Data in brief 24 (2019) 103857

Contents lists available at ScienceDirect

Data in brief

journal homepage: www.elsevier.com/locate/dib

Data Article

Dataset of 24-subject EEG recordings during viewing of real-world objects and planar images of the same items

Francesco Marini [a, b, *], Katherine A. Breeding [a], Jacqueline C. Snow [a]

[a] Department of Psychology, University of Nevada, 1664 N Virginia St, Reno, NV 89557-0296, USA
[b] Swartz Center for Computational Neuroscience, University of California San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0559, USA

ARTICLE INFO

Article history:
Received 16 February 2019
Received in revised form 4 March 2019
Accepted 11 March 2019
Available online 21 March 2019

Keywords:
Real-world objects
Images
EEG
ERP
Mu rhythm

ABSTRACT

Here we present a collection of electroencephalographic (EEG) data recorded from 24 observers (14 females, 10 males, mean age: 25.4) while observing individually-presented stimuli comprised of 96 real-world objects, and 96 images of the same items printed in high-resolution. EEG was recorded from 128 scalp channels. Six additional external electrodes were used to record vertical and horizontal electrooculogram, as well as the signal from the left and right mastoid. EEG has been pre-processed, segmented in non-overlapping epochs, and independent component analysis (ICA) has been conducted to reject artifacts. Moreover, supplemental pre-processing steps have been completed to facilitate the analysis of event-related potentials (ERP). These data are linked to the article “Distinct visuo-motor brain dynamics for real-world objects versus planar images”. Alongside this data we provide the custom-written Matlab® code that can be used to fully reproduce all analyses and figures presented in the linked research article.

DOI of original article: https://doi.org/10.1016/j.neuroimage.2019.02.026.

* Corresponding author.Department of Psychology, University of Nevada, 1664 N Virginia St, Reno, NV 89557-0296, USA.
E-mail address: francesco.pd@gmail.com (F. Marini).

https://doi.org/10.1016/j.dib.2019.103857

Specifications table

Subject area	*Neuroscience, Psychology*
More specific subject area	*Cognitive neuroscience, Visual perception, Sensorimotor processing, Non-invasive brain Imaging*
Type of data	*Electroencephalography data, Analysis scripts (Matlab® code)*
How data was acquired	*EEG was recorded using a 128-channel system (Biosemi ActiveTwo) plus four electrooculogram electrodes and two (i.e., left and right) mastoid electrodes*
Data format	*Pre-processed EEG, custom-written Matlab® code*
Experimental factors	*Twenty-four right-handed young adults (14 females, 10 males) with a mean age of 25.4 years old (standard deviation: 7.5)*
Experimental features	*Human observers viewed real-world three-dimensional (3-D) objects or closely matched 2-D images of the same items and performed delayed verbal ratings of: 'how much physical effort would it take to use this specific object according to its normal function?', on a scale from 1 (not effortful) to 10 (very effortful)*
Data source location	*University of Nevada, Reno, NV, United States*
Data accessibility	*Data are available online at:* https://web.gin.g-node.org/doi/RealObjectsEEG *(doi: 10.12751/g-node.bcccab)*
Related research article	*Marini, F., Breeding, K.A., Snow, J.C. (2019). Distinct visuo-motor brain dynamics for real-world objects versus planar images. NeuroImage. doi: 10.1016/j.neuroimage.2019.02.026*

Value of the data

- This is currently the only existing dataset of EEG data during observation of real-world objects and matched images of the same objects. Due to the complexity of presenting real-world objects under controlled viewing conditions, while simultaneously recording EEG, data collection required an experimental apparatus which was custom-built over six months, and also required three experimenters to conduct each recording session. Other researchers may now benefit from the data without the lengthy preparation and collection phases.
- This dataset consists of high-density EEG recording that can be used to conduct additional analyses than those presented in the related article [1], including, but not limited to, source estimation analysis and multi-variate pattern analysis (MVPA).
- Behavioral ratings of object familiarity and frequency-of-use, which were collected from the same set of participants (after completing the EEG study), are attached to this dataset. These measures were not presented in the attached article [1] but may prove useful for additional analysis directions that have not yet been explored.
- Cortical brain dynamics in response to the observation of real world objects may be used as a benchmark against which researchers can compare responses to objects presented in different display format, including augmented or virtual reality, or responses to objects in other cognitive tasks.

1. Data

Data are available online at: https://web.gin.g-node.org/doi/RealObjectsEEG. This dataset is structured in two main folders (/*data* and/*scripts*), each containing several subfolders. This dataset include pre-processed EEG timeseries segmented in epochs corresponding to the experimental trials and marked with event codes for identifying the experimental events. The corresponding files (under/*data/ersp_analyses*) are provided in EEGLAB [2] format and can be loaded into EEGLAB [2] using 'Load existing dataset' from the 'File' menu. To visualize channel timeseries, use 'Channel data (scroll)' from the 'Plot' menu (Fig. 1). For a description of the event codes and the corresponding experimental events, please see Fig. 2, Table 1 and paragraph 2.2 below. Behavioral data, trial information, and other EEG-related data such as event-codes and latencies, are included in data summary files (under/*data/data_summary*; see Paragraph 2.3 below). We also included the analysis scripts that were used to process the data and generate the figures and results described in the related article [1]. These scripts can be found under/*scripts* and are organized within different subfolders that correspond to the different analyses and figures described in Ref. [1] (see Paragraph 2.4 below). In order to run the analysis code described in this paper and reproduce the results of [1], the Matlab® software package is required as well as EEGLAB [2] with the following plug-ins: ERPLAB [3], Mass Univariate ERP Toolbox [4], BDF-import, CleanLine, FIRfilt. As a preliminary operation we recommend to add the path of the upper-level folder (*ro_eeg_data_repository*), including all subfolders, to the current Matlab® path. It

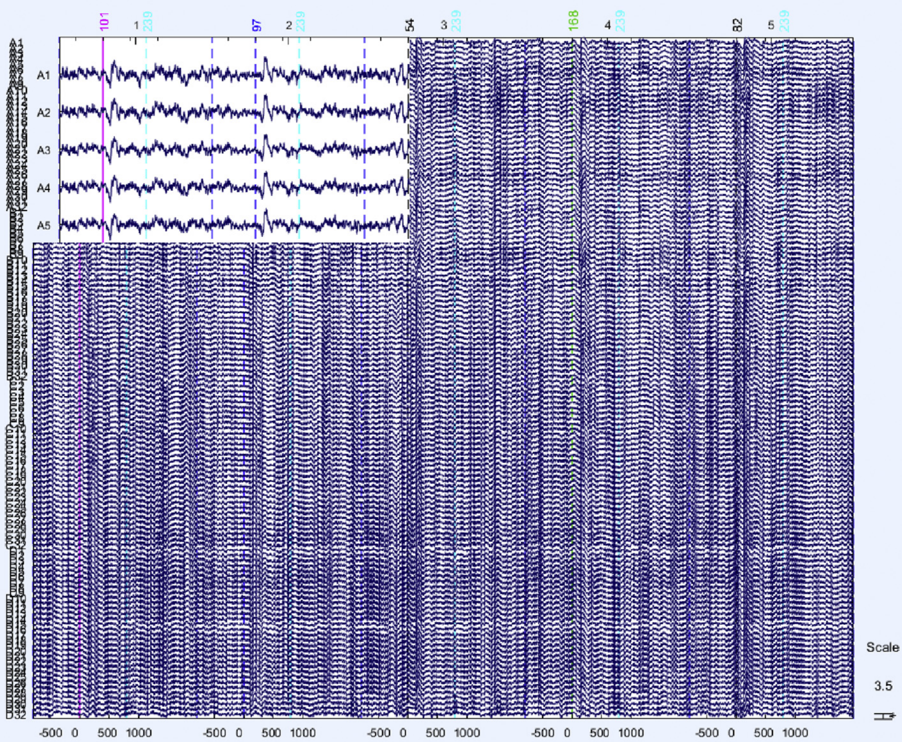

Fig. 1. The first five epochs from Subject 1 data. The top left insert shows a magnification of electrode channels A1 to A5.

may be necessary to edit the path at line 4 of the script *RO_EEG_LoadSettings.m* (under/*scripts/helpers*) to reflect the actual path of the *ro_eeg_data_repository* folder.

2. Experimental design, materials, and methods

The experimental design, task, and data acquisition procedures are described in the linked article [1].

2.1. Data pre-processing

Raw data were digitized at 1 KHz and imported into EEGLAB 14.1.2 [2] using the BDF plugin.
Data were re-referenced to the mastoids average during importing.
Then, data were bandpass filtered (1–100 Hz) using:

```
≫ EEG = pop_eegfiltnew(EEG, 1, 100, 3380, 1, [], 1);
```

Noisy channels were interpolated with the following commands:

```
≫ [~, chan2interp] = pop_rejchan(EEG, 'elec', [1:128], 'threshold', 8,
'norm', 'on', 'measure', 'prob');
≫ EEG = pop_interp(EEG, chan2interp, 'spherical');
```

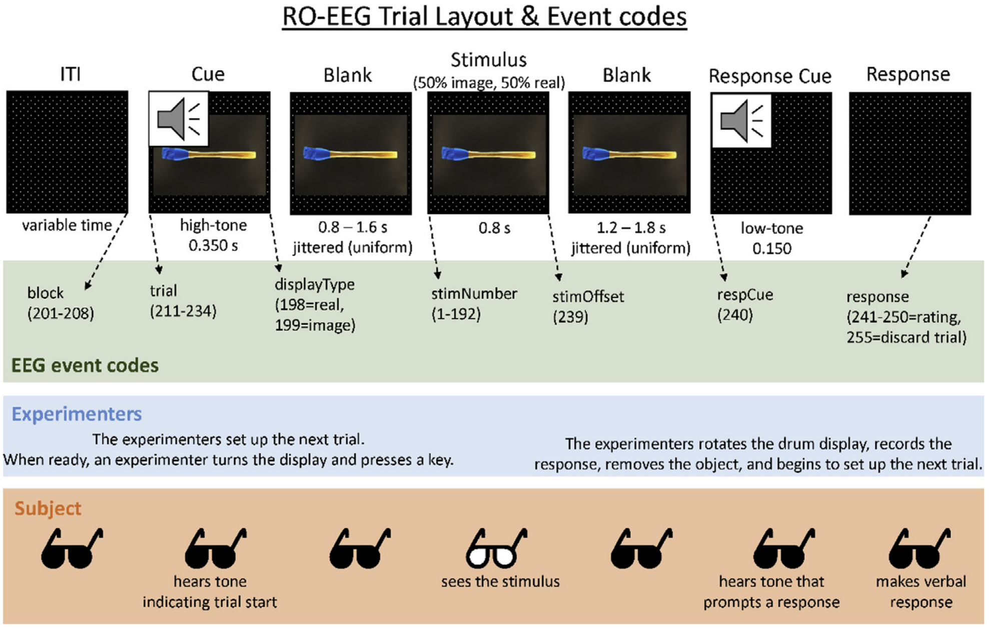

Fig. 2. Schematic representation of a single experimental trial with EEG event codes and their corresponding time-points and meaning. The figure includes a brief description of the experimenters and subjects' tasks at any given moment within a trial.

Line noise was attenuated:

```
≫ EEG = pop_cleanline(EEG, 'bandwidth',2, 'chanlist',[1:134],
'computepower', 1, 'linefreqs', [60 120], 'normSpectrum', 0, 'p', 0.01,
'pad', 2, 'plotfigures', 0, 'scanforlines', 1, 'sigtype', 'Channels',
'tau', 100, 'verb', 1, 'winsize', 4,'winstep', 1);
```

Epochs were created from −800 ms to 2000 ms relative to stimulus onset:

```
≫ EEG = pop_epoch(EEG, 1:192, [-0.8 2], 'newname', 'fullepochs',
'epochinfo', 'yes');
```

Epochs containing artifacts were rejected using a voltage-based threshold:

```
≫ EEG = pop_eegthresh(EEG, 1, [1:71 75 76 77 84 85:90 97 98:128], −
300, 300, −0.8, 2, 0, 0)
```

Independent component analysis (ICA) was performed:

```
≫ EEG = pop_runica(EEG, 'extended', 1, 'interupt', 'on', 'pca',
EEG.nbchan-numel(chan2interp));
```

Components containing artifacts (i.e., eye movements, muscular activity, etc.) were identified by an expert and rejected (see Fig. 3 for a representative example). Prior to the expert's review of the data set for component rejection, equivalent current dipole source estimation was conducted to provide the expert with additional information useful for component rejection (such as the scalp topography and the amount of residual variance for each component). The criteria that were followed for identifying

Table 1
Experimental stimuli used for data collection and their corresponding event codes (**id**), display format (**displ**), category (**cat**), and identity (**name**). See article [1] for photographs.

id	displ	cat	name	id	displ	cat	name	id	displ	cat	name	id	displ	cat	name
1	real	garage	chisels	49	real	kitchen	pasta fork	97	image	garage	chisels	145	image	kitchen	pasta fork
2	real	garage	chisels	50	real	kitchen	pasta fork	98	image	garage	chisels	146	image	kitchen	pasta fork
3	real	garage	chisels	51	real	kitchen	pasta fork	99	image	garage	chisels	147	image	kitchen	pasta fork
4	real	garage	file	52	real	kitchen	fork	100	image	garage	file	148	image	kitchen	fork
5	real	garage	file	53	real	kitchen	fork	101	image	garage	file	149	image	kitchen	fork
6	real	garage	file	54	real	kitchen	fork	102	image	garage	file	150	image	kitchen	fork
7	real	garage	flashlight	55	real	kitchen	grater	103	image	garage	flashlight	151	image	kitchen	grater
8	real	garage	flashlight	56	real	kitchen	grater	104	image	garage	flashlight	152	image	kitchen	grater
9	real	garage	flashlight	57	real	kitchen	grater	105	image	garage	flashlight	153	image	kitchen	grater
10	real	garage	paint sponge	58	real	kitchen	chef knife	106	image	garage	paint sponge	154	image	kitchen	chef knife
11	real	garage	paint sponge	59	real	kitchen	chef knife	107	image	garage	paint sponge	155	image	kitchen	chef knife
12	real	garage	paint sponge	60	real	kitchen	chef knife	108	image	garage	paint sponge	156	image	kitchen	chef knife
13	real	garage	hand clamps	61	real	kitchen	ladle	109	image	garage	hand clamps	157	image	kitchen	ladle
14	real	garage	hand clamps	62	real	kitchen	ladle	110	image	garage	hand clamps	158	image	kitchen	ladle
15	real	garage	hand clamps	63	real	kitchen	ladle	111	image	garage	hand clamps	159	image	kitchen	ladle
16	real	garage	handsaw	64	real	kitchen	lighter	112	image	garage	handsaw	160	image	kitchen	lighter
17	real	garage	handsaw	65	real	kitchen	lighter	113	image	garage	handsaw	161	image	kitchen	lighter
18	real	garage	handsaw	66	real	kitchen	lighter	114	image	garage	handsaw	162	image	kitchen	lighter
19	real	garage	paintbrush	67	real	kitchen	pizza cutter	115	image	garage	paintbrush	163	image	kitchen	pizza cutter
20	real	garage	paintbrush	68	real	kitchen	pizza cutter	116	image	garage	paintbrush	164	image	kitchen	pizza cutter
21	real	garage	paintbrush	69	real	kitchen	pizza cutter	117	image	garage	paintbrush	165	image	kitchen	pizza cutter
22	real	garage	pliers (long)	70	real	kitchen	masher	118	image	garage	pliers (long)	166	image	kitchen	masher
23	real	garage	pliers (long)	71	real	kitchen	masher	119	image	garage	pliers (long)	167	image	kitchen	masher
24	real	garage	pliers (long)	72	real	kitchen	masher	120	image	garage	pliers (long)	168	image	kitchen	masher
25	real	garage	hammer	73	real	kitchen	scissors	121	image	garage	hammer	169	image	kitchen	scissors
26	real	garage	hammer	74	real	kitchen	scissors	122	image	garage	hammer	170	image	kitchen	scissors
27	real	garage	hammer	75	real	kitchen	scissors	123	image	garage	hammer	171	image	kitchen	scissors

(*continued on next page*)

Table 1 (*continued*)

id	displ	cat	name	id	displ	cat	name	id	displ	cat	name	id	displ	cat	name
28	real	garage	pruner	76	real	kitchen	scoop	124	image	garage	pruner	172	image	kitchen	scoop
29	real	garage	pruner	77	real	kitchen	scoop	125	image	garage	pruner	173	image	kitchen	scoop
30	real	garage	pruner	78	real	kitchen	scoop	126	image	garage	pruner	174	image	kitchen	scoop
31	real	garage	putty knife	79	real	kitchen	basting	127	image	garage	putty knife	175	image	kitchen	basting
32	real	garage	putty knife	80	real	kitchen	basting	128	image	garage	putty knife	176	image	kitchen	basting
33	real	garage	putty knife	81	real	kitchen	basting	129	image	garage	putty knife	177	image	kitchen	basting
34	real	garage	screwdriver	82	real	kitchen	spatula	130	image	garage	screwdriver	178	image	kitchen	spatula
35	real	garage	screwdriver	83	real	kitchen	spatula	131	image	garage	screwdriver	179	image	kitchen	spatula
36	real	garage	screwdriver	84	real	kitchen	spatula	132	image	garage	screwdriver	180	image	kitchen	spatula
37	real	garage	trim roller	85	real	kitchen	spoon	133	image	garage	trim roller	181	image	kitchen	spoon
38	real	garage	trim roller	86	real	kitchen	spoon	134	image	garage	trim roller	182	image	kitchen	spoon
39	real	garage	trim roller	87	real	kitchen	spoon	135	image	garage	trim roller	183	image	kitchen	spoon
40	real	garage	utility knife	88	real	kitchen	tongs	136	image	garage	utility knife	184	image	kitchen	tongs
41	real	garage	utility knife	89	real	kitchen	tongs	137	image	garage	utility knife	185	image	kitchen	tongs
42	real	garage	utility knife	90	real	kitchen	tongs	138	image	garage	utility knife	186	image	kitchen	tongs
43	real	garage	wire brush	91	real	kitchen	turner	139	image	garage	wire brush	187	image	kitchen	turner
44	real	garage	wire brush	92	real	kitchen	turner	140	image	garage	wire brush	188	image	kitchen	turner
45	real	garage	wire brush	93	real	kitchen	turner	141	image	garage	wire brush	189	image	kitchen	turner
46	real	garage	wrench	94	real	kitchen	whisk	142	image	garage	wrench	190	image	kitchen	whisk
47	real	garage	wrench	95	real	kitchen	whisk	143	image	garage	wrench	191	image	kitchen	whisk
48	real	garage	wrench	96	real	kitchen	whisk	144	image	garage	wrench	192	image	kitchen	whisk

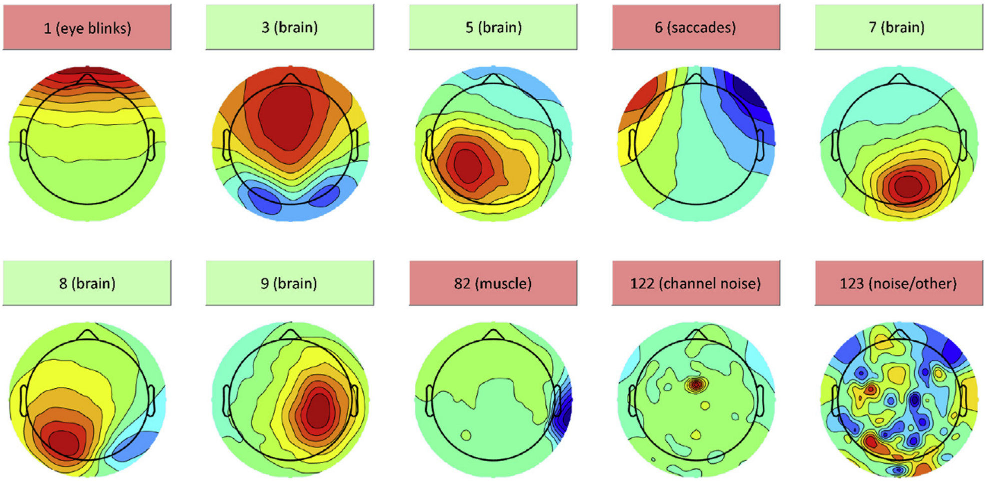

Fig. 3. Example of independent component rejection based on expert review. Ten components from one example subject (#24) are shown prior to rejection, but after an expert has performed labeling. Components with a red background have been selected for rejection, while components with a green background will be retained in the dataset.

candidate ICs for rejection include: spatial topography localized within or near the eyes; non-dipolar spatial topography, as indicated by residual variance of the equivalent current dipole greater than 15%; power spectral density with a profile that did not follow a 1/f pattern (e.g., with relatively low power at lower frequencies at high broadband power). These criteria are standardized and have been validated by a large community of EEG researchers. Further information, including training resources, are available online at: https://labeling.ucsd.edu/tutorial and in a related journal publication [3]. To prevent excessive data trimming, components that were not unequivocally attributed to any category, including components with mixtures of brain-related and non-brain-related activity, were retained in the data. Moreover, researchers who wish to refine the IC selection are encouraged to do so by using an automated labeling toolbox for EEGLAB that has been recently released [4]. The data in/*data/ersp_analyses* were preprocessed up to this level. However, additional pre-processing steps were conducted in preparation for the mass univariate ERP analysis [5], which relies on the utilization of the Mass Univariate ERP Toolbox [5], and for other potential ERP analyses. First, EEG was down-sampled to 128Hz, low-pass filtered with a 30Hz cut-off (although non-filtered EEG was also retained and processed further), and epochs were created from −200 ms to 800 ms and baseline corrected in the period from −200 ms to 0 ms, with all times relative to stimulus onset. Non-filtered single-trial EEG was organized in a 4-D matrix (subject, electrode, timepoint, trial) and stored in the file *n24_SingleTrialEEG.mat* (under/*data/erp_analyses*). Group averages were calculated separately for low-pass filtered and non-filtered data in each experimental condition, and stored in separate variables in the file *GA_24subjects.mat* (under/*data/erp_analyses*). Researchers who are interested in reproducing any ERP analysis described in Ref. [1] should use data files provided in/*data/erp_analyses*; this includes some format-specific files that are necessary to replicate the mass univariate analysis.

2.2. Event codes

EEG data files contain two types of event codes: (i) a code from 1 to 192 that corresponds to the actual experimental stimulus presented on each trial (i.e. what object was presented, and in what display format), and (ii) a code (239) that marks the end of the stimulus presentation period. Please note that codes from 1 to 192 also mark the moment of the beginning of the stimulus presentation period. Additional event codes were used in this experiment (for example, corresponding to participants' responses), but they were delivered outside of the time-windows of this epoched dataset, and therefore they are not visible in the EEG dataset. However, these additional codes may be present elsewhere in the data (for example, they have been used within the analysis scripts and are contained in data summary files; see Paragraph 2.3). Therefore, we provided a figure and a table describing all event codes comprehensively (Fig. 2 and Table 1).

2.3. Data summary files

Behavioral data are available within data summary files. These files are named *SubjXX_DataSummary.mat* (where '*XX*' is replaced by a two-digit subject number from '*01*' to '*24*') and are located in*/data/data_summary*. Data summary files contain on-line effort ratings (variable: *experiment_table*, column 12; see *LoadTableIndexes.m*) as well as off-line familiarity and frequency-of-use ratings (variable: *experiment_table_Quest*, columns 2 and 3, respectively; see *LoadTableIndexes.m*). In addition, data summary files include the variables *EventCodes* and *Latencies*, which contain a trial-by-trial list of all event codes and their corresponding latencies, respectively. Finally, the variable *li*, also included in data summary files, contains logical indexes for trials of the two experimental conditions (*li.Real* and *li.Image*) as well as logical indexes for trials that must be rejected due to EEG artifacts (*li.RejectEpochs*) and for trials with non-missing behavioral responses (*li.trialsToAccept*). The function *LoadTableIndexes.m* is provided as a helper to facilitate column access to the variables within Data Summary mat-files.

2.4. Analysis scripts

Analysis of behavioral data. The methods used for this analysis are described in Ref. [1]. Here, we provide the list of analysis scripts that can be used to reproduce Fig. 1C of [1]. These script are located in*/scripts/behavior*:

1. RO_EEG_SaveStimScores.m
2. RO_EEG_FiguresBehavior.m

ERSP power analysis. The methods used for this analysis are described in Ref. [1]. Here, we provide the list of analysis scripts that can be used to reproduce the figures presented in Ref. [1].

Analysis of ERSP in central electrode cluster (Fig. 2 in Ref. [1]; scripts located in*/scripts/ersp_Ccluster*):

1. RO_EEG_SingleTrial_TimeFrequency_Decomposition_Ccluster.m
2. RO_EEG_TFspectra_Ccluster.m
3. RO_EEG_TFgroup_PermTest_Ccluster.m

Analysis of lateralized ERSPs (Figure 4 in Ref. [1]; scripts located in*/scripts/ersp_lateralized*):

1. RO_EEG_SingleTrial_TimeFrequency_Decomposition_C3.m
2. RO_EEG_SingleTrial_TimeFrequency_Decomposition_C4.m
3. RO_EEG_TFspectra_C3C4.m
4. RO_EEG_TFgroup_PermTest_C3C4.m

Analysis of item-based brain-behavior correlation (Fig. 3 in Ref. [1]; scripts located in*/scripts/ersp_corrBehav*):

1. RO_EEG_SingleTrial_QuickTF_Ccluster.m
2. RO_EEG_ItemAnalysis_SlidingWindow_Analysis.m
3. RO_EEG_ItemAnalysis_SlidingWindow_Figure.m

ERP analysis. The methods used for this analysis are described in Ref. [1]. Here, we provide the list of analysis scripts and related data files that can be used to reproduce the figures presented in Ref. [1].

Mass univariate analysis of ERPs (Figure 5 in Ref. [1]; scripts located in/*scripts/erp_mua*):

1. RO_EEG_MassUnivariateAnalysisERP.m
2. RO_EEG_FiguresERP_ROI1.m
3. RO_EEG_FiguresERP_ROI2.m

Analysis of late parietal ERPs (Figure 6 in Ref. [1]; scripts located in/*scripts/erp_lpp*; please note that this analysis requires to run *RO_EEG_MassUnivariateAnalysisERP.m* as a pre-requisite):

1. RO_EEG_LPP.m
2. RO_EEG_LPP_ROIanalysis.m

Control analysis. This analysis consists of a replication of previously-described ERSP and ERP analyses when only a subset of trials is used (see Ref. [1] for further details). Because we have already provided scripts to conduct both ERSP and ERP analyses, here we are providing a script that identifies the subset of trials used for the control ERSP and ERP analyses in Ref. [1]. This script, *RO_EEG_ControlAnalysis.m*, is located in/*scripts/control*, and its execution produces a.mat file containing the variable *trialsToKeep* as well as a copy of Fig. 7A in Ref. [1]. The variable *trialsToKeep* is a 3-D matrix (subject, trial, condition) with logical indexes corresponding to trials that were used for the control analysis (please note: under 'condition', the first dimension is 'real object' and the second is 'image'). These logical indexes can be used within the previously-described ERSP and ERP analysis scripts in order to restrict such analyses to the desired subset of trials.

Acknowledgements

The work was supported by grants from the National Science Foundation (grant number 1632849 to J.C.S.); the National Eye Institute of the National Institutes of Health (grant number R01EY026701 to J.C.S.); and the National Institute of General Medical Sciences of the National Institutes of Health (grant number P20 GM103650 to J.C·S.). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NSF or NIH.

Transparency document

Transparency document associated with this article can be found in the online version at https://doi.org/10.1016/j.dib.2019.103857.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dib.2019.103857.

References

[1] F. Marini, K.A. Breeding, J.C. Snow, Distinct visuo-motor brain dynamics for real-world objects versus planar images, Neuroimage (2019), https://doi.org/10.1016/j.neuroimage.2019.02.026.
[2] A. Delorme, S. Makeig, EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis, J. Neurosci. Methods 134 (2004) 9–21.
[3] J. Lopez-Calderon, S.J. Luck, ERPLAB: an open-source toolbox for the analysis of event-related potentials, Front. Hum. Neurosci. 8 (2014) 213.
[4] L. Pion-Tonachini, K. Kreutz-Delgado, S. Makeig, ICLabel: an Automated Electroencephalographic Independent Component Classifier, Dataset, and Website, 2019 arXiv preprint arXiv:1901.07915.
[5] D.M. Groppe, T.P. Urbach, M. Kutas, Mass univariate analysis of event-related brain potentials/fields I: a critical tutorial review, Psychophysiology 48 (2011) 1711–1725.