dilution) using transgenic mice expressing the GFP gene product. Western blots were performed using BlokHen® (Aves Labs) as the blocking reagent, and HRP-labeled goat anti-chicken antibodies (Aves Labs, Cat. #H-1004) as the detection reagent. Immunohistochemistry used tetramethyl rhodamine-labeled anti-chicken IgY." The rat anti-mCherry, Invitrogen #M11217 antibody has over 100 documented references in the literature and data from several validation experiments is available on the manufacturer's website.

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	C57BL6/J (Jackson Laboratory #000664), Drd1a-TdTomato (Jackson Laboratory #016204), Drd2-eGFP (Jackson Laboratory #030255), Drd1a-TdTomato;Drd2-eGFP (cross between Jackson Laboratory #016204 and #030255), Drd1-Cre (MMRRC #029178-UCD), and Adora2a-Cre (MMRRC #036158-UCD), and SERT-Cre (MMRRC #017260-UCD) mice of both sexes (>5 weeks old) were used in this study.
Wild animals	No wild animals were used in this study.
Reporting on sex	Efforts were made to include approximately equal numbers of male and female animals in each experimental group, but statistical analyses for sex differences were not performed because of limited sample sizes.
Field-collected samples	No field collected samples were used in this study.
Ethics oversight	Experimental procedures were approved by the Stanford University Administrative Panel on Laboratory Animal Care and the Administrative Panel on Biosafety.

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