nature neuroscience

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Manuscript Type:	Technical Report	# Supplementary Tables:	1
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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 #
+ -	1f	one-way ANOVA	Fig. legend	5, 3, 4, 4, 5	# of Ca+2 imaging experiments; n>30 cells per experiment; n=114-396 total cells per condition	replicates shown in Fig. 1; number of cells in Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.0016	Fig. legend	F(4,16)=7.268	Fig. legend
+ -	1g	two-way ANOVA	Fig. legend	102, 48, 50, 45, 45	# of cells	Fig. legend	error bars are mean +/- SEM	Fig. legend	p<0.0001	Fig. legend	F(4, 32490)=199.1	Fig. legend
+ -	1h	two-way ANOVA	Fig. legend	88, 57	# of cells	Fig. legend	error bars are mean +/- SEM	Fig. legend	p<0.0001	Fig. legend	F(39,5680)=23.7	Fig. legend
+ -	Text	unpaired t-test	Para 2.	88, 57	# of cells	Para. 2	mean +/- SEM	Para. 2	p=0.0055	Para. 2	t(143)=2.819	Fig. legend
+ -	2e	one-way ANOVA	Fig. legend	14, 12, 3	number of cells from n=8 mice	Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.0243	Fig. legend	F(2,26)=4.301	Fig. legend
+ -	2e	unpaired t-test	Fig. legend	5, 3	number of cells from n=8 mice	Fig. legend	error bars are mean +/- SEM	Fig. legend	p<0.0001	Fig. legend	t(7)=13.23	Fig. legend
+ -	3a	two-way ANOVA	Fig. legend	20, 33	number of cells from n=5 fish	Fig. legend	error bars are mean +/- SEM	Fig. legend	p<0.0001	Fig. legend	F(42,2339)=3.248	Fig. legend
+ -	3b	unpaired t-test	Fig. legend	3, 6	experimental replicates; n=17-27 fish per condition	replicates shown in figure; # of fish used stated in legend	error bars are mean +/- SEM	Fig. legend	p=0.0005	Fig. legend	t(7)=6.152	Fig. legend
+ -	3c	one-way ANOVA	Fig. legend	4, 4, 6	experimental replicates; n=17-27 fish per condition	replicates shown in figure; # of fish used stated in legend	error bars are mean +/- SEM	Fig. legend	p<0.0001	Fig. legend	F(2,11)=39.01	Fig. legend
+ -	4c	unpaired t-test	Fig. legend	51, 81	number of neurons from n=5 mice	Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.0017	Fig. legend	t(130)=3.210	Fig. legend
+ -	4e	two-way ANOVA	Fig. legend	23, 28	number of neurons from n=5 mice	Fig. legend	error bars are mean +/- SEM	Fig. legend	p<0.0001	Fig. legend	F(1,5880)=210.9	Fig. legend
+ -	5e	one-way ANOVA	Fig. legend	6, 6, 6	number of mice	Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.0152	Fig. legend	F(2,15)=5.611	Fig. legend
+ -	S3h	one-way ANOVA	Fig. legend	6, 8, 6	experimental replicates; n=437-540 cells per condition	replicates shown in figure; # of cells in Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.0046	Fig. legend	F(2,17)=7.509	Fig. legend
+ -	S7b	unpaired t-test	Fig. legend	12, 12	neurons from n=8 mice	Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.1178	Fig. legend	t(22)=1.628	Fig. legend
+ -	S7b	unpaired t-test	Fig. legend	12, 12	neurons from n=8 mice	Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.1079	Fig. legend	t(22)=1.676	Fig. legend
+ -	S7c	unpaired t-test	Fig. legend	12, 12	neurons from n=8 mice	Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.8498	Fig. legend	t(22)=0.1926	Fig. legend
+ -	S7d	unpaired t-test	Fig. legend	12, 12	neurons from n=8 mice	Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.1954	Fig. legend	t(22)=1.335	Fig. legend

+ -	S7e	unpaired t-test	Fig. legend	12, 12	neurons from n=8 mice	Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.8985	Fig. legend	t(22)=0.1290	Fig. legend
+ -	S7f	unpaired t-test	Fig. legend	12, 12	neurons from n=8 mice	Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.3042	Fig. legend	t(22)=1.052	Fig. legend
+ -	S7g	unpaired t-test	Fig. legend	12, 12	neurons from n=8 mice	Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.6868	Fig. legend	t(22)=0.4086	Fig. legend
+ -	S9c	Chi-squared	Fig. legend	43, 25	number of fish	Fig. legend	bins specified	Figure	p<0.0001	Fig. legend	Chi(3)=36.51	Fig. legend
+ -	S9d	one-way ANOVA	Fig. legend	22, 15, 12, 19	number of fish	Fig. legend/ Figure panel	error bars are mean +/- SEM	Fig. legend	p=0.0129	Fig. legend	F(3,64)=3.89	Fig. legend
+ -	S10a	unpaired t-test	Fig. legend	20, 33	number of cells from n=5 fish	Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.0014	Fig. legend	t(51)=3.373	Fig. legend
+ -	S11a	unpaired t-test	Fig. legend	7, 8	number of cells from n=1 mouse	Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.0472	Fig. legend	t(13)=2.192	Fig. legend
+ -	S11c	unpaired t-test	Fig. legend	6, 6	number of mice	Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.9312	Fig. legend	t(10)=0.08856	Fig. legend
+ -	S6c	Welch's t-test	Fig. legend	3, 5	number of coverslips; n=114 and n=396 cells	Fig. legend	error bars are mean +/- SEM	Fig. legend	p=0.0395	Fig. legend	t(2.882)=4.457	Fig. legend

Representative figures

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

   If so, what figure(s)?

Fig. 1 a-e (calcium imaging micrographs)
Fig. 1 g (traces from single calcium imaging experiments)
Fig. 2 b (GFP immunofluorescence of transduced mouse brain)
Fig. 2 c-d (electrophysiological traces)
Fig. 5 b-c (heat maps of mouse side preference)
Fig. S3 b-g (calcium imaging micrographs)
Fig. S3 i (calcium imaging micrographs)
Fig. S4 a-e (immunocytochemistry)
Fig. S5 a-d (fluorescent reporter expression)
Fig. S6 b (traces from single calcium imaging experiments)
Fig. S7 a, h (electrophysiological traces)
Fig. S8 a-b (electrophysiological traces)
Fig. S9 a (transgene expression)
Fig. S10 e-f (zebrafish in vivo imaging)

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. Each representative image was used in data analysis. Number of replicates for each experiment is explicitly stated in the Figure legend or explicitly shown as replicates in the Figure itself.

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 statistical methods were used to pre-determine sample sizes but our sample sizes are similar to those generally employed in the field. Stated in Methods section, "Statistical methods."

2. Are statistical tests justified as appropriate for every figure? Where (section, paragraph #)?	Yes, tests were chosen based on data representation and are explicitly stated in each Figure legend.
a. If there is a section summarizing the statistical methods in the methods, is the statistical test for each experiment clearly defined?	Yes, Methods, "statistical methods" Specific test and post-test used is also explicitly stated in each Figure legend.
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 #)?	Normality was assumed, but N is too small for D'Agostino-Pearson Omnibus test. This is explicitly stated in Methods, "statistical methods." Two special cases: Chi-squared analysis was used in Sup. Fig. 9c because observation frequency was analyzed. Welch's t-test was used in Sup. Fig. 6c due to unequal sample size with a large variance in the sample with more replicates.
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 #)?	Yes, standard error of the mean is shown in every Figure where applicable and is explicitly stated in the Figure legends.
d. Are tests specified as one- or two-sided?	Yes, explicitly stated in Figure legends. Only two-sided tests were used
e. Are there adjustments for multiple comparisons?	Yes, Bonferroni corrections were used and are explicitly stated in Figure legends.
3. Are criteria for excluding data points reported? Was this criterion established prior to data collection? Where is this described (section, paragraph #)?	Yes, this was established prior to data collection. Calcium imaging: described in Methods, "In vitro magnetic calcium imaging," Paragraph 3, second sentence. Electrophysiology: described in Main Text, Paragraph 3, Sentence 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 #)?	Randomization was used for both calcium imaging and behavioral experiments. The criteria are specifically stated in Methods, "In vitro magnetic calcium imaging," paragraph 4, and "Zebrafish behavioral tests."
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 #)?	No blinding was performed and this is stated in Methods, "Statistical methods".
6. For experiments in live vertebrates, is a statement of compliance with ethical guidelines/regulations included? Where (section, paragraph #)?	Yes, Methods section "Zebrafish husbandry," first sentence
7. Is the species of the animals used reported? Where (section, paragraph #)?	Yes, Methods section, "Mice information" and "Zebrafish husbandry".

8. Is the strain of the animals (including background strains of KO/ transgenic animals used) reported? Where (section, paragraph #)?	Yes, Methods section, "Mice information" and "Zebrafish husbandry".
9. Is the sex of the animals/subjects used reported? Where (section, paragraph #)?	Yes, Methods section, "Mice information" and "Zebrafish husbandry."
10. Is the age of the animals/subjects reported? Where (section, paragraph #)?	Yes, Methods section, "Mice information," "Zebrafish behavioral tests."
11. For animals housed in a vivarium, is the light/dark cycle reported? Where (section, paragraph #)?	Yes, "Mice information"
12. For animals housed in a vivarium, is the housing group (i.e. number of animals per cage) reported? Where (section, paragraph #)?	Yes, "Mice information"
13. For behavioral experiments, is the time of day reported (e.g. light or dark cycle)? Where (section, paragraph #)?	Yes, Methods, "Zebrafish behavioral tests," and "Mouse behavioral testing."
14. Is the previous history of the animals/subjects (e.g. prior drug administration, surgery, behavioral testing) reported? Where (section, paragraph #)?	Yes, Methods, "Zebrafish behavioral tests," and "Single unit recordings in vivo in freely moving mice," paragraph 2.
a. If multiple behavioral tests were conducted in the same group of animals, is this reported? Where (section, paragraph #)?	Multiple tests were not performed on zebrafish, this is stated in Methods, "Zebrafish behavioral tests." Mice testing specified in "Single unit recordings in vivo in freely moving mice," and "Mouse behavioral testing."
15. If any animals/subjects were excluded from analysis, is this reported? Where (section, paragraph #)?	2 animals were excluded from zebrafish behavioral analysis (Fig 3c). This is reported in Methods, "zebrafish behavioral tests." 1 animal was excluded from the in vivo electrophysiology analysis because it failed to yield >3 characterizable units. This is reported in Methods, "Single unit recordings in vivo in freely behaving mice"
a. How were the criteria for exclusion defined? Where is this described (section, paragraph #)?	Criteria for exclusion were defined as stereotypic coiling, defined as constant movement during the movie without any gaps in the behavior. This is described in Methods, "Zebrafish behavioral tests." The mouse did not yield >n=3 units for the analysis. This is stated in Methods, "Single unit recordings in vivo in freely behaving mice"

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 #)?

2 WT animals were excluded from the uninjected control group analysis under conditions of magnetic field exposure due to the above criteria. This is described in Methods, "zebrafish behavioral tests."

1 mouse failed to yield >n=3 units for electrophysiological recordings. Described in Methods, "Single unit recordings in vivo in freely behaving mice"

Reagents

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

Yes

a. Is antibody catalog number given?

Where does this appear (section, paragraph #)?

Yes, Methods, "Zebrafish whole mount immunostaining" & "Immunohistochemistry"

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

Where does this appear (section, paragraph #)?

Zebrafish citation: Smith et al., PLoS Biol. 12, e1001961 (2014); "Zebrafish whole mount immunostaining"

Mouse: NOTE: our validation using antibodies against TRPV4 showed that they are not sufficient for use in this study

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 #)?

No

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 #)?

Source specified in Methods, "Cell transfection and cell culture," Cells were tested for authenticity and contamination, stated in Methods, "Cell transfection and cell culture."

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.

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

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.

N/A

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