

## Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our [Editorial Policies](#) and the [Editorial Policy Checklist](#).

### Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a | Confirmed

- The exact sample size ( $n$ ) for each experimental group/condition, given as a discrete number and unit of measurement
- A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
- The statistical test(s) used AND whether they are one- or two-sided  
*Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
- A description of all covariates tested
- A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
- A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
- For null hypothesis testing, the test statistic (e.g.  $F$ ,  $t$ ,  $r$ ) with confidence intervals, effect sizes, degrees of freedom and  $P$  value noted  
*Give  $P$  values as exact values whenever suitable.*
- For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
- For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
- Estimates of effect sizes (e.g. Cohen's  $d$ , Pearson's  $r$ ), indicating how they were calculated

*Our web collection on [statistics for biologists](#) contains articles on many of the points above.*

### Software and code

Policy information about [availability of computer code](#)

Data collection: Presentation Software (<https://www.neurobs.com>)

Data analysis: MNE Python 1.0.3, scikit-learn 1.1, Freesurfer 7.1, R 3.6, Python 3.9, Maxfilter 2.2, MNE-RSA 0.7dev

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#) for further information.

### Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

The text corpus containing 1.5 billion Finnish words used to derive the statistical model cannot be publicly distributed due to the Finnish copyright law limitations. It is available upon request for research purposes, for contact information see <http://bionlp.utu.fi/finnish-internet-parsebank.html>. The word2vec models used in this study (derived from the above-mentioned corpus), together with the custom code used in the study can be accessed at <https://github.com/AaltoImagingLanguage/ghazaryan2023>. The code to compute RSA can be found at <https://github.com/wmvanvliet/mne-rsa>.

The stimulus words are publicly available and listed in the appendix. The MEG and MRI data are available upon reasonable request from the authors; the data is not publicly available as it contains personal information, and its reuse for other research purposes requires renewed consent from the participants and a new ethical pre-review.

## Research involving human participants, their data, or biological material

Policy information about studies with [human participants or human data](#). See also policy information about [sex, gender \(identity/presentation\), and sexual orientation](#) and [race, ethnicity and racism](#).

Reporting on sex and gender	Self-reported gender was collected and reported. Analysis did not directly make use of the gender of the participants, but equal number of males and females participated.
Reporting on race, ethnicity, or other socially relevant groupings	Not recorded.
Population characteristics	See above.
Recruitment	Participants were recruited through university mailing lists. They were volunteers and were compensated for their time.
Ethics oversight	Aalto University Research Ethics Committee

Note that full information on the approval of the study protocol must also be provided in the manuscript.

## Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

Life sciences  Behavioural & social sciences  Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://nature.com/documents/nr-reporting-summary-flat.pdf)

## Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	Brain imaging study with quantitative data (MEG measurement).
Research sample	Adult native Finnish speakers, right-handed (aged 20-27 years, mean 22); 10 males, 10 females.
Sampling strategy	Convenience sample. Required sample size was determined based on previous studies, no formal power analysis was performed, but most analysis was done on individual level.
Data collection	Participants viewed stimuli on a computer screen while MEG was recorded. Head position was continuously tracked using coils attached to head. Eye movements were tracked using electrodes. Only research staff and laboratory technicians were present with participants at the laboratory. Researchers were not blinded, but there was no specific experiment manipulation, so it was not deemed necessary.
Timing	June 2015 - August 2015
Data exclusions	Data from one participant was excluded due to technical issues with MEG measurement.
Non-participation	No participants dropped out after beginning participation.
Randomization	Participants were not allocated into experimental groups.

## Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

## Materials &amp; experimental systems

- n/a  Involved in the study
- Antibodies
- Eukaryotic cell lines
- Palaeontology and archaeology
- Animals and other organisms
- Clinical data
- Dual use research of concern
- Plants

## Methods

- n/a  Involved in the study
- ChIP-seq
- Flow cytometry
- MRI-based neuroimaging

## Magnetic resonance imaging

## Experimental design

- Design type
- Design specifications
- Behavioral performance measures

## Acquisition

- Imaging type(s)
- Field strength
- Sequence & imaging parameters
- Area of acquisition
- Diffusion MRI  Used  Not used

## Preprocessing

- Preprocessing software
- Normalization
- Normalization template
- Noise and artifact removal
- Volume censoring

## Statistical modeling &amp; inference

- Model type and settings
- Effect(s) tested
- Specify type of analysis:  Whole brain  ROI-based  Both
- Statistic type for inference
- (See [Eklund et al. 2016](#))
- Correction

## Models & analysis

- | n/a                                 | Involvement in the study  |
|-------------------------------------|---|
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Functional and/or effective connectivity     |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Graph analysis                               |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Multivariate modeling or predictive analysis |