nature neuroscience

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Main Figures: 3

Supplementary Figures: 9

Supplementary Tables: 3

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 #
+ -	1a upper and lower panels	two-tailed unpaired t-test	Fig 1 legend	8,15	slices from 5 and 8 mice	Fig 1 legend	error bars are mean +/- SEM	Fig 1 legend	forS1 p=0.84 for S2 p=0.0011	Fig 1 legend, Supplementary Table 1		
+ -	1b upper and lower panels	two-tailed unpaired t-test	Figure 1 legend	37,11; 44,11	slices from 17,7 and 21,6 mice	Figure 1 legend	error bars are mean +/- SEM	Fig 1 legend	p=0.91 for young, p=-2.7E-7 for old	Fig 1 legend		
+ -	1c	two-tailed paired t-test	Fig 1 legend	7,4,4;7, 12,10	BMI applications, 5, 2, 2 slices from 2,1,1 young mice; 7,8,8 slices from 2, 2, 2 old mice	Supplementary Table 2	error bars are mean +/- SEM	Fig 1 legend	p=0.0913, p=0.8296, p=0.735, p=0.5866, p=0.0005, p=0.0186	Supplementary Table 2		
+ -	2a, b	two-tailed unpaired t-test	Fig 2 legend	8,11,7; 15, 6, 4	slices from 5,4,3 young mice and 8,3,1 old mice	Supplementary Table 3	error bars are mean +/- SEM	Fig 2 legend	p=0.4 p=0.0041 p=0.47 p=0.58 p=0.545 p=0.0021 p=0.2 p=0.21	Supplementary Table 3		
+ -	2c	Pearson's correlation ceofficient and two-tailed t-test	Fig 2 legend	8,11,7;15 ,6,4	slices from 5,4,3 young mice and 8,3,1 old mice	Supplementary Table 3	mean and SD	Fig 2 legend	p=0.154 p=0.179 p=0.554 p=0.097 p=0.947 p=0.688	Fig 2c inset		
+ -	3b	one-way ANOVA, Tukey's post correction for multiple comparisons	Fig 3 legend	8,7,12,7; 14, 14, 11, 15	slices from 2,6 young and 2,7 old mice	Fig 3 legend	error bars are mean +/- SEM	Fig 3 legend	p<0.0001	Fig 3 legend	@10 min F[3, 30] = 12.34 @40 min F[3, 50] = 31.75	Fig 3 legend
+ -	3d	one-way ANOVA, Tukey's post correction for multiple comparisons	Fig 3 legend	8,7,12,7; 14, 14, 11, 15	slices from 2,6 young and 2,7 old mice	Fig 3 legend	error bars are mean +/- SEM	Fig 3 legend	p=0.3080 p<0.0001 p=0.0008 p<0.0001 p=0.0002	Fig 3 legend	@10 min F[3, 30] = 1.253 @40 min F[3, 50] = 12.39	Fig 3 legend
+ -	Suppl 3b	χ^2 with Yates continuity correction	Suppl Fig 3 legend	9,7,28; 6,21,23	slices	Suppl Fig 3 legend	χ^2 = 5.45 and 0.105	Suppl Fig 3 legend	p= 0.0195 and p=0.746	Suppl Fig 3 legend		
+ -	Suppl 3c	two-tailed unpaired t-test	Suppl Fig 3 legend	37,44	slices from 17 young and 21 old mice	Suppl Fig 3 legend	error bars are mean +/- SEM	Suppl Fig 3 legend	p=0.0021	Suppl Fig 3 legend		

+ -	Suppl 4a	Two-way ANOVA	Suppl Fig 4 legend	16,30	slices	Suppl Fig 4 legend	box and whiskers	Suppl Fig 4 legend	Interaction p=0.1599 F=2.009 Age p=0.2306 F=1.458 TBS p=0.3284 F=0.9658	Suppl Fig 4 legend	effect of TBS F[1, 88]=0.9658, p=0.5284; effect of age F[1,88]=1.458, p=0.2306; and interaction TBS×age F[1,88]=2.009, p=0.1599	Suppl Fig 4 legend
+ -	Suppl 4b	two-tailed paired t-test	Suppl Fig 4 legend	16,30	slices	Suppl Fig 4 legend	error bars are mean +/- SEM	Suppl Fig 4 legend	p=0.5166 p=0.2571 p=1820 p=0.0227	Suppl Fig 4 legend		
+ -	Suppl 5a,b	two-tailed unpaired t-test	Suppl Fig 5 legend	9,37;6,37 ;11,44;9, 44	slices	Suppl Fig 5 legend	error bars are mean +/- SEM	Suppl Fig 5 legend	p=0.84, p=0.0055, p=0.00086, p=0.00148	Suppl Fig 5 legend		
+ -	Suppl 6a,c	two-tailed paired t-test	Suppl Fig 6 legend	17,14;5,1 4	slices	Suppl Fig 6 legend	error bars are mean +/- SEM	Suppl Fig 6 legend	p=0.0015, p=0.65, p=0.60, p=0.0044	Suppl Fig 6 legend		
+ -	Suppl 7a-c	Mann Whitney test	Suppl Fig 7 legend	6, 15	slices	Suppl Fig 7 legend	error bars are mean +/- SEM	Suppl Fig 7 legend	p=0.969, p=0.5855, p=0.4596	Suppl Fig 7 legend		
+ -	Suppl 8c	two-tailed unpaired t-test	Suppl Fig 8 legend	4, 4	slices	Suppl Fig 8 legend	error bars are mean +/- SEM	Suppl Fig 8 legend	p=0.7461	Suppl Fig 8 legend		

Representative figures

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

   If so, what figure(s)?

Yes.

Figs 1-3, Supplementary Figs 1, 3, 5, 6.

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.
Figure legends, Online Methods, Supplementary Tables 1-3.

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.

No a priori sample size was determined but our sample sizes are equivalent or larger than those used in previous publications on the topic.
Online Methods. Statistics.

2. Are statistical tests justified as appropriate for every figure?

   Where (section, paragraph #)?

Yes.
Online Methods, Statistics.

   a. If there is a section summarizing the statistical methods in the methods, is the statistical test for each experiment clearly defined?

Online Methods, Statistics.

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 #)?

Not formally tested, but individual data points are shown.

Online Methods, Statistics.

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 t-tests were performed according to equality of variance assessed by an F test.

Online Methods, Statistics.

d. Are tests specified as one- or two-sided?

All tests were two-sided.

e. Are there adjustments for multiple comparisons?

Yes.

3. To promote transparency, *Nature Neuroscience* has stopped allowing bar graphs to report statistics in the papers it publishes. If you have bar graphs in your paper, please make sure to switch them to dot-plots (with central and dispersion statistics displayed) or to box-and-whisker plots to show data distributions.

All bar graphs also show individual data points.

4. Are criteria for excluding data points reported?

Was this criterion established prior to data collection?

Where is this described (section, paragraph #)?

Yes, we reported the fraction of slices not showing LTP which has been excluded from further analyses.

Online Methods, Statistics.

5. 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 #)?

Collection of data was not randomized.
In each of the experiments testing synaptic specificity, one of the two independent pathways was randomly chosen (coin toss) to be tetanized.
Reported in Online Methods.

6. 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 #)?

Collection of data was not not done blindly, but experiments were repeated over a long study period (>2 years). Data analyses were done by a blinded investigator, and the conditions of the experiments were revealed only after all data were analyzed.
Online Methods, Statistics.

7. For experiments in live vertebrates, is a statement of compliance with ethical guidelines/regulations included?

Where (section, paragraph #)?

Yes, in Online Methods, Subjects.

8. Is the species of the animals used reported?

Where (section, paragraph #)?

Yes, in Online Methods, Subjects.

9. Is the strain of the animals (including background strains of KO/ transgenic animals used) reported?

Where (section, paragraph #)?

Yes, in Online Methods, Subjects.

10. Is the sex of the animals/subjects used reported?

    Where (section, paragraph #)?

Yes, in Online Methods, Subjects.

11. Is the age of the animals/subjects reported?

    Where (section, paragraph #)?

Yes, in Online Methods, Subjects.

12. For animals housed in a vivarium, is the light/dark cycle reported?

    Where (section, paragraph #)?

Yes, in Online Methods, Subjects.

13. For animals housed in a vivarium, is the housing group (i.e. number of animals per cage) reported?

    Where (section, paragraph #)?

Yes, in Online Methods, Subjects.

14. For behavioral experiments, is the time of day reported (e.g. light or dark cycle)?

    Where (section, paragraph #)?

N/A.

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

    Where (section, paragraph #)?

N/A.

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

       Where (section, paragraph #)?

N/A.

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

    Where (section, paragraph #)?

No animal subjects were excluded.

    a. How were the criteria for exclusion defined?

       Where is this described (section, paragraph #)?

N/A.

    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 #)?

N/A.

Reagents

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

Yes, several previously published studies.

    a. Is antibody catalog number given?

       Where does this appear (section, paragraph #)?

Yes, Methods, Quantitative Western Blots

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

Where does this appear (section, paragraph #)?

Citation (ref# 25) and also see Manufacturers website for more citations on the topic, due to the upper limit of citations allowed by the journal.

2. Cell line identity

a. Are any cell lines used in this paper listed in the database of commonly misidentified cell lines maintained by ICLAC and NCBI Biosample?

Where (section, paragraph #)?

N/A

b. If yes, include in the Methods section a scientific justification of their use--indicate here in which section and paragraph the justification can be found.

N/A

c. For each cell line, include in the Methods section a statement that specifies:

- the source of the cell lines
- have the cell lines been authenticated? If so, by which method?
- have the cell lines been tested for mycoplasma contamination?

Where (section, paragraph #)?

N/A

Data availability

Provide a Data availability statement in the Methods section under "Data availability", which should include, where applicable:

- Accession codes for deposited data
- Other unique identifiers (such as DOIs and hyperlinks for any other datasets)
- At a minimum, a statement confirming that all relevant data are available from the authors
- Formal citations of datasets that are assigned DOIs
- A statement regarding data available in the manuscript as source data
- A statement regarding data available with restrictions

See our data availability and data citations policy page for more information.

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.

We encourage publication of Data Descriptors (see Scientific Data) to maximize data reuse.

Where is the Data Availability statement provided (section, paragraph #)?

Provided.

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.

Custom-made Igor-Pro (Wavemetrics) procedures for fEPSP slope analysis.

2. If computer code was used to generate results that are central to the paper's conclusions, include a statement in the Methods section under "**Code availability**" to indicate whether and how the code can be accessed. Include version information as necessary and any restrictions on availability.

N/A

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	N/A