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Corresponding Author: Bram-Ernst Verhoef

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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

		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 #
+ -	2d,e	Linear regression	Result, para 6	2533424, 1270826	spike-count correlation per combination of neuron pair and stimulus pair	Results para 6 and Methods "Statistics "	error bars are mean +/- SEM	Fig. legend	For selectivity > 0: main effect selectivity: p = 9.6x10-14, main effect suppression: p = 5x10-17, interaction p = 5x10-91 For selectivity < 0: main effect selectivity: p = 0.02, main effect suppression: p = 0.003, interaction p = 4x10-15	Results , para 6 NB: Throughout the text, for very small p-values we report p<0.0001 because for extremely small p-values, small deviations from the model assumptions and numerical issues can seriously affect the observed smallness of the p-value	For selectivity > 0: main effect selectivity: t(2533421) = 7.5 main effect suppression: t(2533421) = -8.4 interaction: t(2533421) = 20.2 For selectivity < 0: main effect selectivity: t(1270823) = 2.4 main effect suppression: t(1270823) = -3.0 interaction: t(1270823) = 7.9	No t-statistics reported in the text
+ -	3a	Linear regression	Result, para 12	1266712	spike-count correlation per combination of neuron pair and stimulus pair	Results, para 12	error bars are mean +/- SEM (see Fig. 3d)	Fig. legend	main effect selectivity: p = 2.9x10-45, main effect suppression: p = 0.48, interaction p = 9.7x10-16	Results, para 12	main effect selectivity: t(1266709) = -14.1 main effect suppression: t(1266709) = 0.7 interaction: t(1266709) = -8.0	No t-statistics reported in the text
+ -	3b	Linear regression	Result, para 13	1266712	spike-count correlation per combination of neuron pair and stimulus pair	Results, para 13 and Methods "Statistics "	error bars are mean +/- SEM (see Fig. 3d)	Fig. legend	main effect selectivity: p = 4x10-12, main effect suppression: p = 5x10-10, interaction p = 5x10-7	Results, para 13	main effect selectivity: t(1266709) = 7.0 main effect suppression: t(1266709) = -6.2 interaction: t(1266709) = 5.0	No t-statistics reported in the text

+ -	6a	Linear regression	Results, para 27	854610, 483452	spike-count correlation per combination of neuron pair and stimulus pair	Not reported	Not reported	NA	For selectivity > 0: main effect selectivity: p = 4x10-7, main effect suppression: p = 0.26, interaction p = 5x10-91 For selectivity < 0: main effect selectivity: p = 8x10-6, main effect suppression: p = 0.76, interaction p = 2x10-10	Results, para 27	For selectivity > 0: main effect selectivity: t(854607) = 5.1 main effect suppression: t(854607) = -1.1 interaction: t(854607) = 10.0 For selectivity < 0: main effect selectivity: t(483449) = -4.5 main effect suppression: t(483449) = -0.3 interaction: t(483449) = 6.4	No t-statistics reported in the text
+ -	6b	Linear regression	Results, para 27	793810, 134932	spike-count correlation per combination of neuron pair and stimulus pair	Not reported	Not reported	NA	For selectivity > 0: main effect selectivity: p = 1x10-91, main effect suppression: p = 0.5, interaction p = 1.5x10-7 For selectivity < 0: main effect selectivity: p = 0.001, main effect suppression: p = 0.004, interaction p = 0.001	Results, para 27	For selectivity > 0: main effect selectivity: t(793807) = 21 main effect suppression: t(854607) = 0.6 interaction: t(854607) = 5.2 For selectivity < 0: main effect selectivity: t(134929) = -3.2 main effect suppression: t(134929) = 2.9 interaction: t(134929) = 3.2	No t-statistics reported in the text
+ -	6c	Linear regression	Results, para 28	427305	spike-count correlation per combination of neuron pair and stimulus pair	Not reported	Not reported	NA	main effect selectivity: p = 4x10-14, main effect suppression: p = 0.69, interaction p = 4.6x10-7	Results, para 28	main effect selectivity: t(427302) = -7.6 main effect suppression: t(427302) = 0.4 interaction: t(427302) = -5.0	No t-statistics reported in the text
+ -	6d	Linear regression	Results, para 28	396905	spike-count correlation per combination of neuron pair and stimulus pair	Not reported	Not reported	NA	main effect selectivity: p = 1x10-91, main effect suppression: p = 0.04, interaction p = 7x10-7	Results, para 28	main effect selectivity: t(396902) = -10 main effect suppression: t(396902) = 2.0 interaction: t(396902) = -5.0	No t-statistics reported in the text
+ -	6e	Linear regression	Results, para 28	427305	spike-count correlation per combination of neuron pair and stimulus pair	Not reported	Not reported	NA	main effect selectivity: p = 9x10-8, main effect suppression: p = 0.0003, interaction p = 0.003	Results, para 28	main effect selectivity: t(427302) = 5.3 main effect suppression: t(427302) = -3.6 interaction: t(427302) = 2.9	No t-statistics reported in the text

+ -	6f	Linear regression	Results, para 28	396905	spike-count correlation per combination of neuron pair and stimulus pair	Not reported	Not reported	NA	main effect selectivity: p = 1x10-91, main effect suppression: p = 0.01, interaction p = 0.005	Results, para 28	main effect selectivity: t(396902) = 8.5 main effect suppression: t(396902) = -2.5 interaction: t(396902) = 2.8	No t-statistics reported in the text

Representative figures

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

   If so, what figure(s)?

   All data figures (Figure 2b, c, d and e, Figure 3a, b and c, and Figure 4a and b, 6a-f) show average effects.

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 #)?

   Even if no sample size calculation was performed, authors should report why the sample size is adequate to measure their effect size.

   Following standard practices in neurophysiological research on monkeys, we recorded neuronal activity in two monkeys (Results). To examine how selectivity and non-preferred suppression affect spike-count correlations we required a large dataset because spike-count correlations are generally small (~0) and highly variable (Results). Each figure was based on over a million correlations (see Results and figure caption of supplemental figure 5), obtained from 12067 multi-units (Results).

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

   Where (section, paragraph #)?

   Yes, all statistical tests are based on linear regression analysis (Results). We also provide additional ANOVA analyses (Results) that validate the regression analyses.

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

   See section "Statistics" in Online Methods. All statistical tests are clearly defined in the text.

   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 performed linear regression to point out specific trends in our data, including main effects and interactions. Although the distribution of the residuals from the regression analyses closely approximated a normal distribution based on visual inspection (i.e. comparing the empirical residual distribution to the best-fitted Gaussian distribution) the residuals did deviate from normality in a kolmogorov-Smirnov test. This statistical deviation from Normality is unsurprising given our extremely large dataset, and is one of the reasons why we do not report extremely small exact p-values (see above). One of the results of this paper is a new more realistic stochastic model for our data (Results and Online Methods).

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 groups were compared.
d. Are tests specified as one- or two-sided?	All tests were two-sided
e. Are there adjustments for multiple comparisons?	Few statistical tests were performed and most p-values were extremely small, so no multiple comparison corrections were required.
3. To promote transparency, *Nature Neuroscience* has stopped allowing bar graphs to report statistics in the papers it publishes. If you have bar graphs in your paper, please make sure to switch them to dot-plots (with central and dispersion statistics displayed) or to box-and-whisker plots to show data distributions.	We have retained the bar plots in Figure 2e, 3d and 4b, but show the corresponding box-and-whisker plots in Supplementary Figure 6.
4. Are criteria for excluding data points reported? Was this criterion established prior to data collection? Where is this described (section, paragraph #)?	Criteria for excluding data points are reported in the Online Methods (section "Statistics"). These criteria were established prior to data collection.
5. 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 #)?	The two monkeys participated in all experimental conditions. Each day, experimental conditions were presented in a random order ("Section Spatial attention task" in Online Methods). Due to the chronic nature of our recordings, it is possible that some units were resampled across days, as mentioned in Online Methods (Section "Statistics"). Because we adjusted the orientations and locations of the stimuli each day for a randomly selected unit, any such resampling would have rarely involved identical stimulus configurations.
6. 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 #)?	Each day, experimental conditions were presented in a random order ("Section Spatial attention task" in Online Methods), as selected by a computer.
7. For experiments in live vertebrates, is a statement of compliance with ethical guidelines/regulations included? Where (section, paragraph #)?	Yes, see Online Methods, section "Surgical Procedures".
8. Is the species of the animals used reported? Where (section, paragraph #)?	Yes, see Online Methods, section "Surgical Procedures".
9. Is the strain of the animals (including background strains of KO/ transgenic animals used) reported? Where (section, paragraph #)?	No, not applicable.

10. Is the sex of the animals/subjects used reported? Where (section, paragraph #)?	Yes, see Online Methods, section "Surgical Procedures".
11. Is the age of the animals/subjects reported? Where (section, paragraph #)?	Monkey M1 and M2 were 7 and 10 years old respectively.
12. For animals housed in a vivarium, is the light/dark cycle reported? Where (section, paragraph #)?	Yes, see Online Methods, section "Surgical Procedures".
13. For animals housed in a vivarium, is the housing group (i.e. number of animals per cage) reported? Where (section, paragraph #)?	Yes, see Online Methods, section "Surgical Procedures".
14. For behavioral experiments, is the time of day reported (e.g. light or dark cycle)? Where (section, paragraph #)?	This is not reported in the text. All experiments were performed between 9AM and 7PM.
15. Is the previous history of the animals/subjects (e.g. prior drug administration, surgery, behavioral testing) reported? Where (section, paragraph #)?	Yes, see Online Methods, section "Surgical Procedures".
a. If multiple behavioral tests were conducted in the same group of animals, is this reported? Where (section, paragraph #)?	The animals only performed in this experiment.
16. If any animals/subjects were excluded from analysis, is this reported? Where (section, paragraph #)?	No animals were excluded from analysis.
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 #)?	NA

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

Where does this appear (section, paragraph #)?

NA

2. Cell line identity

a. Are any cell lines used in this paper listed in the database of commonly misidentified cell lines maintained by ICLAC and NCBI Biosample?

Where (section, paragraph #)?

NA

b. If yes, include in the Methods section a scientific justification of their use--indicate here in which section and paragraph the justification can be found.

NA

c. For each cell line, include in the Methods section a statement that specifies:

- the source of the cell lines
- have the cell lines been authenticated? If so, by which method?
- have the cell lines been tested for mycoplasma contamination?

Where (section, paragraph #)?

NA

Data availability

Provide a Data availability statement in the Methods section under "Data availability", which should include, where applicable:

- Accession codes for deposited data
- Other unique identifiers (such as DOIs and hyperlinks for any other datasets)
- At a minimum, a statement confirming that all relevant data are available from the authors
- Formal citations of datasets that are assigned DOIs
- A statement regarding data available in the manuscript as source data
- A statement regarding data available with restrictions

See our data availability and data citations policy page for more information.

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.

Where is the Data Availability statement provided (section, paragraph #)?

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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.

Computer code for running the experiments is available from https://github.com/MaunsellLab/Lablib-Public-05-July-2016.git. Further code is available from the corresponding author upon reasonable request.

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.

NA

Human subjects

1. Which IRB approved the protocol?

   Where is this stated (section, paragraph #)?

   NA

2. Is demographic information on all subjects provided?

   Where (section, paragraph #)?

   NA

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

   Where (section, paragraph #)?

   NA

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

   Where (section, paragraph #)?

   NA

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 #)?

   NA

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

   Where (section, paragraph #)?

   NA

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?

   NA

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

      Where (section, paragraph #)?

      NA

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

   Where (section, paragraph #)?

   NA

3. Is the length of each trial and interval between trials specified?

   NA

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.

   NA

5. Is the task design clearly described? Where (section, paragraph #)?	NA
6. How was behavioral performance measured?	NA
7. Is an ANOVA or factorial design being used?	NA
8. For data acquisition, is a whole brain scan used? If not, state area of acquisition.	NA
a. How was this region determined?	NA
9. Is the field strength (in Tesla) of the MRI system stated?	NA
a. Is the pulse sequence type (gradient/spin echo, EPI/spiral) stated?	NA
b. Are the field-of-view, matrix size, slice thickness, and TE/TR/ flip angle clearly stated?	NA
10. Are the software and specific parameters (model/functions, smoothing kernel size if applicable, etc.) used for data processing and pre-processing clearly stated?	NA
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 #)?	NA
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 #)?	NA
13. How were anatomical locations determined, e.g., via an automated labeling algorithm (AAL), standardized coordinate database (Talairach daemon), probabilistic atlases, etc.?	NA
14. Were any additional regressors (behavioral covariates, motion etc) used?	NA
15. Is the contrast construction clearly defined?	NA
16. Is a mixed/random effects or fixed inference used?	NA
a. If fixed effects inference used, is this justified?	NA
17. Were repeated measures used (multiple measurements per subject)?	NA

a. If so, are the method to account for within subject correlation and the assumptions made about variance clearly stated?	NA
18. If the threshold used for inference and visualization in figures varies, is this clearly stated?	NA
19. Are statistical inferences corrected for multiple comparisons?	NA
a. If not, is this labeled as uncorrected?	NA
20. Are the results based on an ROI (region of interest) analysis?	NA
a. If so, is the rationale clearly described?	NA
b. How were the ROI's defined (functional vs anatomical localization)?	NA
21. Is there correction for multiple comparisons within each voxel?	NA
22. For cluster-wise significance, is the cluster-defining threshold and the corrected significance level defined?	NA

Additional comments

Additional Comments	None