DATA DESCRIPTOR

TITLE

Contrast maps obtained from Individual Brain Charting

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SUMMARY

This dataset contains contrast maps that are the main product of the Individual Brain Charting (IBC) dataset, and represent brain responses for the cognitive contrasts defined in all tasks performed by the IBC participants. Contrast maps are delivered per subject. They were obtained by the application of a General Linear Model to the time courses extracted from the preprocessed IBC data available on EBRAINS[1], together with the event descriptors. The contrast specification and description are publicly available on https://individual-brain-charting.github.io/docs/. Contrast maps are provided both as volume maps in MNI space and as surface-sample data on three different meshes (individual mesh, fsaverage7, fsaverage5) for both hemispheres. The data can be used to inform systematic analyses of brain function (see e.g. 2 and 3).

VERSION SPECIFICATIONS:

This version contains data from the same 13 participants as the previous versions, but more fMRI tasks are included: a total of 68 tasks are included. The directory contains both surface and volume data.

The tasks with contrast maps are the following:

ArchiEmotional, ArchiSocial, ArchiSpatial, ArchiStandard, BreathHolding, Checkerboard, FingerTap, ItemRecognition, Bang, Color, Motion, FaceBody, Scene, VisualSearch, Audio, ContRing, ExpRing, WedgeAnti, WedgeClock, Discount, DotPatterns, SelectiveStopSignal, StopSignal, Stroop, TwoByTwo, ColumbiaCards, WardAndAllport, Attention, EmoMem, EmoReco, StopNogo, Catell, VSTMC, FingerTapping, HcpEmotion, HcpGambling, HcpLanguage, HcpMotor, HcpRelational, HcpSocial, HcpWm, Lec1, Lec2, MCSE, MVEB, MVIS, Moto, Audi, Visu, MTTNS, MTTWE, MathLanguage, RSVPLanguage, VSTM, Enumeration, SpatialNavigation, NARPS, RewProc, BiologicalMotion1, BiologicalMotion2, PainMovie, EmotionalPain, TheoryOfMind, Self, PreferenceFaces, PreferenceFood, PreferenceHouses, PreferencePaintings

MATERIALS AND METHODS

We use the preprocessed IBC dataset[1].

The fMRI data were analyzed using the General Linear Model (GLM). Regressors of the model were designed to capture variations in BOLD response strictly following stimulus timing specifications. They were estimated through the convolution of temporal representations referring to the task-conditions with the defined canonical Hemodynamic Response Function (HRF)[4,5].

The temporal profile of the conditions was characterized by boxcar functions. To build such models, paradigm descriptors grouped in triplets (i.e. onset time, duration, and trial type according to BIDS Specification) were determined from the log files’ registries generated by the stimulus-delivery software.

To account for small fluctuations in the latency of the HRF peak response, additional regressors were computed based on the convolution of the same task-conditions profile with the time derivative of the HRF.

Nuisance regressors were also added to the design matrix in order to minimize the final residual error. To remove signal variance associated with spurious effects arising from movements, six temporal regressors were defined for the motion parameters. Further, the first five principal components of the signal, extracted from voxels showing the 5% highest variance, were also regressed to capture physiological noise.

In addition, a discrete-cosine transform set was applied for high-pass filtering (cutoff=128 seconds). The model specification was implemented using Nilearn library[6].

In order to restrict GLM parameters estimation to voxels inside functional brain regions, a brain mask was extracted from the mean fMRI volume. The procedure implemented in the Nilearn software simply thresholds the mean fMRI image of each subject in order to separate brain tissue from the background, and then performs a spatial filtering of the resulting image to remove spurious voxels.

Regarding noise modelling, a first-order autoregressive model was used in the maximum likelihood estimation procedure.

A mass-univariate GLM fit was applied separately to the preprocessed data of each fMRI time series with respect to a specific task. Parameter estimates pertaining to the experimental conditions were thus computed, along with the respective covariance at every voxel. Various contrasts (linear combinations of the effects), were then defined, referring only to differences in evoked responses between either (i) two conditions-of-interest or (ii) one condition-of-interest and baseline. GLM estimation and subsequent statistical analyses were also implemented using Nilearn. fMRI data analysis was first run on unsmoothed data and, afterward, on data smoothed with a 5mm full-width-at-half-maximum kernel. Such a procedure allows for increased Signal-to-Noise Ratio (SNR) and it facilitates between-image comparison.

USAGE NOTES

The resulting statistical maps are in z-scale, meaning that the value distribution corresponds to a standard Gaussian under the null hypothesis. One map is obtained per contrast, fMRI time series, and subject.

Analysis scripts are available here: https://github.com/hbp-brain-charting/public_analysis_code

SPATIAL ANCHORING:

The fMRI volumes have been resampled in MNI ICBM 152 [2009c, nonlinear, asymmetric] with their native resolution (1mm for anatomical MRI, 1.5mm for fMRI).

DATA RECORDS

The data are stored in the following structure :

where XXXX represents the subject id, YYY represents the session id, ZZZ represents the task id and CCC represents the contrast id

∕ repository-root/

∕ resulting_smooth_maps/

ibc_neurovault.csv *[document listing tasks and contrast used]*

∕ sub-XXX

∕ ses-YYY/

∕ sub-XXX_ses-YYY_task-ZZZ_dir-{pa;ap; ffx}_space-MNI305_Zmap-CCC.nii.gz *[NiftiImage representing a Volume-sampled Contrast map]*

/sub-XXX_ses-YYY_task-ZZZ_dir-{pa;ap; ffx}_space-MNI305_Zmap-CCC.json *[BIDS-type sidecar json file]*

∕ resulting_smooth_maps_surface/

ibc_neurovault.csv *[document listing tasks and contrast used]*

∕ sub-XXX

∕ ses-YYY/

∕ sub-XXX_ses-YYY_task-ZZZ_dir-ffx_space-{fsaverage5 ; fsaverage7 ; individual}_hemi-{lh,rh}_Zmap-CCC.gii *[Gifti file representing a Surface-sampled Contrast map]*

/sub-XXX_ses-YYY_task-ZZZ_dir-ffx_space-{fsaverage5 ; fsaverage7 ; individual}_hemi-{lh,rh}_Zmap-CCC.json *[BIDS-type sidecar json file]*

Format	***Extension***	***Software used / file specification***
Comma-Separated Value	*csv*	*self made* ***ibc_neurovault.csv:****column headers: ‘modality’, ‘image_type’, ‘map_type’, ‘study’, ‘task’, ‘analysis_level’, ‘number_of_subjects’, ‘tags’*
JavaScript Object Notation	*json*	***sub-XXX_ses-YYY_task-ZZZ_dir-{pa;ap; ffx}_space-MNI152NLin2009cAsym_desc-preproc_Zmap-CCC.json*** **sub-XXX_ses-YYY_task-ZZZ_dir-ffx_space-{fsaverage5 ;**

		fsaverage7 ; individual}_hemi-{lh,rh}_Zmap-CCC.json *keys: path, subject, modality, image_type, map_type, study, task, analysis_level, number_of_subjects, tags, cognitive_paradigm_cogatlas, cognitive_paradigm_description_url, contrast_definition*
Gzipped Nifti1Image	*.nii.gz*	***sub-XXX_ses-YYY_task-ZZZ_dir-{pa;ap;ffx}_space-MNI305_Zmap-CCC.nii.gz*** "pa" stands for "posterior-anterior" phase encoding direction "ap" stands for "anterior-posterior" phase encoding direction "ffx" stands for "fixed effects", generally across an {ap, pa} acquisition pair, sometimes across more runs.
Gifti surface data	*.gii*	***sub-XXX_ses-YYY_task-ZZZ_dir-ffx_space-{fsaverage5 ; fsaverage7 ; individual}_hemi-{lh,rh}_Zmap-CCC.gii*** • *space-{fsaverage5 ; fsaverage7 ; individual} corresponds to the mesh used to project the fMRI data* • *hemi-{lh,rh} stands for left/right hemisphere*

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Author contributions

Himanshu Aggarwal: data acquisition, data annotation

Ana Fernanda Ponce: data acquisition, data annotation

Bertrand Thirion: data analysis

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