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.

<table>
<thead>
<tr>
<th>FIGURE NUMBER</th>
<th>WHICH TEST?</th>
<th>SECTION &amp; PARAGRAPH #</th>
<th>n</th>
<th>EXACT VALUE</th>
<th>DEFINED?</th>
<th>DESCRPTIVE STATS (AVERAGE, VARIANCE)</th>
<th>P VALUE</th>
<th>DEGREES OF FREEDOM &amp; F/(I)/Z/R/ETC VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>one-way ANOVA</td>
<td>Fig. legend</td>
<td>9, 9, 10, 15 mice from at least 3 litters/group</td>
<td>Methods para 8</td>
<td>error bars are mean +/- SEM</td>
<td>Fig. legend</td>
<td>p = 0.044</td>
<td>F(3, 36) = 2.97</td>
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<tr>
<td>results para 6</td>
<td>unpaired t-test</td>
<td>Results para 6</td>
<td>15 slices from 10 mice</td>
<td>Results para 6</td>
<td>error bars are mean +/- SEM</td>
<td>Results para 6</td>
<td>p = 0.0006</td>
<td>t(28) = 2.808</td>
</tr>
<tr>
<td>1c</td>
<td>paired t-test</td>
<td>Results para 2</td>
<td>24 all participants</td>
<td>Methods para 1</td>
<td>in main text and figure; error bars are mean +/- SEM</td>
<td>Results para 2</td>
<td>p &lt; .001</td>
<td>t(23) = 6.53</td>
</tr>
<tr>
<td>FIGURE NUMBER</td>
<td>WHICH TEST</td>
<td>SECTION &amp; PARAGRAPH #</td>
<td>n</td>
<td>DESCRIPTIONS (AVERAGE, VARIANCE)</td>
<td>P VALUE</td>
<td>DEGREES OF FREEDOM &amp; F/T/Z/R/ETC VALUE</td>
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<tr>
<td>1c middle</td>
<td>One-way ANOVA</td>
<td>Results para 2</td>
<td>24</td>
<td>all participants</td>
<td>Methods para 1</td>
<td>in figure; error bars are mean +/- SEM</td>
<td>Result para 2</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>1d upper</td>
<td>2x2 ANOVA paired t-test</td>
<td>Results para 3</td>
<td>24</td>
<td>all participants</td>
<td>Methods para 1</td>
<td>in text and figures; boxes represent median +/- 1st and 3rd quartile, error bars represent minimum and maximum</td>
<td>Result para 3</td>
<td>p = 0.041</td>
</tr>
<tr>
<td>1d lower</td>
<td>2x2 ANOVA paired t-test</td>
<td>Results para 3</td>
<td>24</td>
<td>all participants</td>
<td>Methods para 1</td>
<td>in text and figures; boxes represent median +/- 1st and 3rd quartile, error bars represent minimum and maximum</td>
<td>Result para 3+4, Fig.1 legend</td>
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<tr>
<td>3a lower black solid</td>
<td>2x4 ANOVA paired t-test</td>
<td>Results para 7</td>
<td>24</td>
<td>all participants</td>
<td>Methods para 1</td>
<td>error bars are mean +/- SEM</td>
<td>Fig.3 legend</td>
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<td>One-way ANOVA linear fit</td>
<td>Results para 7</td>
<td>24</td>
<td>all participants</td>
<td>Methods para 1</td>
<td>error bars are mean +/- SEM</td>
<td>Fig.3 legend</td>
<td>p = 0.002</td>
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<tr>
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<td>2x4 ANOVA paired t-test</td>
<td>Results para 8 + 9</td>
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<td>24</td>
<td>all participants</td>
<td>Methods para 1</td>
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<td>Fig.3 legend</td>
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<td>Results para 7</td>
<td>24</td>
<td>all participants</td>
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<td>Fig.3 legend</td>
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<td>Fig.3 legend</td>
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<td>Methods para 1</td>
<td>Error bars are mean +/- SEM</td>
<td>Fig. legend</td>
<td>p</td>
<td>Results para 8</td>
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<td>Methods para 1</td>
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<td>Two separate 2-sample t-tests</td>
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<td>24</td>
<td>All participants (median split)</td>
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<td>Fig. 5 legend</td>
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<td>Methods para 1</td>
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<td>Fig. 6 legend</td>
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<td>Results para 19</td>
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<tr>
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<td>24</td>
<td>All participants</td>
<td>Methods para 1</td>
<td>Error bars are mean +/- SEM</td>
<td>Fig. 6 legend</td>
<td>p = 0.028 and p = 0.023</td>
<td>Results para 19</td>
</tr>
<tr>
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<td>Results para 19</td>
<td>24</td>
<td>All participants</td>
<td>Methods para 1</td>
<td>Error bars are mean +/- SEM</td>
<td>Fig. 7 legend</td>
<td>p &lt; 0.001 and p = 0.196</td>
<td>Results para 19</td>
</tr>
<tr>
<td>2x4 ANOVA main effect and interaction</td>
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<td>24</td>
<td>All participants</td>
<td>Methods para 1</td>
<td>Error bars are mean +/- SEM</td>
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<td>24</td>
<td>All participants</td>
<td>Methods para 1</td>
<td>Error bars are mean +/- SEM</td>
<td>Fig. 7 legend</td>
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<td>24</td>
<td>All participants</td>
<td>Methods para 1</td>
<td>Error bars are mean +/- SEM</td>
<td>Fig. 7 legend</td>
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<td>Results para 20</td>
</tr>
<tr>
<td>One-sample t-test</td>
<td>Results para 19</td>
<td>24</td>
<td>All participants</td>
<td>Methods para 1</td>
<td>Error bars are mean +/- SEM</td>
<td>Fig. 7 legend</td>
<td>p &lt; 0.001</td>
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<td>One-sample t-test</td>
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<td>24</td>
<td>All participants</td>
<td>Methods para 1</td>
<td>Error bars are mean +/- SEM</td>
<td>Fig. 7 legend</td>
<td>p = 0.013</td>
<td>Results para 19</td>
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</tbody>
</table>
### 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 #)?  
   NA

### Statistics and general methods

1. Is there a justification of the sample size?  
   If so, how was it justified?  
   Where (section, paragraph #)?  
   Behavioral piloting of the exact same task showed an effect of forgetting vs. baseline of 6.06% (SEM 1.73%), which was significant in a sample of n = 11. We therefore felt comfortable to replicate this effect in our larger imaging sample of n = 24 (the exact number of participants chosen based on counterbalancing of materials across conditions).

2. Are statistical tests justified as appropriate for every figure?  
   Where (section, paragraph #)?  
   Yes.  
   Online Methods paragraphs #13 and #18.

   a. If there is a section summarizing the statistical methods in the methods, is the statistical test for each experiment clearly defined?  
      Yes.  
      Online Methods paragraphs #13 and #18.

   b. Do the data meet the assumptions of the specific statistical test you chose (e.g. normality for a parametric test)?  
      Yes.  
      Similarity measures of neural activity were z-transformed before calculating any statistics. Univariate fMRI data were smoothed with a Gaussian Kernel to meet assumptions for parametric tests (Methods para #13). Non-parametric correlations were used throughout for brain-behaviour correlations as reported in the Online Methods paragraph #18.

   c. Is there any estimate of variance within each group of data?  
      Is the variance similar between groups that are being statistically compared?  
      All measures are within-group, and SEM is provided throughout. No group comparisons are conducted.

   d. Are tests specified as one- or two-sided?  
      Yes. Methods #13 and #18.
3. Are criteria for excluding data points reported?
   Was this criterion established prior to data collection?
   Where is this described (section, paragraph #)?
   No data points were excluded, and all 24 participants who took part in the experiment are included in all analyses. The sample is described in Online Methods para #1.

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 #)?
   There was only one experimental group, with all manipulations carried out within-participants. Materials were counterbalanced as described in Online Methods para #2.

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 #)?
   Not applicable (no group allocation)

6. For experiments in live vertebrates, is a statement of compliance with ethical guidelines/regulations included?
   Where (section, paragraph #)?
   Yes, as stated in Online Methods #1.

7. Is the species of the animals used reported?
   Where (section, paragraph #)?
   NA

8. Is the strain of the animals (including background strains of KO/transgenic animals used) reported?
   Where (section, paragraph #)?
   NA

9. Is the sex of the animals/subjects used reported?
   Where (section, paragraph #)?
   Yes. Online Methods #1.

10. Is the age of the animals/subjects reported?
    Where (section, paragraph #)?
    Yes. Online Methods #1.

11. For animals housed in a vivarium, is the light/dark cycle reported?
    Where (section, paragraph #)?
    NA

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

e. Are there adjustments for multiple comparisons?
   Yes, where appropriate. In response to the reviewers, overall ANOVAs are now reported before conducting any posthoc t-tests. Only planned comparisons were conducted posthoc.
13. For behavioral experiments, is the time of day reported (e.g. light or dark cycle)?
   Where (section, paragraph #)?
   No.

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

   a. If multiple behavioral tests were conducted in the same group of animals, is this reported?
      Where (section, paragraph #)?
      NA

15. If any animals/subjects were excluded from analysis, is this reported?
   Where (section, paragraph #)?
   No subjects were excluded in any of the analyses.

   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)?
   NA

   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 #)?
   NA

   a. Were they recently authenticated?
      Where is this information reported (section, paragraph #)?
Data deposition

Data deposition in a public repository is mandatory for:
- Protein, DNA and RNA sequences
- Macromolecular structures
- Crystallographic data for small molecules
- 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 #)?
   NA

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 to extract voxel-wise patterns of brain activity, based on the "RSA Toolbox" which is freely available here: http://www.mrc-cbu.cam.ac.uk/methods-and-resources/toolboxes/

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.
   SPM and the RSA toolbox are open access and freely available. For the additional classification analyses conducted for the revision, the freely available toolbox LIBSVM was used.

Human subjects

1. Which IRB approved the protocol?
   Where is this stated (section, paragraph #)?
   Local ethics board of the MRC Cognition and Brain Sciences Unit, Cambridge, UK. State in Online Methods para #1.

2. Is demographic information on all subjects provided?
   Where (section, paragraph #)?
   Gender and age are provided. Online Methods para #1.

3. Is the number of human subjects, their age and sex clearly defined?
   Where (section, paragraph #)?
   Yes. Online Methods para #1.

4. Are the inclusion and exclusion criteria (if any) clearly specified?
   Where (section, paragraph #)?
   Yes. Stated in Online Methods para #1.

5. How well were the groups matched?
   Where is this information described (section, paragraph #)?
   NA
6. Is a statement included confirming that informed consent was obtained from all subjects?
   Where (section, paragraph #)?
   Yes. Online Methods para #1.

7. For publication of patient photos, is a statement included confirming that consent to publish was obtained?
   Where (section, paragraph #)?
   NA

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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?
   ---

2. Is the number of blocks, trials or experimental units per session and/or subjects specified?
   Yes. Online Methods para #6 and #7.

3. Is the length of each trial and interval between trials specified?
   Yes. Online Methods para #6 and #7.

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. Design was optimized using statistical distribution of events according to Wager & Nichols, as stated in the Online Methods para #10.

5. Is the task design clearly described?
   Yes. Online Methods para #5-#7, plus descriptions in Introduction and Results sections.

6. How was behavioral performance measured?
   Memory test as described in Introduction (para #4), Results (para #3) and Online Methods (para #6).

7. Is an ANOVA or factorial design being used?
   One-way repeated-measures ANOVAs used for linear trend analysis, and for univariate analysis of BOLD activity. 2x2 repeated-measures ANOVAS are used for overall tests before conducting posthoc t-tests (planned comparisons).

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?
   Yes. Online Methods para #11.
   a. Is the pulse sequence type (gradient/spin echo, EPI/spiral) stated?
   Yes. Online Methods para #11.
   b. Are the field-of-view, matrix size, slice thickness, and TE/TR/flip angle clearly stated?
   Yes. Online Methods para #11.

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. Online Methods para #12-14.

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. Online Methods para #12.

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 #)?
    Anatomical locations were defined based on the AAL atlas as implemented in the WFU pickatlas software, and anatomical ROIs were also created based on the same atlas (see Online Methods para #15).

13. How were anatomical locations determined, e.g., via an automated labeling algorithm (AAL), standardized coordinate database (Talairach daemon), probabilistic atlases, etc.?
    Motion regressors and button presses were used as additional regressors, as stated in Online Methods para #13.

14. Were any additional regressors (behavioral covariates, motion etc) used?
    No, but the threshold has been lowered to conservative p < 0.001 with a minimum of 10 adjacent voxels, consistent with prior studies using the same contrast.

15. Is the contrast construction clearly defined?
    Yes.

16. Is a mixed/random effects or fixed inference used?
    Random-effects.
   a. If fixed effects inference used, is this justified?
    Fixed-effects analyses are only used for single-trial (logistic) regression analyses. The justification can be found in the Online Methods para #18.

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?
    AR(1) was used to account for within-subject correlations, and all data were detrended to account for linear global effects across scanning time (see Online Methods para #12).

18. If the threshold used for inference and visualization in figures varies, is this clearly stated?
    Yes (see Fig. 5).

19. Are statistical inferences corrected for multiple comparisons?
   No, but the threshold has been lowered to conservative p < 0.001 with a minimum of 10 adjacent voxels, consistent with prior studies using the same contrast.
   a. If not, is this labeled as uncorrected?
    Yes, throughout the manuscript and figures.
20. Are the results based on an ROI (region of interest) analysis?
   a. If so, is the rationale clearly described?
      Yes. Online Methods para #15.
   b. How were the ROI’s defined (functional vs anatomical localization)?
      Anatomical.

21. Is there correction for multiple comparisons within each voxel?

22. For cluster-wise significance, is the cluster-defining threshold and the corrected significance level defined?

<table>
<thead>
<tr>
<th>Additional comments</th>
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