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Main Figures: 3

Supplementary Figures: 10

Supplementary Tables: 1

Supplementary Videos: 0

Reporting Checklist for Nature Neuroscience

This checklist is used to ensure good reporting standards and to improve the reproducibility of published results. For more information, please read Reporting Life Sciences Research.

Please note that in the event of publication, it is mandatory that authors include all relevant methodological and statistical information in the manuscript.

Statistics reporting, by figure

- Please specify the following information for each panel reporting quantitative data, and where each item is reported (section, e.g. Results, & paragraph number).
- Each figure legend should ideally contain an exact sample size (n) for each experimental group/condition, where n is an exact number and not a range, a clear definition of how n is defined (for example x cells from x slices from x animals from x litters, collected over x days), a description of the statistical test used, the results of the tests, any descriptive statistics and clearly defined error bars if applicable.
- For any experiments using custom statistics, please indicate the test used and stats obtained for each experiment.
- Each figure legend should include a statement of how many times the experiment shown was replicated in the lab; the details of sample collection should be sufficiently clear so that the replicability of the experiment is obvious to the reader.
- For experiments reported in the text but not in the figures, please use the paragraph number instead of the figure number.

Note: Mean and standard deviation are not appropriate on small samples, and plotting independent data points is usually more informative. When technical replicates are reported, error and significance measures reflect the experimental variability and not the variability of the biological process; it is misleading not to state this clearly.

		TEST USED		n			DESCRIPTIVE STATS (AVERAGE, VARIANCE)		P VALUE		DEGREES OF FREEDOM & F/t/z/R/ETC VALUE	
	FIGURE NUMBER	WHICH TEST?	SECTION & PARAGRAPH #	EXACT VALUE	DEFINED?	SECTION & PARAGRAPH #	REPORTED?	SECTION & PARAGRAPH #	EXACT VALUE	SECTION & PARAGRAPH #	VALUE	SECTION & PARAGRAPH #
example	1a	one-way ANOVA	Fig. legend	9, 9, 10, 15	mice from at least 3 litters/group	Methods para 8	error bars are mean +/- SEM	Fig. legend	p = 0.044	Fig. legend	F(3, 36) = 2.97	Fig. legend
example	results, para 6	unpaired t-test	Results para 6	15	slices from 10 mice	Results para 6	error bars are mean +/- SEM	Results para 6	p = 0.0006	Results para 6	t(28) = 2.808	Results para 6

		TEST USED		n			DESCRIPTIVE STATS (AVERAGE, VARIANCE)		P VALUE		DEGREES OF FREEDOM & F/t/z/R/ETC VALUE	
	FIGURE NUMBER	WHICH TEST?	SECTION & PARAGRAPH #	EXACT VALUE	DEFINED?	SECTION & PARAGRAPH #	REPORTED?	SECTION & PARAGRAPH #	EXACT VALUE	SECTION & PARAGRAPH #	VALUE	SECTION & PARAGRAPH #
+ -	Main Section, Page 4, Paragraph 1	Kruskal-Wallis ANOVA	Main Section, Paragraph 3	7	7 animals	Online Methods, Paragraph 1	Boxplot figure (median, IQR, whole range)	Figure ~~1b~~	p=0.17	Main Section, Paragraph 3	$\chi2(2)=4.88$	Main Section, Paragraph 3
+ -	Main Section, Page 4, Paragraph 1	Kruskal-Wallis ANOVA	Main Section, Paragraph 3	7	7 animals	Online Methods, Paragraph 1	Boxplot figure (median, IQR, whole range)	Figure ~~1d~~	p=0.40	Main Section, Paragraph 3	$\chi2(2)=1.66$	Main Section, Paragraph 3
+ -	2~~c~~-d	Permutation Test	Fig. legend and Online Methods, Data Analysis, Paragraph 1	7	7 animals	Online Methods, Paragraph 1	mean area under the receiver operating characteristic curve	Fig. 2~~c~~-d	p<0.05 (range reported due to multiple comparisons)	Fig. legend	grey boundaries = population of 1000 permuted sessions (null distribution)	Fig. 2~~c~~-d, Fig. legend and Online Methods, Data Analysis, Paragraph 1
+ -	S3a-b	Permutation Test	Fig. legend Online Methods, Data Analysis, Paragraph 1	7	7 animals	Online Methods, Paragraph 1	mean area under the receiver operating characteristic curve	Fig. S3a-c	p<0.05 (range reported due to multiple comparisons)	Fig. legend	grey boundaries = population of 1000 permuted sessions (null distribution)	Fig. S3a-b, Fig. legend and Online Methods, Data Analysis, Paragraph 1
+ -	S6c	Wilcoxon Signed Rank Test	Fig. legend	7	7 animals	Online Methods, Paragraph 1	Boxplot figure (median, IQR, whole range)	Fig. legend	p=0.02	Fig. legend	W=0	Fig. legend
+ -	S4a-b	Permutation Test	Fig. legend and Online Methods, Data Analysis, Paragraph 1	7	7 animals	Online Methods, Paragraph 1	mean area under the receiver operating characteristic curve	Fig. S4a-c	p<0.05 (range reported due to multiple comparisons)	Fig. legend	shaded area = population of 1000 permuted sessions (null distribution)	Fig. S4a-b, Fig. legend and Online Methods, Data Analysis, Paragraph 1

+ -	S5e	Permutation Test	Online Methods, Data Analysis, Paragraph 3	7	7 animals	Online Methods, Paragraph 1	mean regression coefficients	Fig. S4e	p<0.05 (range reported due to multiple comparisons)	Fig. legend	1000 permutations	Online Methods, Data Analysis, Paragraph 3
+ -	S5a-c	Permutation Test	Fig. legend and Online Methods, Data Analysis, Paragraph 1	7	7 animals	Online Methods, Paragraph 1	mean area under the receiver operating characteristic curve	Fig. S5a-b	p<0.05 (range reported due to multiple comparisons)	Fig. legend	shaded area = population of 1000 permuted sessions (null distribution)	Fig. S5a-b, Fig. legend and Online Methods, Data Analysis, Paragraph 1
+ -	S6a-b	Permutation Test	Fig. legend and Online Methods, Data Analysis, Paragraph 1	7	7 animals	Online Methods, Paragraph 1	mean area under the receiver operating characteristic curve	Fig. S6a-b	p<0.05 (range reported due to multiple comparisons)	Fig. legend	shaded area = population of 1000 permuted sessions (null distribution)	Fig. S6, Fig. legend and Online Methods, Data Analysis, Paragraph 1
+ -	2e	Permutation Test	Online Methods, Data Analysis, Paragraph 3	7	7 animals	Online Methods, Paragraph 1	mean regression coefficients	Fig. 2e	p<0.05 (range reported due to multiple comparisons)	Fig. legend	1000 permutations	Online Methods, Data Analysis, Paragraph 3
+ -	Main Section, Page 6, Paragraph 2	Kruskal-Wallis ANOVA	Main Section, Paragraph 7	6	6 animals each with 2 averaged behavioural sessions	Online Methods, Data Analysis, Paragraph 1	Boxplot figure (median, IQR, whole range)	Fig. ~~3b~~	p = 0.004	Main Section, Paragraph 7	$\chi 2(3)=13.62$	Main Section, Paragraph 7
+ -	Main Section, Page 6, Paragraph 2	Wilcoxon Signed Rank Test	Main Section, Paragraph 7	6	6 animals each with 2 averaged behavioural sessions	Online Methods, Data Analysis, Paragraph 1	Boxplot figure (median, IQR, whole range)	Fig. ~~3b~~	all p = 0.03	Main Section, Paragraph 7	all W = 0	Main Section, Paragraph 7
+ -	Main Section, Page 6, Paragraph 2	Wilcoxon Signed Rank Test	Main Section, Paragraph 7	6	6 animals each with 2 averaged behavioural sessions	Online Methods, Data Analysis, Paragraph 1	Boxplot figure (median, IQR, whole range)	Fig. ~~3b~~	Go small vs NoGo small, p = 0.44 and Go small vs NoGo Large, p = 0.69	Main Section, Paragraph 7	Go small vs NoGo small, W = 15 and Go small vs NoGo Large, and 13	Main Section, Paragraph 7-
+ -	Main Section, Page 6, Paragraph 2	Wilcoxon Signed Rank Test	Main Section, Paragraph 7	6	6 animals each with 2 averaged behavioural sessions	Online Methods, Data Analysis, Paragraph 1	Bar Figure (mean ± SD)	Fig. S8	all p = 0.03	Main Section, Paragraph 7	all W = 0	Main Section, Paragraph 7-

+ -	S9	Permutation Test	Fig. legend and Online Methods, Data Analysis, Paragraph 3	9	9 electrodes	Online Methods, Paragraph 1 and Data Analysis, Paragraph 1	mean area under the receiver operating characteristic curve	Fig. S9	p<0.05 (range reported due to multiple comparisons)	Fig. legend	grey boundaries = population of 1000 permuted sessions (null distribution)	Fig. S9, Fig. legend and Online Methods, Data Analysis, Paragraph 3
+ -	3e	Permutation Test	Online Methods, Data Analysis, Paragraph 3	9	9 electrodes	Online Methods, Paragraph 1 and Data Analysis, Paragraph 1	mean regression coefficients	Fig. 3e	p<0.05 (range reported due to multiple comparisons)	Fig. legend	1000 permutations	Online Methods, Data Analysis, Paragraph 3
+ -	S7a	Permutation Test	Fig. legend and Online Methods, Data Analysis, Paragraph 3	7	7 animals	Online Methods, Paragraph 1	mean area under the receiver operating characteristic curve	Fig. S7a	p<0.05 (range reported due to multiple comparisons)	Fig. legend	grey boundaries = population of 1000 permuted sessions (null distribution)	Fig. S7, Fig. legend and Online Methods, Data Analysis, Paragraph 3
+ -	S4c	Wilcoxon Signed Rank Test	Fig. legend	7	7 animals	Online Methods, Paragraph 1	Boxplot figure (median, IQR, whole range)	Fig. S4c	p = 0.02	Fig. legend	W = 0	Fig. legend
+ -	S5	Wilcoxon Signed Rank Test	Fig. legend	6	6 animals each with 2 averaged behavioural sessions	Online Methods, Data Analysis, Paragraph 1	statement in figure legend	Fig. S5	p = 0.02	Fig. legend	W = 0	Fig. legend

Representative figures

1. Are any representative images shown (including Western blots and immunohistochemistry/staining) in the paper?

   If so, what figure(s)?

   Yes. One representative Nissl stained coronal section showing a lesion in the NAcc at the recording location. Supplementary Figure 1

2. For each representative image, is there a clear statement of how many times this experiment was successfully repeated and a discussion of any limitations in repeatability?

   If so, where is this reported (section, paragraph #)?

   Yes, a clear statement of successful and unsuccessful recording locations is reported in Online Methods, Paragraph 1. Line 3. Each of the successful recording locations is explicitly shown in Supplementary Figure 1.

Statistics and general methods

1. Is there a justification of the sample size? If so, how was it justified? Where (section, paragraph #)? Even if no sample size calculation was performed, authors should report why the sample size is adequate to measure their effect size.	Sample size in this study are similar to those generally employed in the field and were not pre-determined by a sample size calculation. The sample size is justified by the high rate of exclusion due to the difficulty of the technique (correct electrode placement, etc.), which is explained in Online Methods, Paragraph 1.
2. Are statistical tests justified as appropriate for every figure? Where (section, paragraph #)?	Yes, standard statistical tests are used in this study. Used tests are clearly stated in Main Section, Figure Legends and Online Methods, Statistical Analysis section.
a. If there is a section summarizing the statistical methods in the methods, is the statistical test for each experiment clearly defined?	Yes, general statistical tests used are summarized in Online Methods, Statistical Analysis, Paragraph 1, Line 1: 'Behavioral data from the included recording sessions was analyzed using non-parametric statistics: Kruskal-Wallis ANOVA and Wilcoxon Signed Rank Test (though note that all effects remained the same when analyzed using equivalent parametric tests).' Each individual statistical test is then clearly described in the Statistical Analysis section of the Online Methods and defined where the test results are reported in the Main Section or Figure Legend as shown in the above table.
b. Do the data meet the assumptions of the specific statistical test you chose (e.g. normality for a parametric test)? Where is this described (section, paragraph #)?	Yes. Non-parametric statistical tests were chosen because best suited to small sample size although the effects of each test was confirmed using the equivalent parametric test. This is described in Online Methods, Statistical Analysis, Paragraph 1, Line 1: 'Behavioral data from the included recording sessions was analyzed using non-parametric statistics: Kruskal-Wallis ANOVA and Wilcoxon Signed Rank Test (though note that all effects remained the same when analyzed using equivalent parametric tests).'
c. Is there any estimate of variance within each group of data? Is the variance similar between groups that are being statistically compared? Where is this described (section, paragraph #)?	All the analysis is performed within group. The data is reported as mean and standard error of the mean and is depicted as such in the figures except for the box plots (Fig. 1b, 1d, S4c and S6c) which show median, IQR and whole range of data points and the bar figure Fig. 1c which shows mean and standard deviation. In this latter case this is explicitly stated in the Figure legend.
d. Are tests specified as one- or two-sided?	No but all tests are two-sided.
e. Are there adjustments for multiple comparisons?	Yes adjustments are made where appropriate and a clearly stated in the text: 'Permutation tests were considered significant at any time point when $p<0.05$, corrected for multiple comparisons (i.e.,$p<0.001$)'.

3. Are criteria for excluding data points reported? Was this criterion established prior to data collection? Where is this described (section, paragraph #)?	Yes: 'Trials where the PCA failed to successfully extract dopamine current on >50% of data points in a trial were excluded.' Yes, this criterion was established before data collection and is routinely used in the field. Online Methods, Data Analysis, Paragraph 2, Line 7
4. Define the method of randomization used to assign subjects (or samples) to the experimental groups and to collect and process data. If no randomization was used, state so. Where does this appear (section, paragraph #)?	No randomization was necessary as only one experimental group is shown here.
5. Is a statement of the extent to which investigator knew the group allocation during the experiment and in assessing outcome included? If no blinding was done, state so. Where (section, paragraph #)?	Blinding was not necessary for this experimental design.
6. For experiments in live vertebrates, is a statement of compliance with ethical guidelines/regulations included? Where (section, paragraph #)?	Yes: 'All procedures were carried out in accordance with the UK Animals (Scientific Procedures) Act (1986) and its associated guidelines'. Online Methods, Paragraph 1, Line 1.
7. Is the species of the animals used reported? Where (section, paragraph #)?	Yes. Abstract, throughout Main Section and in Online Methods, Paragraph 1.
8. Is the strain of the animals (including background strains of KO/ transgenic animals used) reported? Where (section, paragraph #)?	Yes: '[...] naïve male Sprague-Dawley rats were used for this experiment (Harlan,UK)' Online Methods, Paragraph 1, Line 2 and Line 8.
9. Is the sex of the animals/subjects used reported? Where (section, paragraph #)?	Yes: '[...] naïve male Sprague-Dawley rats were used for this experiment (Harlan,UK)' Online Methods, Paragraph 1, Line 2 and Line 8.
10. Is the age of the animals/subjects reported? Where (section, paragraph #)?	Yes: '[...] rats were [...] aged ~2 months at the start of training' Online Methods, Page 14, Paragraph 1, Line 3 and '[...] rats were [...] aged ~5 months at the start of training' Online Methods, Paragraph 1, Line 9.
11. For animals housed in a vivarium, is the light/dark cycle reported? Where (section, paragraph #)?	Yes: 'Animals were maintained on a twelve-hour light/dark cycle (lights on 07.00).' Online Methods, Paragraph 1, Line 13.
12. For animals housed in a vivarium, is the housing group (i.e. number of animals per cage) reported? Where (section, paragraph #)?	Yes: 'Animals [...] were group housed during initial habituation and training but individually housed following surgery.' Online Methods, Paragraph 1, Line 13.
13. For behavioral experiments, is the time of day reported (e.g. light or dark cycle)? Where (section, paragraph #)?	Yes: 'All testing was carried out during the light phase.' Online Methods, Paragraph 1, Line 14.

14. Is the previous history of the animals/subjects (e.g. prior drug administration, surgery, behavioral testing) reported?

    Where (section, paragraph #)?

    No. The animals used in this study had no prior history and we can add an explicit statement to this effect after review.

    a. If multiple behavioral tests were conducted in the same group of animals, is this reported?

       Where (section, paragraph #)?

       Only one behavioural test was conducted on this group of animals.

15. If any animals/subjects were excluded from analysis, is this reported?

    Where (section, paragraph #)?

    Yes: '2 rats were excluded for being unable to maintain a No-Go response for the required time, 5 rats were excluded for misplaced electrodes outside the nucleus accumbens core (either in the medial or ventral shell), 1 rat was unable to be connected to the recording device due to a misaligned implant, and 2 rats had broken/noisy electrodes.'
    Online Methods, Paragraph 1, Line 4.

    '1 rat was culled due to post-surgical complication; and out of the 22 remaining electrodes, 6 were broken/noisy, and 7 were misplaced'
    Online Methods, Paragraph 1, Line 9.

    a. How were the criteria for exclusion defined?

       Where is this described (section, paragraph #)?

       The exclusion criteria were all defined prior to the experimental design based on utility of subject and each criterion is reported in Online Methods, Paragraph 1, Line 4 and Line 9.

    b. Specify reasons for any discrepancy between the number of animals at the beginning and end of the study.

       Where is this described (section, paragraph #)?

       The animals were excluded at the beginning of the study and are not included in the presented dataset. There is therefore no discrepancy between the beginning and the end of the study.

Reagents

1. Have antibodies been validated for use in the system under study (assay and species)?

   No antibodies have been used in this study.

   a. Is antibody catalog number given?

      Where does this appear (section, paragraph #)?

      n/a

   b. Where were the validation data reported (citation, supplementary information, Antibodypedia)?

      Where does this appear (section, paragraph #)?

      n/a

2. If cell lines were used to reflect the properties of a particular tissue or disease state, is their source identified?

   Where (section, paragraph #)?

   No cell lines have been used in this study.

a. Were they recently authenticated?

Where is this information reported (section, paragraph #)?

n/a

Data deposition

Data deposition in a public repository is mandatory for:

a. Protein, DNA and RNA sequences
b. Macromolecular structures
c. Crystallographic data for small molecules
d. Microarray data

Deposition is strongly recommended for many other datasets for which structured public repositories exist; more details on our data policy are available here. We encourage the provision of other source data in supplementary information or in unstructured repositories such as Figshare and Dryad.

1. Are accession codes for deposit dates provided?

   Where (section, paragraph #)?

n/a

Computer code/software

Any custom algorithm/software that is central to the methods must be supplied by the authors in a usable and readable form for readers at the time of publication. However, referees may ask for this information at any time during the review process.

1. Identify all custom software or scripts that were required to conduct the study and where in the procedures each was used.

Software written in LabView was used to acquire and analyse voltammetric data and scripts written in Matlab were used for all the rest of the data and statistical analysis. This is reported in Online Methods, Data Analysis section.

2. Is computer source code/software provided with the paper or deposited in a public repository? Indicate in what form this is provided or how it can be obtained.

No computer source code/software is provided with the paper or deposited in a public repository.

Human subjects

1. Which IRB approved the protocol?

   Where is this stated (section, paragraph #)?

n/a

2. Is demographic information on all subjects provided?

   Where (section, paragraph #)?

n/a

3. Is the number of human subjects, their age and sex clearly defined?

   Where (section, paragraph #)?

n/a

4. Are the inclusion and exclusion criteria (if any) clearly specified?

   Where (section, paragraph #)?

n/a

5. How well were the groups matched?

   Where is this information described (section, paragraph #)?

   n/a

6. Is a statement included confirming that informed consent was obtained from all subjects?

   Where (section, paragraph #)?

   n/a

7. For publication of patient photos, is a statement included confirming that consent to publish was obtained?

   Where (section, paragraph #)?

   n/a

fMRI studies

For papers reporting functional imaging (fMRI) results please ensure that these minimal reporting guidelines are met and that all this information is clearly provided in the methods:

1. Were any subjects scanned but then rejected for the analysis after the data was collected?

   n/a

   a. If yes, is the number rejected and reasons for rejection described?

      Where (section, paragraph #)?

      n/a

2. Is the number of blocks, trials or experimental units per session and/or subjects specified?

   Where (section, paragraph #)?

   n/a

3. Is the length of each trial and interval between trials specified?

   n/a

4. Is a blocked, event-related, or mixed design being used? If applicable, please specify the block length or how the event-related or mixed design was optimized.

   n/a

5. Is the task design clearly described?

   Where (section, paragraph #)?

   n/a

6. How was behavioral performance measured?

   n/a

7. Is an ANOVA or factorial design being used?

   n/a

8. For data acquisition, is a whole brain scan used?

   If not, state area of acquisition.

   n/a

   a. How was this region determined?

      n/a

9. Is the field strength (in Tesla) of the MRI system stated?	n/a
a. Is the pulse sequence type (gradient/spin echo, EPI/spiral) stated?	n/a
b. Are the field-of-view, matrix size, slice thickness, and TE/TR/ flip angle clearly stated?	n/a
10. Are the software and specific parameters (model/functions, smoothing kernel size if applicable, etc.) used for data processing and pre-processing clearly stated?	n/a
11. Is the coordinate space for the anatomical/functional imaging data clearly defined as subject/native space or standardized stereotaxic space, e.g., original Talairach, MNI305, ICBM152, etc? Where (section, paragraph #)?	n/a
12. If there was data normalization/standardization to a specific space template, are the type of transformation (linear vs. nonlinear) used and image types being transformed clearly described? Where (section, paragraph #)?	n/a
13. How were anatomical locations determined, e.g., via an automated labeling algorithm (AAL), standardized coordinate database (Talairach daemon), probabilistic atlases, etc.?	n/a
14. Were any additional regressors (behavioral covariates, motion etc) used?	n/a
15. Is the contrast construction clearly defined?	n/a
16. Is a mixed/random effects or fixed inference used?	n/a
a. If fixed effects inference used, is this justified?	n/a
17. Were repeated measures used (multiple measurements per subject)?	n/a
a. If so, are the method to account for within subject correlation and the assumptions made about variance clearly stated?	n/a
18. If the threshold used for inference and visualization in figures varies, is this clearly stated?	n/a
19. Are statistical inferences corrected for multiple comparisons?	n/a
a. If not, is this labeled as uncorrected?	n/a

20. Are the results based on an ROI (region of interest) analysis?	n/a
a. If so, is the rationale clearly described?	n/a
b. How were the ROI's defined (functional vs anatomical localization)?	n/a
21. Is there correction for multiple comparisons within each voxel?	n/a
22. For cluster-wise significance, is the cluster-defining threshold and the corrected significance level defined?	n/a

Additional comments

Additional Comments	