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>TEST USED</th>
<th>WHICH TEST?</th>
<th>n</th>
<th>DESCRIPTIVE STATS (AVERAGE, VARIANCE)</th>
<th>P VALUE</th>
<th>DEGREES OF FREEDOM &amp; F/T/Z/R/ETC VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2a</td>
<td>SPM t-test</td>
<td>Methods: Statistics</td>
<td>16</td>
<td>All participants (except KD)</td>
<td>p&lt;0.0001</td>
<td>Methods: Data analysis t(15) SPM map</td>
</tr>
<tr>
<td>2b</td>
<td>SPM t-test</td>
<td>Methods: Statistics</td>
<td>5</td>
<td>5 participants who were scanned four times</td>
<td>p&lt;0.05 (FWE-corrected)</td>
<td>Methods: Data analysis t(7348) SPM map</td>
</tr>
<tr>
<td>3</td>
<td>RM-ANOVA</td>
<td>Methods: Statistics</td>
<td>15</td>
<td>All participants who were scanned with the uncompressed speech stimuli</td>
<td>all p&lt;0.05</td>
<td>Methods: Statistics</td>
</tr>
<tr>
<td>4b,d</td>
<td>RM-ANOVA</td>
<td>Methods: Statistics</td>
<td>9.5</td>
<td>Modulation group, Co-modulation group</td>
<td>all p&lt;0.05</td>
<td>Methods: Statistics</td>
</tr>
<tr>
<td>5</td>
<td>RM-ANOVA</td>
<td>Methods: Statistics</td>
<td>5</td>
<td>Environmental sounds group</td>
<td>all p&lt;0.05</td>
<td>Methods: Statistics</td>
</tr>
<tr>
<td>6</td>
<td>RM-ANOVA</td>
<td>Methods: Statistics</td>
<td>5</td>
<td>Noise-vocoded speech group</td>
<td>all p&lt;0.05</td>
<td>Methods: Statistics</td>
</tr>
<tr>
<td>7a</td>
<td>RM-ANOVA</td>
<td>Methods: Statistics</td>
<td>16</td>
<td>Naturalness rating group</td>
<td>p&lt;0.05</td>
<td>Methods: Statistics</td>
</tr>
<tr>
<td>7b</td>
<td>Bootstrap</td>
<td>Methods: Statistics</td>
<td>15,11</td>
<td>All participants who were scanned with the uncompressed speech stimuli</td>
<td>p&lt;0.05</td>
<td>Methods: Statistics</td>
</tr>
<tr>
<td>8</td>
<td>Parcellation algorithm</td>
<td>Methods: Statistics</td>
<td>15</td>
<td>All participants who were scanned with the uncompressed speech stimuli</td>
<td>p&lt;0.001 (uncorrected)</td>
<td>Methods: Data analysis t(15) SPM map</td>
</tr>
</tbody>
</table>

Methods: Statistical analysis of data. Results: Significant differences were observed in the data.
### Representative figures

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

   If so, what figure(s)?

   Figure 2b shows the individual data of 5 participants who took part in four separate scanning sessions; Supplementary Figure S3 shows the response in individual fROIs of 12 participants who were scanned between two and four times.

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; Methods: Participants

### Statistics and general methods

1. Is there a justification of the sample size?

   If so, how was it justified?

   Where (section, paragraph #)?

   We planned a priori to test ~18 participants on the main functional localizer contrast, as this is comparable to other studies in the field and provides an estimate of interindividual variation; see Methods: Participants. When the initial participants revealed large and stable effects in each of the control experiments (Supplementary Figure 2), we decided to use fewer participants per control experiment, in order to keep the overall number of scans to a reasonable number.

   Where (section, paragraph #)?

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

   Where (section, paragraph #)?

   Yes; Methods: Data analysis & Methods: Statistics

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

   Yes; Methods: Statistics

   b. Do the data meet the assumptions of the specific statistical test you chose (e.g. normality for a parametric test)?

   Data distribution was assumed to be normal but this was not formally tested (Methods: Statistics). Greenhouse-Geisser correction was used in cases where Mauchly’s test indicated significant violations of the assumption of sphericity; Methods: Statistics

   Where is this described (section, paragraph #)?

<table>
<thead>
<tr>
<th>Method</th>
<th>Details</th>
<th>p-value</th>
<th>Results</th>
<th>Methods</th>
<th>Table/Paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>paired t-test</strong></td>
<td>Methods: Statistics</td>
<td>0.06</td>
<td>t(15) = 2.03</td>
<td>Methods: Statistics</td>
<td>Paragraph 4</td>
</tr>
<tr>
<td><strong>paired t-test</strong></td>
<td>Methods: Statistics</td>
<td>0.0068</td>
<td>t(14) = 3.17</td>
<td>Methods: Statistics</td>
<td>Paragraph 2</td>
</tr>
</tbody>
</table>

Table S1

- mean rms error
- average volume

**Pairwise comparisons**

All participants who were scanned with the uncompressed speech stimuli
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>c. Is there any estimate of variance within each group of data?</td>
<td>Mauchly’s test was used for each group; Methods: Statistics</td>
</tr>
<tr>
<td>Is the variance similar between groups that are being statistically compared?</td>
<td></td>
</tr>
<tr>
<td>Where is this described (section, paragraph #)?</td>
<td></td>
</tr>
<tr>
<td>d. Are tests specified as one- or two-sided?</td>
<td>One-sided for SPM contrasts, two-sided for all others</td>
</tr>
<tr>
<td>e. Are there adjustments for multiple comparisons?</td>
<td>Yes, family-wise error (FWE) for SPM contrasts, otherwise Bonferroni correction</td>
</tr>
<tr>
<td>3. Are criteria for excluding data points reported?</td>
<td>Yes; Methods: Participants</td>
</tr>
<tr>
<td>Was this criterion established prior to data collection?</td>
<td></td>
</tr>
<tr>
<td>Where is this described (section, paragraph #)?</td>
<td></td>
</tr>
<tr>
<td>4. Define the method of randomization used to assign subjects (or samples) to the experimental groups and to collect and process data.</td>
<td>Participants were semi-randomly assigned for their initial scanning session; subsequent sessions were constrained such that no participant took part in the same control experiment twice. Methods: Repeat sessions</td>
</tr>
<tr>
<td>If no randomization was used, state so.</td>
<td></td>
</tr>
<tr>
<td>Where does this appear (section, paragraph #)?</td>
<td></td>
</tr>
<tr>
<td>5. Is a statement of the extent to which investigator knew the group allocation during the experiment and in assessing outcome included?</td>
<td>N/A</td>
</tr>
<tr>
<td>If no blinding was done, state so.</td>
<td></td>
</tr>
<tr>
<td>Where (section, paragraph #)?</td>
<td></td>
</tr>
<tr>
<td>6. For experiments in live vertebrates, is a statement of compliance with ethical guidelines/regulations included?</td>
<td>N/A</td>
</tr>
<tr>
<td>Where (section, paragraph #)?</td>
<td></td>
</tr>
<tr>
<td>7. Is the species of the animals used reported?</td>
<td>N/A</td>
</tr>
<tr>
<td>Where (section, paragraph #)?</td>
<td></td>
</tr>
<tr>
<td>8. Is the strain of the animals (including background strains of KO/transgenic animals used) reported?</td>
<td>N/A</td>
</tr>
<tr>
<td>Where (section, paragraph #)?</td>
<td></td>
</tr>
<tr>
<td>9. Is the sex of the animals/subjects used reported?</td>
<td>Yes; Methods: Participants</td>
</tr>
<tr>
<td>Where (section, paragraph #)?</td>
<td></td>
</tr>
<tr>
<td>10. Is the age of the animals/subjects reported?</td>
<td>Yes; Methods: Participants</td>
</tr>
<tr>
<td>Where (section, paragraph #)?</td>
<td></td>
</tr>
<tr>
<td>11. For animals housed in a vivarium, is the light/dark cycle reported?</td>
<td>N/A</td>
</tr>
<tr>
<td>Where (section, paragraph #)?</td>
<td></td>
</tr>
</tbody>
</table>
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 #)?  
   Yes; Methods: Participants  
   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; Methods: Participants  
   a. How were the criteria for exclusion defined?  
      Where is this described (section, paragraph #)?  
      Methods: Participants  
   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 #)?  
      | N/A |

Reagents

1. Have antibodies been validated for use in the system under study (assay and species)?  
   | N/A |
   a. Is antibody catalog number given?  
      Where does this appear (section, paragraph #)?  
      | N/A |
   b. Where were the validation data reported (citation, supplementary information, Antibodypedia)?  
      Where does this appear (section, paragraph #)?  
      | N/A |

2. If cell lines were used to reflect the properties of a particular tissue or disease state, is their source identified?  
   Where (section, paragraph #)?  
   | N/A |
a. Were they recently authenticated?
Where is this information reported (section, paragraph #)?
N/A

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.
   Quilting software written by author JHM; parcellation software provided by Evelina Fedorenko; functional clustering algorithm by Danial Lashkari

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.
   Quilting code will be made available for download upon publication

Human subjects

1. Which IRB approved the protocol?
   Where is this stated (section, paragraph #)?
   NYU Committee on Activities involving Human Subjects & MIT Committee on the Use of Humans as Experimental Subjects; Methods: Participants

2. Is demographic information on all subjects provided?
   Where (section, paragraph #)?
   Yes; Methods: Participants

3. Is the number of human subjects, their age and sex clearly defined?
   Where (section, paragraph #)?
   Yes; Methods: Participants
4. Are the inclusion and exclusion criteria (if any) clearly specified?
   Where (section, paragraph #)?
   Yes; Methods: Participants

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: Participants

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 #)?
      Yes; Methods: Participants

2. Is the number of blocks, trials or experimental units per session and/or subjects specified?
   Where (section, paragraph #)?
   Yes; Methods: Experimental design

3. Is the length of each trial and interval between trials specified?
   Yes; Methods: Experimental design

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.
   The stimuli were presented in a pseudo-randomized fashion that boosted contrast selectivity between certain conditions of interest (e.g. by ensuring they were not too far apart in time); Methods: Experimental design

5. Is the task design clearly described?
   Where (section, paragraph #)?
   Yes; Methods: Experimental design

6. How was behavioral performance measured?
   Response button box; Methods: Experimental design

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.
   No; the acquisition volume (30 slices) covered much of the temporal lobe and was tilted forward such that slices were parallel to and centered on the superior temporal gyrus
a. How was this region determined?
   The positioning of the scanning volume was determined based on an initial structural localizer scan

9. Is the field strength (in Tesla) of the MRI system stated?
   Yes; Methods: Image acquisition
   a. Is the pulse sequence type (gradient/spin echo, EPI/spiral) stated?
   Yes; Methods: Image acquisition
   b. Are the field-of-view, matrix size, slice thickness, and TE/TR/flip angle clearly stated?
   Yes; Methods: Image acquisition

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: 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: Data 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, this is described in the first paragraph of Methods: Data analysis

13. How were anatomical locations determined, e.g., via an automated labeling algorithm (AAL), standardized coordinate database (Talairach daemon), probabilistic atlases, etc.?
   Visually via superposition of activations onto the group average normalized anatomical scan, and via regions of interest (ROIs) from published probabilistic maps; Methods: Data analysis

14. Were any additional regressors (behavioral covariates, motion etc) used?
   No

15. Is the contrast construction clearly defined?
   Yes; Methods: Data analysis

16. Is a mixed/random effects or fixed inference used?
   Random-effects inference for the main analysis
   a. If fixed effects inference used, is this justified?
      For repeat scanning sessions of a given participant; Methods: Data analysis

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?
      Repeated-measures ANOVAs were used to analyze the results

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?
   Yes, via family-wise error (FWE) correction
   a. If not, is this labeled as uncorrected?
      Yes
20. Are the results based on an ROI (region of interest) analysis?
   a. If so, is the rationale clearly described? Yes
   b. How were the ROI’s defined (functional vs anatomical localization)?
      Functionally via an independent functional localizer contrast (L960>L30); anatomically via published probabilistic maps

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

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

Additional comments

Additional Comments