nature neuroscience

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Manuscript Number: NN-A50634D

Manuscript Type: Article

Main Figures: 7

Supplementary Figures: 10

Supplementary Tables: 2

Supplementary Videos:

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 #
+ -	1d	Friedman ANOVA; post-hoc Wilcoxon paired test	legend	6 and 16	Averaged correlations over the first breath pos-odor for the different sub-groups 4 mice	legend and methods	Error bars are means +/- SEM	legend	p=0.04; post-hoc: at least p > 0.068	legend	X2=10; Z=1.83	legend
+ -	1f	Friedman ANOVA; post-hoc Wilcoxon paired test	legend	10	Averaged correlations for the 8 bins post-odor for different sub-groups 4 mice	legend and methods	Error bars are means +/- SEM	legend	at least p < 10e-5 p=0.15	legend	X2=13.2	legend
+ -	2d	Mann-Whitney U test	methods	10 values	Rate averaged over the breathing cycle for each trial 78 cells, 16 odors, in 6 mice	legend and methods	Bars are percentage of breath-odor pair	legend	To be selected as reponsive odor-cell pair, at least p<0.05	methods		
+ -	2e	Kolmogorv Smirnoff test	methods	Number of spikes for 10 trials	Spike timing over the breathing cycle for 10 trials 78 cells, 16 odors in 6 mice	legend and methods	Bars are percentage of breath-cell pair	legend	To be selected as reponsive odor-cell pair, at least p<0.05	methods		
+ -	2g	Mann-Whitney U test	legend	6 or 16 correlations values	Correlation for each odor pair defined by color schema averaged over 8 bins in the breath 78 cells in 6 mice	legend and methods	Error bars are means +/- SEM	legend	p=0.003; 0.007; 0.01; 3.1x10-4; 1.5x10-4; 0.01; 0.02	figure panel		
+ -	2h	Kolmogorv Smirnoff test	legend	112	Correlation for all mixture pair averaged over 8 bins in the breath 78 cells in 6 mice	legend	Scatter plot	legend	p=2x10-15	figure panel		
+ -	2h	Regression	legend	112 pairs of mixtures	Correlation for all mixture pair averaged over 8 bins in the breath 78 cells in 6 mice	legend	Scatter plot	legend		figure panel	R2=0.044	figure panel
+ -	3b	Friedman ANOVA	legend	8 values of correlation for the 5 subgroups of mixtures	Correlations averaged over the different odors of the subgroups. 78 cells in 6 mice	legend	Error bars are means +/- SEM	legend	p=0.0007	legend		legend

+ -	4c	One way ANOVA	legend	6 or 16 correlations values	Rate averaged over the different odors of the subgroups. 78 cells in 6 mice	legend	Error bars are means +/- SEM	legend	p=0.67; p=0.27	figure panel		
+ -	5c	ANOVA	legend	10 correlations/ performances	Correlations values averaged over 8 bins of the 1st breath post-odor for 10 mixtures pairs 78-169 cells in 4- 8 mice Discrimination performances averaged over 300 trials in 18 mice	legend and methods	box plots (25th and 75th percentiles), bar (mean), whiskers (10th and 90th percentiles)	legend	p=0.2	figure panel	R2=0.17	figure panel
+ -	5d-e	ANOVA	legend	10 correlations/ performances	Mean/minimium correlations values over 8 bins of the 1st breath post-odor for 10 mixtures pairs 78-169 cells in 4- 8 mice Discrimination performances averaged over 300 trials in 18 mice	legend	Error bars are means +/- SEM	legend	p=0.0021; p=0.0058	figure panel	R2=0.67; R2=0.59	figure panel
+ -	6g	Wilcoxon paired test	legend	38	Rate averaged over 6 odors and 10 trials pair 98 cells in 7 mice	legend and methods	box plots (25th and 75th percentiles), bar (mean), whiskers (10th and 90th percentiles)	legend	p=0.002; p=0.031	legend		
+ -	6h	Wilcoxon paired test	legend	30	Correlation for 3 odor pairs and 10 bins in the first breath post-odor 38 cells in 7 mice	legend and methods	box plots (25th and 75th percentiles), bar (mean), whiskers (10th and 90th percentiles)	legend	p=0.23, 0.0054, 0.0001	legend		
+ -	6i	Wilcoxon paired test	legend	15	Correlation for 3 odor pairs and 10 bins in the half of the first breath post-odor 38 cells in 7 mice	legend and methods	box plots (25th and 75th percentiles), bar (mean), whiskers (10th and 90th percentiles)	legend	p=0.016; p=0.026	legend		
+ -	6k	Repeated mesures ANOVA	legend	7	Average of 100 trials 7 mice	legend and methods	Error bars are means +/- SEM	legend	p=0.015; post-hoc fischer test, at least p<0.034; p=008	legend	F=8.3; F=3.7	legend
+ -	7b	Mann Withney U test	legend	40 and 55	Percentage values of pre-CNO rate 40 and 55 cells in 4 and 5 mice respectivels	legend and methods	box plots (25th and 75th percentiles), bar (mean), whiskers (10th and 90th percentiles)	legend	p=0.0051	legend		

+ -	7c	Mann Withney U test	legend	30	Percentage values of pre-CNO correlations for 3 odor pairs and 10 bins in the first breath post-odor 40 and 55 cells in 4 and 5 mice respectively	legend and methods	box plots (25th and 75th percentiles), bar (mean), whiskers (10th and 90th percentiles)	legend	p=0.0055	legend		
+ -	7d	Repeated mesures ANOVA	legend	9	Average of 100 trials 9 mice	legend and methods	Error bars are means +/- SEM	legend	p=0.023; post-hoc LSD, at least p<0.045;	legend	F=6.32	legend
+ -	Suppl. 1f	Mann-Whitney U test	legend	6 and 16	Correlation for each odor pair defined by color schema averaged over 8 bins in the breath 4 mice	legend	Error bars are means +/- SEM	legend	p=2.4x10-4; p=5.8x10-4; 3.6x10-5; 0.006	legend		
+ -	Suppl. 2	Regression	legend	112	Correlation averaged over the 8 bins for the first breath post-odor for all different odor pairs		Scatter plot			figure panel	R=0.03	
+ -	Suppl. 3b	Kolmogorv Smirnoff test	legend		Responses amplitudes averaged on the first breath for all glomeruli 2 mice	legend	Cumulative plot		p < 0.05	legend		
+ -	Suppl. 4e	Repeated measures MANOVA	legend	6 and 16	Averaged correlation over the first breath for the different subgroups 4 mice	legend	Error bars are means +/- SEM	legend	p=0.055; post-hoc test: p=0.28, 0.016, 0.17	legend	F=3.125	legend
+ -	Suppl. 5a-b	Mann-Whitney U test	legend and methods	10 values of rate	Rate averaged over the breathing cycle for each trial 169 cells, 24 odors, in 4 animals	legend and methods	Bars are percentage of breath-odor pair and breath-cell pair		To be selected as reponsive odor-cell pair, at least p<0.05	legend		
+ -	Suppl. 5a-b	Kolmogorv Smirnoff test	legend and methods	Number of spikes for 10 trials	Spike timing over the breathing cycle for 10 trials 169 cells, 24 odors in 4 mice	legend and methods	Bars are percentage of breath-odor pair and breath-cell pair		To be selected as reponsive odor-cell pair, at least p<0.05	legend		
+ -	Suppl. 5c-d	Mann-Whitney U test	legend and methods	5 values of rate	Rate averaged over the breathing cycle for each trial 130 cells, 24 odors, in 8 mice	legend and methods	Bars are percentage of breath-odor pair and breath-cell pair		To be selected as reponsive odor-cell pair, at least p<0.05	legend		
+ -	Suppl. 5c-d	Suppl. Kolmogorv Smirnoff test5c-d	legend and methods	Number of spikes for 5 trials	Spike timing over the breathing cycle for 5 trials 130 cells, 24 odors in 8 mice	legend and methods	Bars are percentage of breath-odor pair and breath-cell pair		To be selected as reponsive odor-cell pair, at least p<0.05	legend		

+ -	Suppl. 6a-b	Kruskal-Wallis ANOVA; post-hoc	legend	6 and 16	Averaged correlation over the half breath for the different subgroups 78 cells in 6 mice	legend	Error bars are means +/- SEM	legend	(a) p=0.0001; post-hoc: p=0.049; p=0.006; p=0.03; p=0.0002; p=0.0009; (b) p=0.0003; p=0.003; p=0.002; p=0.002; p=0.002	figure panel		
+ -	Suppl. 6b-b	Wilcokon paired test	legend	4 x 5	Averaged correlation over the half breath in each bin 78 cells in 6 mice	legend	Error bars are means +/- SEM	legend	P = 0.028, 0.028, 0.17, 0.028, 0.0004	legend	H=28.2; H=32.3	legend
+ -	Suppl. 10b-c	Repeated mesures ANOVA	legend	7 and 8	Average of 100 trials 7 and 8 mice	legend	Error bars are means +/- SEM	legend	p=0.74; p=0.0038; post-hoc LSD test: at least p=0.05	legend	F=0.11; F=12.3	legend
+ -	Results para 1 of "GABA neurons modulate pattern separation and learning"	Chi square	text	228	Cell odor-pair 38 cells, 6 odors in 7 mice	text			p=0.01	text		
+ -	Fig.3 c	Wilcoxon paired test	legend	6 and 16	6 or 16 correlation values per group, at max and min	legend	Errors bars are means +/- SEM	legend	at least p < 0.0022	legend		
+ -	Fig.3 e	Friedman ANOVA	legend	120	120 correlation values from odor pairs, 6 bins	legend	Errors bars are means +/- SEM	legend	at least p < 0.001	legend		
+ -	Fig 3 f	Friedman ANOVA	legend	120	120 correlation values from odor pairs, 10 bins	legend	Errors bars are means +/- SEM	legend	at least p<0.001;			
+ -	Suppl. 7b,c	ANOVA	legend	9	Correlations values averaged over 4 bins of the 1st breath post-odor for 9 mixtures pairs 78 cells in 8 mice Discrimination performances averaged over 300 trials in 18 mice	legend	Errors bars are means +/- SEM	legend	p=0.036; p=0.006	legend	R2=0.72; R2=0.68	

+ -	Suppl. 7d,e	ANOVA	legend	9	Correlations values averaged over 7 bins of the 1st breath post-odor for 9 mixtures pairs 78 cells in 6 mice Discrimination performances averaged over 300 trials in 18 mice	legend	Errors bars are means +/- SEM	legend	p=0.014; p=0.022	legend	R2=0.6; R2=0.55	
+ -	Suppl. 10a	Wilcoxon paired test	legend	10	Correlation for 5 odor pairs and 10 bins in the first breath post-odor 39 cells in 7 mice	legend	Errors bars are means +/- SEM	legend	p=0.08	legend		
+ -	Suppl. 10d	Mann Whitney test	legend	7-14	Reaction time computed for each mouse	legend	Errors bars are means +/- SEM	legend	at least p<0.05	legend		

Representative figures

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

   If so, what figure(s)?

   Fig. 5b

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 #)?

   19 mice

   Fig. 5 and 6 legend and methods

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

   Mentioned in Methods

   Similar sample size was used in previously published studies

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

   Where (section, paragraph #)?

   Yes

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

      Yes (legends and methods)

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 #)?

For all the data that do not follow a normal distribution or equal variance, we performed non parametric tests.
It is specified in the methods, last paragraph "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 #)?

Yes

yes or no

It is specified in the methods, last paragraph "Statistics"

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

All test were two sided

e. Are there adjustments for multiple comparisons?

Yes

3. Are criteria for excluding data points reported?

Was this criterion established prior to data collection?

Where is this described (section, paragraph #)?

No data were excluded

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 to form experimental groups and record data (no particular method used)

It is specified in the methods, last paragraph "Statistics"

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 #)?

None of the experiments were blind of the genotype

It is specified in the methods, first paragraph "Animals and initial preparation"

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

Where (section, paragraph #)?

Yes

It is specified in the methods, first paragraph "Animals and initial preparation"

7. Is the species of the animals used reported?

Where (section, paragraph #)?

Yes
It is specified in the methods, first paragraph "Animals and initial preparation"

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

Where (section, paragraph #)?

Yes

It is specified in the methods, first paragraph "Animals and initial preparation"

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

Where (section, paragraph #)?

Yes
It is specified in the methods, first paragraph "Animals and initial preparation"

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

Where (section, paragraph #)?

Yes
It is specified in the methods, first paragraph "Animals and initial preparation"

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

    Where (section, paragraph #)?

Yes
It is specified in the methods, first paragraph "Animals and initial preparation"

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

    Where (section, paragraph #)?

Yes
It is specified in the methods, first paragraph "Animals and initial preparation"

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

    Where (section, paragraph #)?

Yes
It is specified in the methods, first paragraph "Animals and initial preparation"

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

    Where (section, paragraph #)?

Yes
It is specified in the methods, first paragraph "Animals and initial preparation"

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

       Where (section, paragraph #)?

Yes
It is specified in the methods, paragraph 6 "Head-restrained behavioral paradigm"

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

    Where (section, paragraph #)?

No data were excluded

not reported

    a. How were the criteria for exclusion defined?

       Where is this described (section, paragraph #)?

    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 #)?

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
It is specified in the methods, paragraph 1 "Immunohistochemistry and quantification"

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

       Where does this appear (section, paragraph #)?

yes
It is specified in the methods, paragraph 1 "Immunohistochemistry and quantification"

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

   Where (section, paragraph #)?

   not applicable

   a. Were they recently authenticated?

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

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 #)?

   Not applicable

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.

   Not applicable

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.

   Not applicable

Human subjects

1. Which IRB approved the protocol?

   Where is this stated (section, paragraph #)?

   Not applicable

2. Is demographic information on all subjects provided?

   Where (section, paragraph #)?

   Not applicable

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

   Where (section, paragraph #)?

   Not applicable

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

   Where (section, paragraph #)?

   Not applicable

5. How well were the groups matched?

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

   Not applicable

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

   Where (section, paragraph #)?

   Not applicable

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

   Where (section, paragraph #)?

   Not applicable

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?

   Not applicable

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

      Where (section, paragraph #)?

      Not applicable

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

   Where (section, paragraph #)?

   Not applicable

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

   Not applicable

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.

   Not applicable

5. Is the task design clearly described?

   Where (section, paragraph #)?

   Not applicable

6. How was behavioral performance measured?

   Not applicable

7. Is an ANOVA or factorial design being used?

   Not applicable

8. For data acquisition, is a whole brain scan used? If not, state area of acquisition.	Not applicable
a. How was this region determined?	Not applicable
9. Is the field strength (in Tesla) of the MRI system stated?	Not applicable
a. Is the pulse sequence type (gradient/spin echo, EPI/spiral) stated?	Not applicable
b. Are the field-of-view, matrix size, slice thickness, and TE/TR/ flip angle clearly stated?	Not applicable
10. Are the software and specific parameters (model/functions, smoothing kernel size if applicable, etc.) used for data processing and pre-processing clearly stated?	Not applicable
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 #)?	Not applicable
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 #)?	Not applicable
13. How were anatomical locations determined, e.g., via an automated labeling algorithm (AAL), standardized coordinate database (Talairach daemon), probabilistic atlases, etc.?	Not applicable
14. Were any additional regressors (behavioral covariates, motion etc) used?	Not applicable
15. Is the contrast construction clearly defined?	Not applicable
16. Is a mixed/random effects or fixed inference used?	Not applicable
a. If fixed effects inference used, is this justified?	Not applicable
17. Were repeated measures used (multiple measurements per subject)?	Not applicable
a. If so, are the method to account for within subject correlation and the assumptions made about variance clearly stated?	Not applicable
18. If the threshold used for inference and visualization in figures varies, is this clearly stated?	Not applicable
19. Are statistical inferences corrected for multiple comparisons?	Not applicable

a. If not, is this labeled as uncorrected?	Not applicable
20. Are the results based on an ROI (region of interest) analysis?	Not applicable
a. If so, is the rationale clearly described?	Not applicable
b. How were the ROI's defined (functional vs anatomical localization)?	Not applicable
21. Is there correction for multiple comparisons within each voxel?	Not applicable
22. For cluster-wise significance, is the cluster-defining threshold and the corrected significance level defined?	Not applicable

Additional comments

Additional Comments	