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Corresponding Author: Livingstone

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Main Figures: 6

Supplementary Figures: 12

Supplementary Tables: 2

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
+ -	1	Pearson's correlation test	fig legend		behavior from 7 monkeys		error bars are mean +/- SEM	fig 1 legend	p=0.1057 p=0.9366		r=-03828; r=0.1057	

		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 #
+ -	2a-c	t-score corrected for multiple comparisons	Methods 'Data Analysis' section	7			cluster size and p-value	Methods 'Data Analysis' section	31 voxel p<0.002	Methods 'Data Analysis' section		
+ -	2d	2-tailed t-test	fig legend	7			error bars are mean +/- SEM % Signal Change	fig legend				
+ -	fig 2	2x2 anova	fig legend	7			% signal change Main Effect of Stimulus		Helvetica Patch: p <0.05; Tetris Patch: p<0.01; Cartoon Face patch: p<0.05		[Helvetica Patch F(1,4) = 3.55, Tetris Patch F(1,4) = 8.6, Cartoon Face patch: F(1,4)=2.17,	
+ -	fig 2	2x2 ANOVA	fig legend	7			% signal change Main Effect of Training		Helvetica Patch: p <0.01; Tetris Patch: p<0.05; Cartoon Face patch: p<0.01		Helvetica Patch F(1,1) = 79.42; Tetris Patch F(1,1) = 2.7; Cartoon Face patch: F(1,1)=19.29	
+ -	fig 2	2x2 anova	fig legend	7			% signal change Interaction between Stimulus and Training		Helvetica Patch: p <0.01; Tetris Patch: p<0.01; Cartoon Face patch: p<0.01		Helvetica Patch F(1,4) = 9.88 Tetris Patch [F(1,4) = 6.91; Cartoon Face patch: F(1,4)=5.07	
+ -	fig 2	2x2 anova	fig legend	7			Hypothesis driven t-tests on % signal changes		Helvetica Patch: p <0.05; Tetris Patch: p<0.05; Cartoon Face patch: p<0.001; Cartoon Face Patch p < 0.001 Helvetica Patch p<0.01 p=0.02 p<0.05 p<0.05		Helvetica patch: t(12) = 2.188; Tetris patch: t(12) = 2.74; Cartoon Face Patch t(12)=-3.97; Cartoon Face Patch t(12)=-4.97; Helvetica Patch t(12)=-3.10 t(12)=-2.60 t(12)=2.45 t(12)=2.19	

+ -	fig 3	t-score corrected for multiple comparisons	Methods 'Data Analysis' section	10			cluster size and p-value	Methods 'Data Analysis' section	31 voxel p<0.002	Methods 'Data Analysis' section		
+ -	fig 4	t-score	Methods 'Data Analysis' section	4				Methods 'Data Analysis' section	8<abs(t)<2	Methods 'Data Analysis' section		
+ -	fig 5	bootstrap	Methods 'Correlation Coefficients' section	4			correlation coefficients	Methods 'Correlation Coefficients' section	p < 0.05	Methods 'Correlation Coefficients' section		
+ -	fig 6	Z- Scoring	Fig Legend	4			mean +/- SEM	fig legend				

Representative figures

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

   If so, what figure(s)?

   no

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 #)?

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. we used 7 monkeys, which is more monkeys than are usually used in monkey studies because we needed two groups, but 2-3 monkeys is standard given their price and difficulty of working with.

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

   Where (section, paragraph #)?

   yes. Methods paragraph "Data analysis"

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

      yes. Methods paragraphs "Data analysis" and "Correlation Coefficients" and "Conficence limits..."

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 #)?	We used shuffle tests, which do not make any assumptions about the distribution.
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 #)?	no
d. Are tests specified as one- or two-sided?	yes
e. Are there adjustments for multiple comparisons?	yes. Methods "Data Analysis"
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 #)?	we randomly assigned 3 monkeys to be trained on Tetris first, and 6 to Helvetica first, and one of the Tetris-first monkeys died accidentally.
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 done.
6. For experiments in live vertebrates, is a statement of compliance with ethical guidelines/regulations included? Where (section, paragraph #)?	yes, at end of Methods.
7. Is the species of the animals used reported? Where (section, paragraph #)?	yes, in Methods first sentence
8. Is the strain of the animals (including background strains of KO/ transgenic animals used) reported? Where (section, paragraph #)?	yes, first sentence of Methods
9. Is the sex of the animals/subjects used reported? Where (section, paragraph #)?	yes, in first sentence of methods
10. Is the age of the animals/subjects reported? Where (section, paragraph #)?	yes Fig S1

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

    Where (section, paragraph #)?

yes, in Methods last paragraph

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

    Where (section, paragraph #)?

yes, in Methods last para

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

    Where (section, paragraph #)?

yes, in Methods first para

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

    Where (section, paragraph #)?

yes in Methods first para

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

       Where (section, paragraph #)?

yes Fig S1

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

    Where (section, paragraph #)?

none were excluded except one died

    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 #)?

one monkey died accidentally.

Reagents

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

    a. Is antibody catalog number given?

       Where does this appear (section, paragraph #)?

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

       Where does this appear (section, paragraph #)?

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

   Where (section, paragraph #)?

   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.

1. Are accession codes for deposit dates provided?

   Where (section, paragraph #)?

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.

   we have written software to present symbols on touchscreens and reward the monkeys according to the value assigned to each symbol.

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.

   This software will be provided upon request.

Human subjects

1. Which IRB approved the protocol?

   Where is this stated (section, paragraph #)?

2. Is demographic information on all subjects provided?

   Where (section, paragraph #)?

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

   Where (section, paragraph #)?

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

   Where (section, paragraph #)?

5. How well were the groups matched?

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

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

   Where (section, paragraph #)?

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

   Where (section, paragraph #)?

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? — no

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

      Where (section, paragraph #)?

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

   Where (section, paragraph #)? — yes. Methods paragraph "Scanning"

3. Is the length of each trial and interval between trials specified? — yes Methods paragraph "Scanning"

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. — yes Methods paragraph "Scanning"

5. Is the task design clearly described?

   Where (section, paragraph #)? — yes Methods paragraph "Scanning"

6. How was behavioral performance measured? — percent larger choices

7. Is an ANOVA or factorial design being used? — yes

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

   If not, state area of acquisition. — whole brain

a. How was this region determined?	
9. Is the field strength (in Tesla) of the MRI system stated?	yes Methods paragraph "Scanning"
a. Is the pulse sequence type (gradient/spin echo, EPI/spiral) stated?	yes Methods paragraph "Scanning"
b. Are the field-of-view, matrix size, slice thickness, and TE/TR/ flip angle clearly stated?	yes Methods paragraph "Scanning"
10. Are the software and specific parameters (model/functions, smoothing kernel size if applicable, etc.) used for data processing and pre-processing clearly stated?	yes Methods paragraph "Data Analysis"
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 #)?	yes, Methods paragraphs "Data Analysis" and "ROI analysis"
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 #)?	yes, Methods paragraph "Data Analysis"
13. How were anatomical locations determined, e.g., via an automated labeling algorithm (AAL), standardized coordinate database (Talairach daemon), probabilistic atlases, etc.?	CARET
14. Were any additional regressors (behavioral covariates, motion etc) used?	motion correction was used and is described inMethods paragraph "Data Analysis"
15. Is the contrast construction clearly defined?	yes
16. Is a mixed/random effects or fixed inference used?	no
a. If fixed effects inference used, is this justified?	
17. Were repeated measures used (multiple measurements per subject)?	yes
a. If so, are the method to account for within subject correlation and the assumptions made about variance clearly stated?	yes. Methods paragraph "Data Analysis"
18. If the threshold used for inference and visualization in figures varies, is this clearly stated?	yes, it is shown in each figure and stated in the figure legend.
19. Are statistical inferences corrected for multiple comparisons?	yes yes, Methods paragraph "Data Analysis"
a. If not, is this labeled as uncorrected?	

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

Additional comments

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