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Corresponding Author: Laurence T. Hunt

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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
+ -	1e	n/a	n/a	19	subjects	Methods, para 1	error bars are mean +/- SEM	Legend to fig 1e	n/a		n/a	

		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 #
+ -	3a	paired T-test (high integrated V3 vs. low integrated V3)	Results, para 12	19	subjects	Methods, para 1	error bars are mean +/- SEM	Legend to figure 3	p=0.0053 (stimulus distractor effect); p = 0.025 (response distractor effect)	Results, para 12	T(18) = 3.17 (stimulus distractor effect); T(18) = 2.45 (response distractor effect)	28
+ -	3b	paired T-test (high V3(stim) vs low V3(stim)	Results, para 15	19	subjects	Methods, para 1	error bars are mean +/- SEM	Legend to figure 3	p=0.021 (stimulus distractor effect); p = 0.82 (response distractor effect)	Results, para 15	T(18) = 2.51 (stimulus distractor effect); T(18) = 0.82 (response distractor effect)	Results, para 15
+ -	3c	paired T-test (high V3(resp) vs low V3(resp)	Results, para 15	19	subjects	Methods, para 1	error bars are mean +/- SEM	Legend to figure 3	p=0.0052 (response distractor effect); p = 0.092 (stimulus distractor effect)	Results, para 15	T(18) = 3.18 (response distractor effect); T(18) = 1.78 (stimulus distractor effect)	Results, para 15
+ -	3d	Interaction, two-way ANOVA	Results, para 15	19	subjects	Methods, para 1	error bars are mean +/- SEM	Legend to figure 3	p=0.00017	Results, para 15	F(1,72)=16.62	Results, para 15
+ -	3e	one-sample T-test (on parameter estimates from multiple regression model on log(reaction time))	Results, para 21	19	subjects	Methods, para 1	error bars are mean +/- SEM	Legend to figure 3	p=0.000213 (value difference, relevant); p=0.08 (value difference, irrelevant); p=0.84 (integrated value difference)	Results, para 21	T(18)=-4.62 (value difference, relevant); T(18)=-1.48 (value difference, irrelevant); T(18)=-0.19 (integrated value difference)	Results, para 21
+ -	5a	family-wise error (whole brain) corrected cluster with Z<-2.3 cluster-forming threshold	Results, para 27	19	subjects	Methods, para 1	cluster size	Supp info	p=0.0023	Results, para 27	peak Z=-3.65	Results, para 27
+ -	5b	ROI analysis (using leave-one-out cross-validation): one-sample T-test of contrast of parameter estimates	Results, para 27	19	subjects	Methods, para 1	error bars are mean +/- SEM	Legend to figure 5	p=0.011 (relevant attribute); p=0.022 (irrelevant attribute)	Results, para 27	T(18) =-2.83 (relevant attribute); T(18) = 2.50 (irrelevant attribute)	Results, para 27

+ -	6a/b	psychophysiological interaction: whole brain analysis (cluster forming threshold |Z|>2.3)	Results, para 30	19	subjects	Methods, para 1	cluster size>100 voxels, at |Z|>2.3	Legend to figure 6	n/a	n/a	peak Z = 3.52 (stimulus attribute); peak Z = -3.46 (response attribute)	Results, para 30
+ -	7a	family-wise error (whole brain) corrected cluster with Z<-2.3 cluster-forming threshold	Results, para 33	19	subjects	Methods, para 1	cluster size	Supp info	p=0.0054	Results, para 27	peak Z=-3.85	Results, para 33

Representative figures

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

   If so, what figure(s)?

   n/a

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 #)?

   n/a

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.

   Yes. It was based on previous studies of reward-guided decision making that have found reliable effect sizes, and based upon methodolgical recommendations from the literature (e.g. Friston, Neuroimage, 2012).

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

   Where (section, paragraph #)?

   Statistical tests for all figures are highlighted in figure legends

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

   Full details of statistical analyses of behavior and fMRI analysis pipelines are provided in methods; standardised fMRI analysis procedures were used as implemented in FSL

   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 #)?

   Standard parametric analyses of fMRI data were used; fMRI data are known to satisfy assumptions underlying these tests. Logarithms of reaction times were used in behavioural analysis to approximate normality for linear regression (see methods, para 11)

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 #)?	See figure details above; figures generally show means +/- s.e.m., which is derived from variance; variance can be seen to be similar in groups being statistically compared
d. Are tests specified as one- or two-sided?	All tests are two-sided
e. Are there adjustments for multiple comparisons?	Yes - whole-brain fMRI analyses either use cluster-based FWE correction with corrected p<0.05 (for the principal analyses), or minimum cluster size of 100 voxels (for PPI analysis), both with cluster-forming threshold of Z>2.3. In addition, Monte Carlo-based simulation of the null distribution was performed for the PPI analysis for whole-brain correction.
3. Are criteria for excluding data points reported? Was this criterion established prior to data collection? Where is this described (section, paragraph #)?	Some subjects excluded prior to analysis (see 'fMRI studies' section below)
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 randomisation used; all subjects belonged to a single experimental group.
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 #)?	n/a
6. For experiments in live vertebrates, is a statement of compliance with ethical guidelines/regulations included? Where (section, paragraph #)?	n/a
7. Is the species of the animals used reported? Where (section, paragraph #)?	Yes, human - methods, para 1
8. Is the strain of the animals (including background strains of KO/ transgenic animals used) reported? Where (section, paragraph #)?	n/a
9. Is the sex of the animals/subjects used reported? Where (section, paragraph #)?	Yes, methods para 1
10. Is the age of the animals/subjects reported? Where (section, paragraph #)?	Yes, methods para 1

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

    Where (section, paragraph #)?

n/a

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

    Where (section, paragraph #)?

n/a

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

    Where (section, paragraph #)?

n/a

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

    Where (section, paragraph #)?

Experimental training is detailed in methods, para 2

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

       Where (section, paragraph #)?

n/a

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

    Where (section, paragraph #)?

Yes, see 'fMRI studies' section below

    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)?

    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.

   Custom MATLAB scripts were used for behavioral analysis, network modelling and fMRI timeseries plotting.

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.

   Computer source code and raw behavioral data is provided as supplementary material.

   The algorithm underlying network modelling, and methods for timeseries analysis, are presented in the methods section. MATLAB code will be made available on request.

Human subjects

1. Which IRB approved the protocol?

   Where is this stated (section, paragraph #)?

   UCL local research ethics committee, Methods para 1

2. Is demographic information on all subjects provided?

   Where (section, paragraph #)?

   Yes, methods para 1

3. Is the number of human subjects, their age and sex clearly defined? Where (section, paragraph #)?	Yes, methods para 1
4. Are the inclusion and exclusion criteria (if any) clearly specified? Where (section, paragraph #)?	Yes, methods para 1
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 #)?	Yes, methods para 1
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?	Yes
a. If yes, is the number rejected and reasons for rejection described? Where (section, paragraph #)?	2 rejected due to failure to learn task; 3 excluded due to head motion during fMRI acquisition (see methods para 1). Exclusion occurred prior to being included in any analysis.
2. Is the number of blocks, trials or experimental units per session and/or subjects specified? Where (section, paragraph #)?	Yes, methods para 4
3. Is the length of each trial and interval between trials specified?	Yes, figure 1
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.	Event-related. The design was optimised by testing design efficiency in FSL (in particular to decorrelate choice and outcome phases with 4-8s jittering)
5. Is the task design clearly described? Where (section, paragraph #)?	Yes, results paras 1-4 and methods paras 2-5
6. How was behavioral performance measured?	Buttonpress choices (and reaction times)
7. Is an ANOVA or factorial design being used?	No - parametric regression is used

8. For data acquisition, is a whole brain scan used? If not, state area of acquisition.	Yes
a. How was this region determined?	
9. Is the field strength (in Tesla) of the MRI system stated?	3T
a. Is the pulse sequence type (gradient/spin echo, EPI/spiral) stated?	Yes, see methods
b. Are the field-of-view, matrix size, slice thickness, and TE/TR/ flip angle clearly stated?	Yes, see methods
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, see methods
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, para 27
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, para 27
13. How were anatomical locations determined, e.g., via an automated labeling algorithm (AAL), standardized coordinate database (Talairach daemon), probabilistic atlases, etc.?	Combination of inbuilt atlas tools and reference to other literature
14. Were any additional regressors (behavioral covariates, motion etc) used?	Yes, see methods
15. Is the contrast construction clearly defined?	Yes, see methods
16. Is a mixed/random effects or fixed inference used?	Mixed effets
a. If fixed effects inference used, is this justified?	
17. Were repeated measures used (multiple measurements per subject)?	No
a. If so, are the method to account for within subject correlation and the assumptions made about variance clearly stated?	
18. If the threshold used for inference and visualization in figures varies, is this clearly stated?	Yes
19. Are statistical inferences corrected for multiple comparisons?	Yes

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)?	Leave-one-out cross-validation, with activations from all other subjects' data used to define each subject's ROI
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?	Yes

Additional comments

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