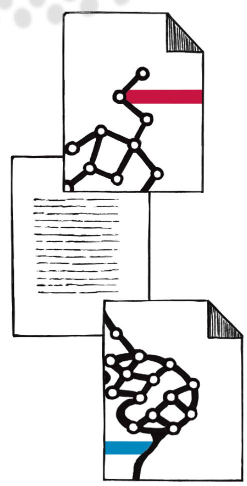

Data Release Documentation

Version	Author(s)
1.0	Taheriyan, F., Kahraman, K., Sripad, P., Bonacchi, N., Brown, T., Oh, H., Melloni, L.
Date	**Editor(s)**
18.03.2024	Taheriyan, F., Kahraman, K., Sripad, P., Bonacchi, N., Brown, T., Melloni, L.

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Updates

This is the first version (V1.0) of the COGITATE data release document. New updates or any changes to the previous versions will be announced here, and on COGITATE_wiki as well.

In V1.0, we released a subset of magnetoencephalography (MEG) data (batch 1) in the Brain Imaging Data Structure (BIDS) format. It includes data from 48 subjects who participated in Experiment 1, packaged in a Bundle format.

****The demography of subjects for this release can be found here.**

Future Releases

Here are the items that will be released soon:

Experiment 1

- BIDS format of the rest of the M-EEG data along with the unprocessed/raw data
- Unprocessed/raw and BIDS format of fMRI and iEEG data

Attention: M-EEG, MEEG, M/EEG, MEG/EEG or MEG might be used interchangeably throughout this document or the name of data folders, but all of them pertain to a singular data. This also applies to iEEG and ECoG (Electrocorticography).

Introduction

This document provides guidance and detailed information on the datasets released by COGITATE, how to access them, the directory structure, and a description on various types of data acquired for each modality.

Overview of COGITATE

What are the mechanisms that give rise to consciousness? This question has been the focus of extensive research, leading to the development of several prominent theories, including Global Neuronal Workspace Theory (GNWT) and Integrated Information Theory (IIT). Critically, however, the focus so far has been on testing each theory independently, gathering evidence for/against them separately, leaving open a crucial question: which theory has higher explanatory power when tested against each other directly?

COGITATE is a pioneering Open Science adversarial collaboration to bridge this gap and evaluate GNWT and IIT through two studies, named Experiment 1 (EXP1) and Experiment 2

(EXP2). In these experiments, multimodal empirical tests are conducted on human volunteers (over 550 subjects from different populations), combining magneto-electroencephalography (M-EEG), functional magnetic resonance imaging (fMRI) and invasive intracortical recordings (iEEG) along with behavioral and eye tracking measurements. The reason for this approach is to maximize the sensitivity and specificity to the tests of each hypothesis, while accounting for trade-offs between temporal and spatial specificity inherent to the currently available methods in human neuroscience.

Goals

The aim of the COGITATE project is to accelerate research on consciousness and establish a groundbreaking model for scientific practices in cognitive neuroscience at large, by demonstrating the impact of team-based adversary research and open data to address some of the major riddles in the field, much like established practices in other fields of inquiry such as physics and genomics.

Furthermore, the resulting products of this research include a large and unique multimodal database, high-end analysis tools, and a new paradigm for probing consciousness in naturalistic settings. All experimental procedures, multimodal datasets, and analysis tools developed in this project will be made openly available to the public. These products will propel further discoveries in the field of consciousness, and in cognitive neuroscience in general, which will exceed and outlast the direct outputs of the proposed studies.

Experiments

The COGITATE consortium performed two experiments:

In Experiment 1 (EXP1), two sets of clearly visible task relevant and irrelevant stimuli were shown to the subjects with different durations. The goal was to test the effects of maintenance of a percept in consciousness and task relevance and contradictory predictions regarding the involvement of prefrontal and posterior, category selective cortical areas in consciousness. Specifically, the main questions were: *How is the persistence of a stimulus in consciousness reflected in cortical hemodynamic and electrophysiological activity, i.e., are the neural responses phasic or sustained throughout a conscious experience? Do activity patterns in prefrontal areas relate to visual consciousness per se or to its consequences, i.e., task-related processes?*

In Experiment 2 (EXP2), a novel paradigm was developed to test the key predictions of GNWT and IIT while overcoming a major obstacle in the field: *creating more naturalistic conditions of invisibility that do not degrade the physical input.* To achieve this goal, an engaging video game was used with the help of which salient stimuli were presented for relatively long durations in the background. Sometimes the stimuli was not consciously seen due to attentional engagement by the game. This approach allowed us to uniquely study neural activity elicited by seen or unseen stimuli under naturalistic conditions so that the stimuli can either be task relevant or task irrelevant.

Objective

The primary aim of this experiment was to investigate neural activity in response to stimuli that are consciously perceived. It was designed to manipulate two key factors:

1. **Relevance of the Stimulus to the Task:** This factor was categorized into three levels—Task-relevant target, Task-relevant non-target, and Task-irrelevant stimulus.
2. **Stimulus Duration:** The stimuli were presented for durations of 500 ms, 1000 ms, and 1500 ms

This design framework allowed us to test several key hypotheses, including:

- Disentangling consciousness-related activations from task-related activations.
- Identifying brain regions that convey information about the content of consciousness.
- Examining the persistence of the content of consciousness over time.

Design

This experiment followed a 3x3x4x2 factorial design, with the following items:

Relevance of Stimulus to the Task (3)	• Task-relevant target • Task-relevant non-target • Task-irrelevant stimulus
Stimulus Duration (3)	• 500 ms • 1000 ms • 1500 ms
Stimulus Category (4)	• Faces • Objects • Letters • False-fonts (meaningless symbols)
Stimulus Orientation (2)	• Side view (right or left view) • Front view

Sample Size

The sample sizes were determined based on common practices in the literature, resulting in a total of 120 subjects for fMRI, 102 for M-EEG, and 34 for iEEG. All subjects met specific criteria, including age and health conditions, to ensure data quality.

Task Description

A sequence of images including faces, objects, letters or meaningless symbols (‘false fonts’) with front or side (left or right) view were presented to the subjects. At the beginning of each sequence, the target images were presented and subjects were asked to memorize and remember them during the sequence. Subjects were instructed to press any buttons with their index finger when they saw targets (in either front or side views) as quickly and accurately as possible.

The duration of each sequence was approximately 2 minutes. The next sequence started when the subjects pressed the space key. Here is an example of the tasks:

For a comprehensive summary of more details about the experiments, please refer to the following supplementary resources:

PLOS One Methods paper (COGITATE Main Scientific Paper 1 (MSP-1)):

[Melloni L, Mudrik L, Pitts M, Bendtz K, Ferrante O, et al. (2023) An adversarial collaboration protocol for testing contrasting predictions of global neuronal workspace and integrated information theory. PLOS ONE 18(2): e0268577. https://doi.org/10.1371/journal.pone.0268577]

[COGITATE Preregistration, v4]

EXP 1 Demo video

Experiment 2: Video Game Engagement

Not included in this document. It will be released soon!

Task Code and Stimuli repositories

The **task code** and **stimuli** used for EXP1 and for all modalities are available at COGITATE_code_experiments.

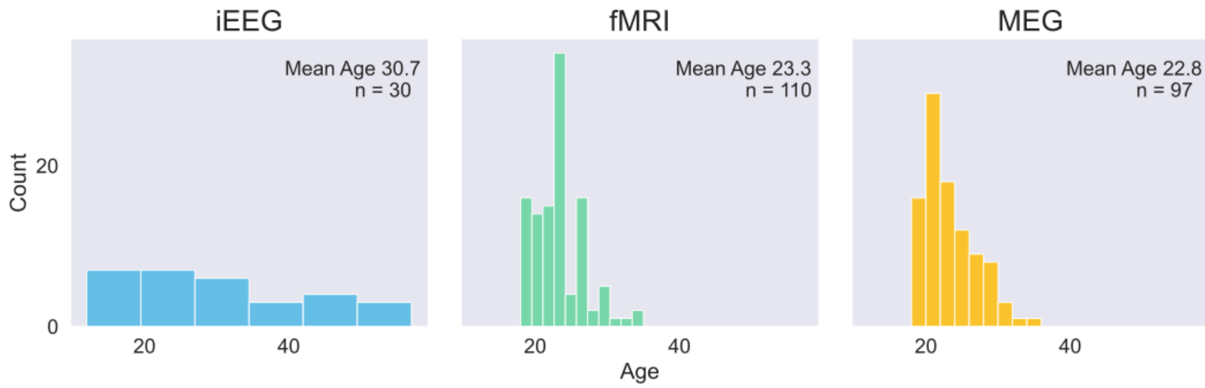
COGITATE Dataset

The COGITATE dataset is a comprehensive collection of multimodal neuroimaging data, encompassing a total of 256 subjects. COGITATE employs three distinct neuroimaging techniques: fMRI, M-EEG, and iEEG/ECoG.

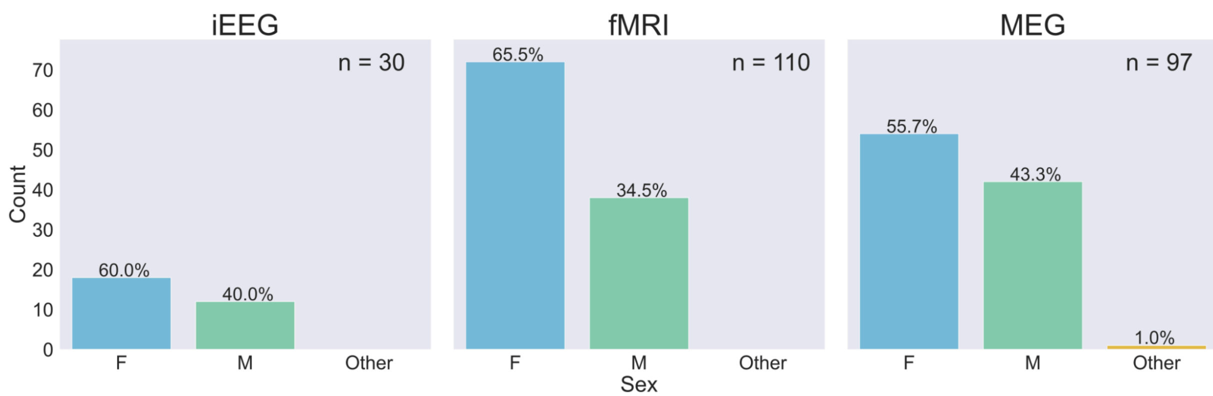
The MEG modality comprised 102 healthy subjects, also above the age of 18, with no known psychiatric or neurological issues. These participants were sourced from the Centre for Human Brain Health at the University of Birmingham (Birmingham, United Kingdom) and the Center for MRI Research of Peking University (Beijing, China).

Similarly, the fMRI modality included 120 healthy volunteers, all of whom were above the age of 18 and predominantly right-handed. These participants had no known history of psychiatric or neurological disorders and were recruited from the Yale Magnetic Resonance Research Center (New Haven, CT, United States) and the Donders Centre for Cognitive Neuroimaging (Nijmegen, Netherlands).

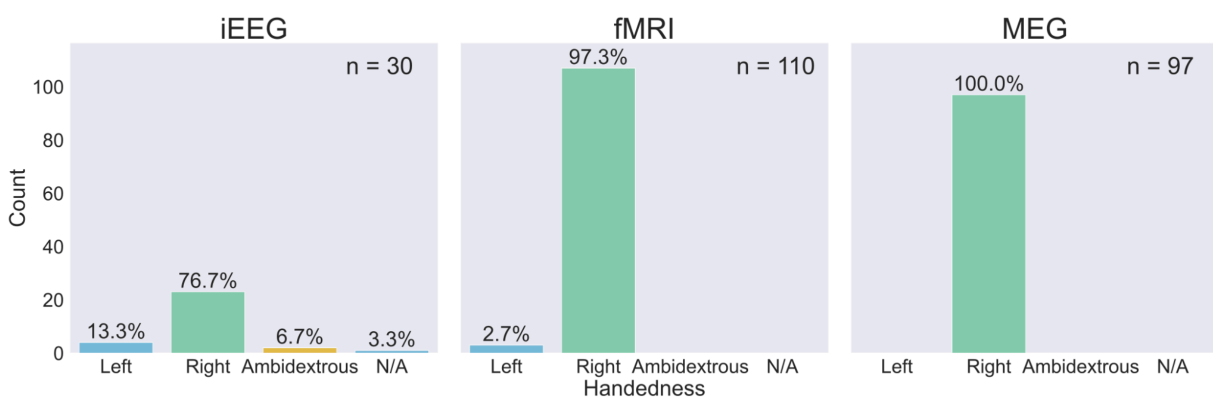
In contrast, the iEEG modality involved a more specialized cohort of 34 patients diagnosed with pharmaco-resistant focal epilepsy. These participants ranged in age from 10 to 65 years, had an IQ above 70, and met specific health criteria. They were recruited from multiple medical centers specializing in epilepsy treatment, including the Comprehensive Epilepsy Center at New York University (New York, NY, United States), Brigham and Women's Hospital, Boston Children's Hospital (Boston, MA, United States), and the University of Wisconsin School of Medicine and Public Health (Madison, WI, United States).



Age Histograms across Modalities



Sex Proportions across Modalities



Handedness Proportions across Modalities

Demography of Subjects

You can find the profile of participants for all modalities at subjects_demography. Here is a brief explanation about the information collected from the subjects.

Demographic Information for M-EEG

The below items are included in the subjects' demography for M-EEG modality:

Participant_ID (participant identifier), sex (biological sex of participant), age (age of participant at the time of testing), handedness (right, left or ambidextrous), included in MSP (whether the data was used for the experiments or not), phase* (determining in which stage the data is, phase 2/phaseII (optimization) or phase 3/phaseIII (replication)), QC** status (passed/not), if Not (in QC status) QC rejection reason, weight (weight of participant at the time of study in pounds), height (height of participant at the time of study in inches), primary and secondary language, race (ethnicity of the participant), education, compensation (whether the subject was paid or not), colorblind (determining whether the subject can distinguish the colors and perceiving them correctly or not), visual correction (none or using any glasses or contact lenses), eye dominance (which eye is dominant), eye chart results (the outcome of a visual acuity test performed using the eye chart) and dioptry (visual acuity of the participant in Diopters).

***Phase:** COGITATE project has three phases. In **phase 1**, all data were acquired by theory neutral teams. To ensure replicability of the results, the entire dataset was split into two halves, each with an equal mixture of data from each of the labs for each modality. In **phase 2**, after evaluating data quality, the first half of the data were used for developing analysis tools (optimization of methods). The purpose of **phase 2** was to define the best analysis practices and to agree upon, in consultation with expert advisors. In **phase 3**, the replication phase, the second half of the data were analyzed using the concurred procedure, agreed upon protocols, thereby allowing an in-house replication of the results obtained in phase 2.

****QC (quality control):** A number of items were checked for all the data of each modality which are elaborated in the section of Quality Check and Exclusion Criteria.

Demographic Information for fMRI

All of the items are similar to the M-EEG modality.

Demographic Information for iEEG

In addition to the properties mentioned for M-EEG modality, the below parameters were also provided for this modality:

Electrode scheme (the scheme used for implanting the electrodes, Stereo, Subdural grid & Strips), number of implanted electrodes, implant hemisphere (brain hemisphere where the electrodes implanted, right, left, both or bilateral), IQ (score and name of the test used for assessment (FSIQ, WISC, VCI, POI, WMI, PSI, AMI, VMI), WADA (intracarotid sodium amobarbital, a test that determines which side of the subject's brain controls language and memory functions), seizure type (classification of seizure type), age of onset (age at which the first symptoms of seizure appeared), auditory normal hearing (indicator of whether the participant had normal hearing capabilities, yes or no), epilepsy seizure classification (categorization of epilepsy as per standard seizure classification), epilepsy seizure aura (description of any sensory or perceptual symptoms before a seizure occured), epilepsy seizure semiology (signs and symptoms exhibited during epileptic seizures), epilepsy seizure frequency (frequency of seizures experienced by participant), epilepsy post ictal semiology (symptoms and signs after an epileptic seizure), epilepsy trigger (identified factors or circumstances that increased the likelihood of experiencing a seizure), epilepsy duration uncontrolled (the duration that seizures had not been successfully managed or medically controlled), epilepsy seizure onset zone (brain region identified as the initial site of seizure activity), epilepsy resection (details of any surgical resection performed for seizure control), epilepsy language lateralization (determination of the dominant hemisphere for language function), epilepsy past surgical history (record of any previous surgeries related to the treatment of epilepsy), epilepsy past medical history (medical history relevant to epilepsy diagnosis and treatment), epilepsy family history (presence of seizure or epilepsy disorders in family members), other neurological disorders (any other diagnosed neurological disorders besides epilepsy), epilepsy MRI findings (summary of MRI findings relevant to epilepsy diagnosis), epilepsy pathology findings (pathological findings from tissue analysis post-surgery or biopsy).

Quality Check

Data from all modalities were checked at three levels. The first level checks tested whether the datasets contained all expected files keeping their naming conventions, and that all personal information had been removed. The second level checks tested subjects' performance with respect to behavior. For Experiment 1, subjects were excluded if their hit rate was lower than 80% or (False Alarm) FAs higher than 20% for M-EEG and fMRI, and for iEEG, a more relaxed criteria of 70% Hits and 30% FAs was used. Two M-EEG subjects were excluded due to low hit rates and one iEEG patient was excluded due to high FAs. The third level checks assessed the quality of the neural data.

Exclusion Criteria

The generic exclusion criteria used across Experiment 1 and Experiment 2 included: (a) insufficient number of trials in each of the experimental conditions (<30 for M-EEG or <20 for fMRI), due to excessive muscular artifacts, movement, noisy recording, or subjects deciding to stop the experiments. If a given analysis showed that a good enough signal could be obtained with fewer trials, these numbers were amended; and (b) low performance in the attention tasks. In Experiment 1, this translates into: <80% Hits, >20% FAs for fMRI and M-EEG subjects; <70% Hits, >30% FAs for iEEG patients. In addition, data was excluded from analysis if it did not pass any of the predefined data quality checks.

Description of COGITATE Data

Although our data collection had a specific purpose, the data we gathered holds potential value for a range of diverse inquiries. Consequently, the COGITATE consortium has chosen to openly share all raw data collected (including the data that did not pass the quality criteria), to facilitate its utilization for various research endeavors and promote data reusability.

We have made available two primary formats for the data acquired during the experimental phase of the COGITATE project, specifically Experiment 1:

1. Unprocessed/Raw Data
2. BIDS Format

1. Unprocessed/Raw Data

The unprocessed data format closely resembles the original acquired data, having undergone minimal processing to ensure compliance with GDPR (General Data Protection Regulation)/HIPAA (Health Insurance Portability & Accountability Act) anonymity standards.

2. BIDS Format

BIDS format, widely adopted in cognitive neuroscience, enhances data reusability. To facilitate others in leveraging our data, we have released it in BIDS format.

File type glossary

Here are the various file formats used for each modality of the COGITATE dataset along with a short description of them.

	Unprocessed /Raw	BIDS Format	Description
Eye Tracking & Behavioral Data	ASC/CSV	ASC/CSV	The two eye trackers used within COGITATE are: 1. EyeLink eye tracker 2. Tobii eye tracker **1) EyeLink eye tracker:** Most of the sites used this eye tracker which produces data in the EDF format, EyeLink Data Format. This data was immediately converted to ASCII text files using the converter provided by Eyelink. This is the ASC files that we used in our data. **2) Tobii eye tracker:** The other eye tracker was the Tobii

			eye tracker used by New York University Langone for ECOG data. This eye tracker produces data in the form of CSV files. The files generated by eye tracking systems, containing information about eye movement and gaze behavior which typically store a time-stamped sequence of gaze data points and include information such as: 1. Timestamps: The exact time at which each gaze data point was recorded. 2. Gaze Coordinates: The x and y coordinates on the screen where the person's gaze is directed. 3. Pupil Diameter: The size of the person's pupil, which can provide insights into changes in visual processing or cognitive load. 4. Fixations: Periods of stable gaze where the person is looking at a specific point without significant movement. 5. Saccades: Rapid eye movements between fixations, indicating shifts in attention. 6. Blinks: Instances when the person's eyes are closed, which can be important for data cleaning and analysis. Behavioral data is available in CSV format and it provides below information: 1. Blocks 2. Events 3. Trials 4. Stimulus and jitter duration 5. Subject's responses
M-EEG	FIF	FIF	File Format for the Input and Output of MEG and EEG data FIF files contain various types of information related to neuroimaging data, including: 1. Raw sensor data: MEG and EEG measurements recorded from sensors placed on the scalp or near the head. 2. Event information: Time-stamped triggers or markers indicating the timing of events, such as stimulus presentations or subject responses. 3. Sensor locations and orientations: Information about the physical positions and orientations of sensors used in the measurements.

			4. Head geometry: Information about the shape and structure of the subject's head, which is crucial for accurate source localization. 5. Covariance matrices: Statistical information about the relationships between sensor measurements at different time points or frequencies. 6. Anatomical MRI data: High-resolution structural images of the subject's brain, used for source localization and spatial alignment.

Data Acquisition

The Cogitate dataset encompasses three distinct neuroimaging modalities, along with synchronized eye-tracking and behavioral data linked to each of these modalities. Here we detail the acquisition protocol for each modality in the corresponding data release: M-EEG

Stimuli

Stimuli belonged to four categories that naturally fell into two groups that were clearly distinct from each other: pictures (20 faces and 20 objects) and symbols (20 letters and 20 false-fonts). Face stimuli were created using the FaceGen Modeler 3.1 program and object stimuli were taken from the Object Databank (Tarr, 1996). Faces and objects were grey-scaled (RGB: 125, 125, 125), and manipulated to have similar size and equal luminance using the SHINE toolbox (Willenbockel et al., 2010). Equal proportions of male and female faces were presented. They all had hair and belonged to different ethnicities (e.g., Caucasian, Asian, African, American) to facilitate face individuation. The orientation of the stimuli was manipulated, such that half of the stimuli from each category had a side view and the other half a front view. All letter stimuli and false fonts were generated with MAXON CINEMA 4D Studio (RC-R20) 20.059 on macOS 10.14, appearing in gray (RGB: 125, 125, 125). Three views were rendered for each font set (real font, false/pseudo font) at 0°, 30° and -30° horizontal viewing angle with the following settings: Extrusion depth 9.79% of character height, camera distance 5.65 times character height and 18° above the center of the letter (High Angle), with a simulated focal length of 135 mm (35 mm equiv.). All stimuli were presented on a rectangular aperture at an average visual angle of 6˚ by 6˚.

Procedure

Stimuli were presented in a sequence, all supra-threshold, with half being task-relevant and half task-irrelevant. Only one stimulus was present on the screen at any given time. To define task relevance, on a subset of stimuli, subjects were instructed to detect (press a button; non-speeded response) the occurrences of two targets belonging to two different categories, regardless of their orientation. This online reporting allowed for an explicit assessment of subjects' performance, and engaged report-related areas, which were later identified in one of the planned analyses. In each block, subjects were asked to perform the task on stimuli from different categories, thereby redefining task relevance of the different stimuli.

The experiment was divided into 10 runs, with 4 blocks each. During each block, a ratio of 34-38 trials was presented, with 32 non-targets (8 of each category) and 2-6 targets (number chosen randomly). A block started by notifying the subject about the two target stimuli. These were either pictorial (faces and objects) or symbolic (letters and false fonts). These couplings were designed to create a clear difference between the task-relevant and the task-irrelevant stimuli, thereby making their classification as either relevant or irrelevant trivial. At the beginning of each block, the specific target stimuli were disclosed by presenting the instruction “detect face A and object B” or "detect letter C and false-font D" for a face/object or letter/false font block, respectively (targets did not repeat across blocks). Each run contained two blocks of the Face/Object task and two blocks of the Letter/False-font task. The order was counterbalanced across runs. Subjects were further asked to maintain central fixation on a circle throughout each trial. Gaze was monitored online through an eye tracker, and repeated calibrations were performed to assure good quality eye tracking data.

Each block included a sequence of stimuli belonging to all four categories, and each stimulus was presented for one of the three predefined durations (500, 1000, 1500 ms), followed by a blank period, such that overall trial length was fixed at 2000 ms. To avoid periodic presentation of the stimuli, random jitter was added to the end of each trial (mean inter-trial interval of 400 ms, jittered 200-2000 ms, with truncated exponential distribution). Each block contained three different trial types: i) Task Relevant Targets, which were the two stimuli being detected (e.g., the specific face and the specific object); ii) Task Relevant Non-Targets, which were the stimuli from the task relevant categories that were not the two specific targets (e.g., other faces and other objects); and iii) Task Irrelevant Stimuli, which were the stimuli from the two other categories (e.g., letters and false-fonts).

M-EEG Data Acquisition

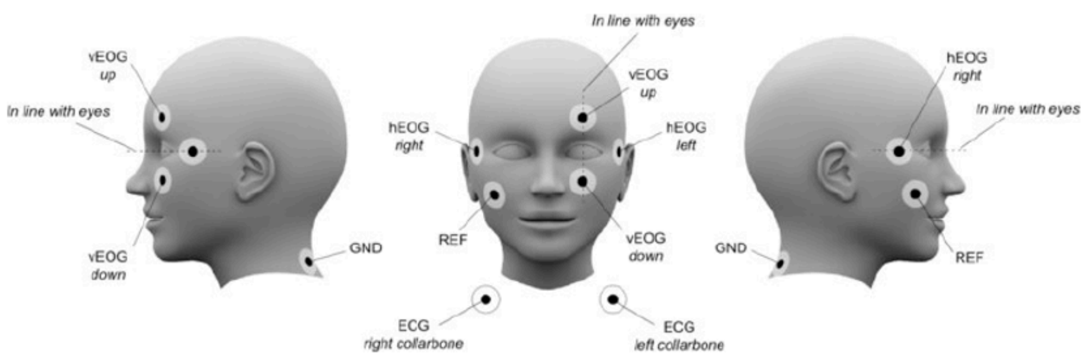
M-EEG recordings were acquired at the Centre for Human Brain Health (CHBH) of University of Birmingham in the United Kingdom, and at the Center for MRI Research of Peking University (PKU) in China.

Hardware

Both centers had a 306-channel, whole-head TRIUX MEG system from MEGIN (York Instruments; formerly Elekta). The MEG system comprised 204 planar gradiometers and 102 magnetometers in a helmet-shaped array. Simultaneous EEG was recorded using an integrated EEG system and a 64-channel electrode cap. The MEG system was equipped with a zero boil-off Helium recycling system and the noise-resilient ARMOR sensors and placed in a shielded room (2 layers of mu-metal and 1 layer of aluminum). To reduce environmental noise, the integrated active shielding system was used at PKU. In order to cover the brain more homogeneously, the MEG gantry was positioned at 68 degrees.

Location of Electrodes and ECG/EOG Measurements

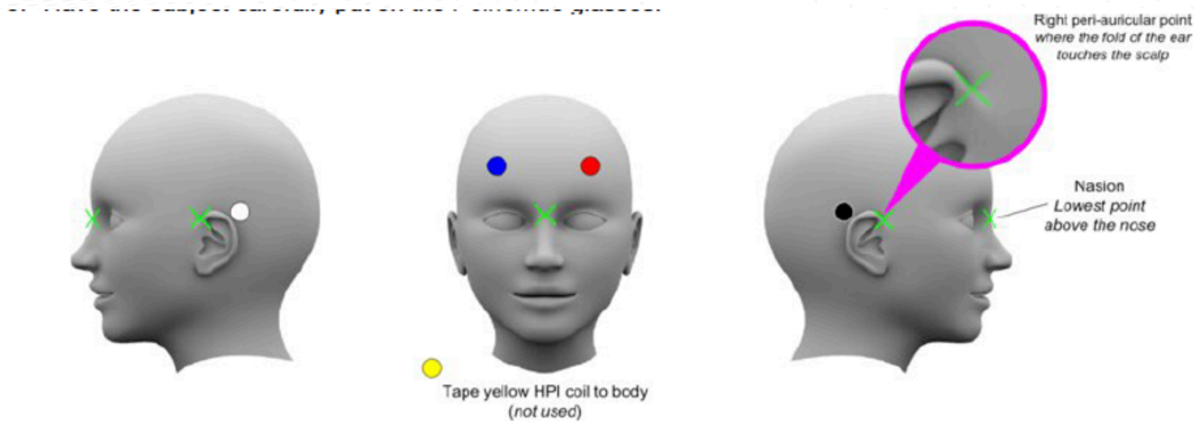
The location of the fiducials, the positions of the 64 EEG electrodes and the participant's head shape were recorded using a 3-D digitizer system (Polhemus Isotrak). A set of bipolar electrodes were placed on the subject's chest (upper left and upper right chest position) to record the cardiac signal (ECG). Two sets of bipolar electrodes were placed around the eyes (two located at the outer canthi of the right and left eyes and two above and below the center of the right eye) to record eye movements and blinks (EOG). Ground and reference electrodes were placed on the back of the neck and on the right cheek, respectively. The impedance of all of the electrodes was checked to be below 10 kOhm.



Standard locations of EOG and ECG electrodes

Head Position Indicator (HPI) Coils

The participant's head position inside the MEG system was measured at the beginning and at the end of each run using four head position indicator (HPI) coils placed on the EEG cap. Specifically, the HPI coils were placed next to the left and right mastoids and on the left and right forehead. Their location relative to anatomical landmarks was digitized with a Polhemus Isotrak System. During the measurement, high frequency (>200 Hz) signals were produced by those coils and the localization of these signals was used to estimate the head position in the sensor space. To avoid the potential artifacts produced by the non-linear interaction between the signals generated by these coils, head position measurement was performed only during resting periods (as opposed to continuously).



Standard locations of HPI coils.
Coil Numbers: 1. Blue, 2. White, 3. Red, 4. Black, 5. Yellow

Anatomical MRI Data Acquisition

For each subject, a high resolution T1-weighted MRI volume (3T Siemens MRI Prisma scanner) was acquired. At CHBH, a 32-channel coil with a resolution of 1 x 1 x 1 mm, 208 sagittal slices and field of view (FOV): 256 x 256 matrix was acquired for source localization with individual realistic head modeling. At PKU, a 64-channel coil with a resolution of 1 x 1 x 1 mm, 198 sagittal slices; FOV: 256 × 256 matrix was used. To avoid possible interference of body magnetization on the MEG recording, all MRI scans were acquired at least one week before the MEG session, or at any time afterwards.

Behavioral Setup

Visual stimuli were presented on a screen placed in front of the subjects with a PROPixx DLP LED projector (VPixx Technologies Inc.) at a resolution of 1920 x 1080 pixels and a refresh rate of 120 Hz. The distance between the subject's eyes and the screen was different at each site (CHBH: 119 cm, PKU: 85 cm) to achieve the same FOV of 36.6 x 21.2 degrees.

Eye Tracking

Eye movements were monitored and recorded from both eyes (binocular eye-tracking) using the MEG-compatible EyeLink 1000 Plus eye-tracker (SR Research Ltd., Ottawa, Canada). Nine-point calibration was performed at the beginning of the experiment, and recalibrated if necessary at the beginning of each block/word. Pupil size and corneal reflection data were collected at a sampling rate of 1000 Hz.

Behavioral Data Code Scheme

Stimuli are coded as a 4-digit number.

- 1st digit = stimulus type (1 = face; 2 = object; 3 = letter; 4 = false font)
- 2nd digit = stimulus orientation (1 = center; 2 = left; 3 = right)
- 3rd & 4th digits = stimulus id (1...20; for faces 1...10 is male, 11...20 is female)

e.g., "1219" = 1 is face, 2 is left orientation and 19 is a female stimulus #19

Eye Tracker and MEG Code Scheme

The channel name that contains the eye tracker data in the FIF file is as follows: MISC1 (X), MISC2 (Y), and MISC3 (pupil)

Defining some terms

Trial: Stimulus presentation followed by a fixation (the two add up to 2 sec) followed by a jitter of 200 msec to 2000 ms.

Mini block: presentation of 34 to 38 stimuli, in the beginning of which the target stimuli were presented.

Block: composed of 4 mini blocks. At the end of each block, there was a break.

Break: Pause between 2 blocks

Successive trigger scheme

The triggers were sent successively. The first trigger represented the stimulus type, followed by orientation, stimulus duration, and task relevance, all interspaced by 50 ms. Additionally, a trigger was sent upon key press.

1st Trigger (on Stimulus Onset): Stimulus Type

- 1 to 20: faces
  - 1 to 10 males,
  - 11 to 20 females
- 21 to 40: objects
- 41 to 60: letters
- 61 to 80: falses

2nd Trigger (2 Frames after Stimulus Onset): Stimulus Orientation

- 101: Center
- 102: Left
- 103: Right

3rd Trigger (4 Frames after Stimulus Onset): Stimulus Duration

- 151: 500 msec
- 152: 1000 msec
- 153: 1500 msec

4th Trigger (6 Frames after Stimulus Onset): Stimulus Task Relevance

- 201: Task relevant target
- 202: Task relevant non target
- 203: Task irrelevant

5th Trigger (8 Frames after Stimulus Onset): Trial ID Triggers

- 111-148: Trial number

Response Trigger

- 255: Following button press.

Stimulus Presentation End

- 96: Offset of stimulus presentation (onset of blank)
- 97: Offset of blank (onset of jitter period)
  - Note that both these are fixations, they are just divided into blank and jitter.

General Triggers to Mark Experiment Progression

86: Onset of experiment

81: Onset of recording

83: Offset of recording

Miniblock ID Triggers

161-200: Miniblock ID trigger

Zeroes

0: Zeros were sent between the successive triggers to reset the LPT, see below. These were also sent to the eye tracker but did not mean anything and they can safely be ignored.

How The LPT Triggers Were Sent

The LPT port of the computer was used for sending the triggers and it was done by using the sendTrig function. This function sets the port in a specific state (whatever trigger we want to send) and logs the trigger afterwards, noting if it is sent and what time the command for sending it is executed. For each trigger that is being sent, the port is being reset after a frame to 0.

In the beginning of the experiment, a few triggers were sent to mark experiment onset and onset of recording. Then, a mini block was initiated. The participant was presented with the target screen and required to press the spacebar to proceed. When the participant pressed the space button, the miniblock ID was sent. Only once the miniblock trigger was sent the fixation appeared. This means that there was a small delay between key press and fixation onset. Following the first fixation, a jitter started, which was also logged. Then, the first stimulus was displayed. Upon the presentation of the stimulus, the successive triggers were initiated. The first trigger occurred directly after the onset of the stimulus, indicating the stimulus ID (1-80). Then, after 2 frames, the orientation trigger (101-103) was sent, followed by the duration trigger (151 to 153) at 4 frames, the task demand trigger (201-203) at 6 frames, and finally, the trial ID trigger (111 to 148) at 8 frames.

Empty Room Recording

Prior to each experiment, MEG signals from the empty room were recorded for 3-minutes.

Resting-State (rM-EEG)

The resting-state data for each participant was also recorded for 5-minutes and the subjects were asked to keep their eyes open and fixated on a point presented at the center of the screen. M-EEG signals were sampled at a rate of 1 kHz and band-pass filtered between 0.01 and 330 Hz prior to sampling.

Task (tM-EEG)

Following the empty room and rM-EEG recordings, subjects were asked to complete the task defined in the Procedure section.

Task	Runs	Blocks	Trials	Total trials
Experiment 1	10	4	34-38 per block	1440

Full Structure of Session

Complete standard procedure of an M-EEG session is available in MEG Standard Operating Procedure.

Inclusion Criteria

The items below were assessed for the subjects before the data was acquired:

- Age range: 18 to 35 (since over the age of 35 subjects might have a hard time maintaining central focus)
- Handedness: right
- Hearing problems: no

- Hearing aid: no
- Vision problems: no, or corrected-to-normal with soft lenses
- No MRI in the last week
- MRI compatible: no metal, medical implants, etc. No claustrophobia. Note: dental implants are allowed (particularly for non-magnetic materials) unless it generates big impacts on MEG signals, and this will be checked prior to MEG recording.
- No known history of psychiatric or neurological disorders, e.g.,
    - Not have been formally diagnosed with attention deficit (hyperactivity) disorder (AD(H)D).
    - Not have been formally diagnosed with autism spectrum disorder (ASD)
    - Not suffer from epilepsy

Quality Check and Exclusion Criteria

For M-EEG, the first stage of the third-level checks focused on system-related and external noise generators. It was tested using the signal spectra in the empty room recording, the resting state session, and the experiment itself for all sensors. Any sensor and/or specific frequency revealing extensive noise using visual inspection, was flagged to document potential problems. Ultimately, this did not lead to any exclusions. Next, all experimental data blocks were visually inspected for abnormalities in spectra (peaks not explainable by physiology), and in ICA components, and checked for extremely noisy (based on the score of differences between the original and Maxwell-filtered data > 7) and flat sensors. The latter step was performed in a collaboration between the data monitoring team and members of the centers where data was acquired to check whether any potential changes in preprocessing for particular subjects were needed. Finally, we tested if all experimental cells (i.e. task-relevant non-targets and task-irrelevant stimuli for each one of the four categories) have enough trials (N=30).

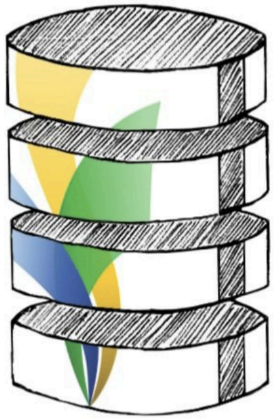
Data Curation Procedures

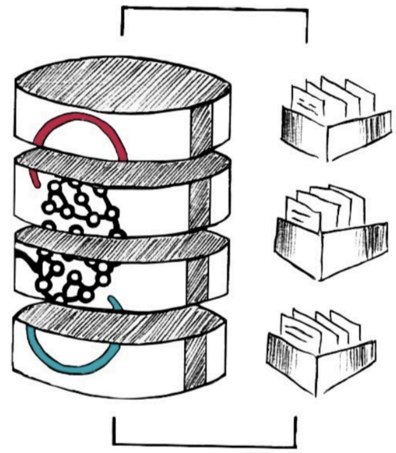
A detailed explanation about the multiple steps that were taken to prepare the data to be released in public will be available in Appendix 7. Data Curation Standard Operating Procedure.

Access to COGITATE Data

There are two ways of accessing the COGITATE data:

1. "Live" Database Release: XNAT (eXtensible Neuroimaging Archive Toolkit)
2. Archival Format: Bundles





Go to XNAT

Access Data Bundles

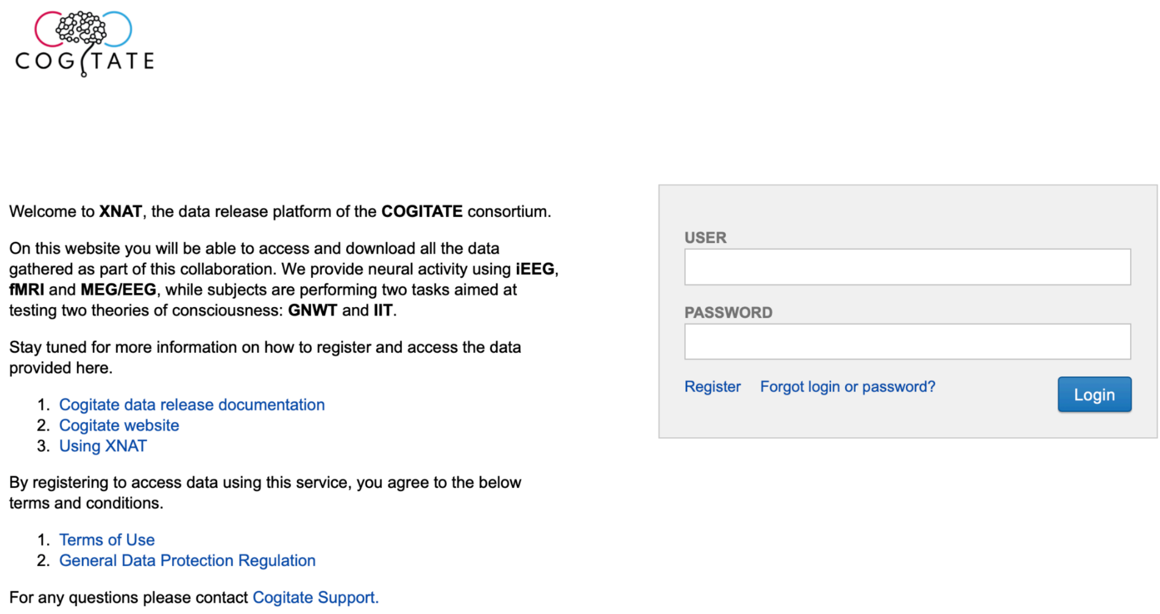
1. XNAT

This database offers a web interface for navigating the data and an API (Application Programming Interface) for programmatically retrieving specific databases based on user interests. Comprehensive instructions on how to register, access, and query our database are provided below.

Step 1: Registration

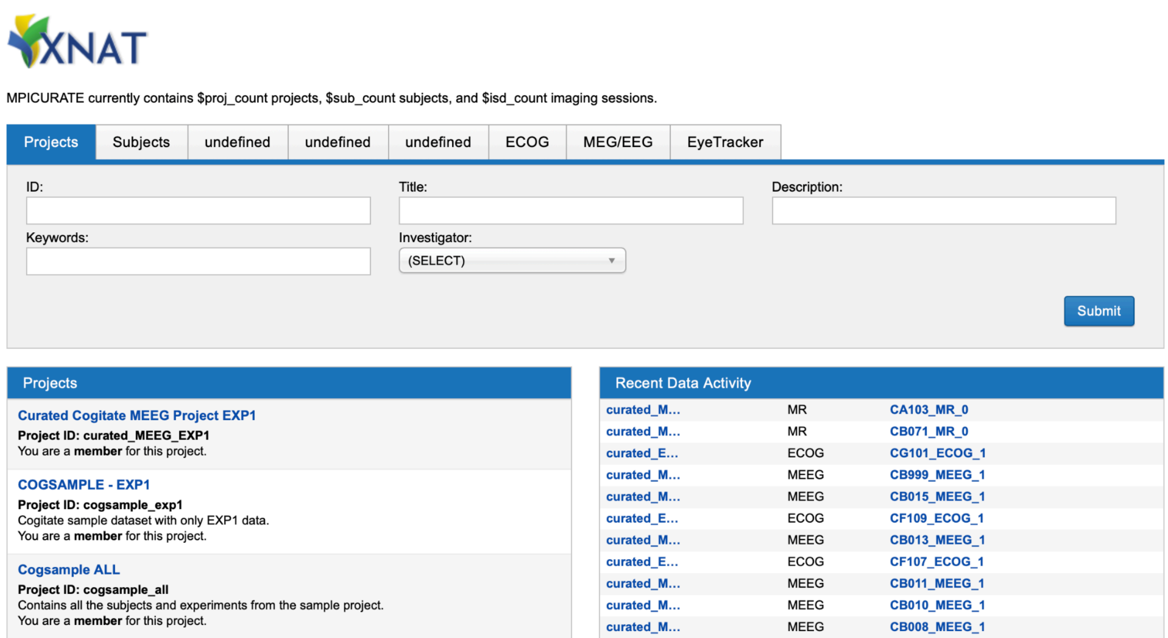
If you are a new user and have not registered yet, you should visit Cogitate_XNAT_registration. Once the registration is done, a verification step, the same as the “Creating an Account”, is needed.

If you have already registered, you can skip this step and login at Cogitate_XNAT.

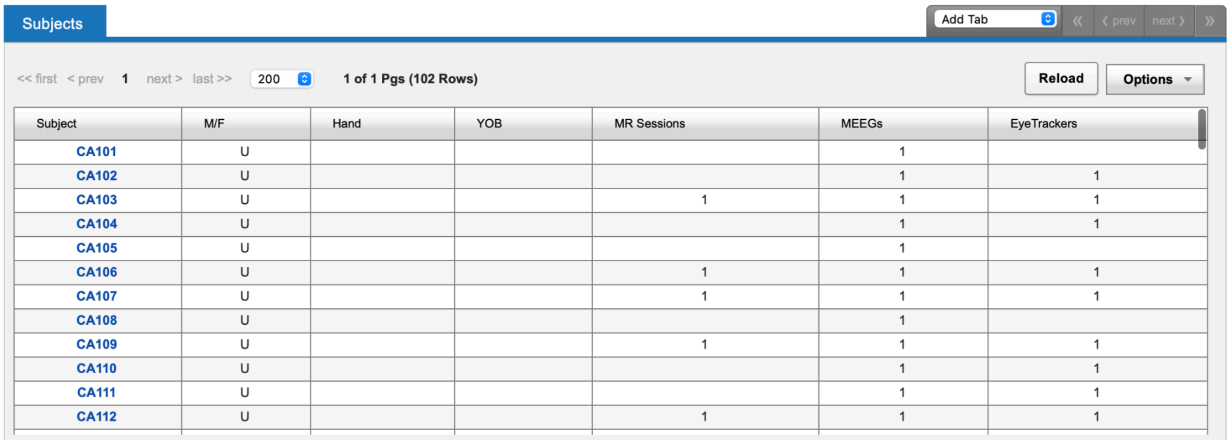


Step 2: Navigating at XNAT

After completing the registration step, you can log in with your User and Password. You can see the list of available datasets under the "Projects" tab.



Once you click the project's name, you will see the list of subjects in the farthest left column.



Subject	M/F	Hand	YOB	MR Sessions	MEEGs	EyeTrackers
CA101	U				1	
CA102	U				1	1
CA103	U			1	1	1
CA104	U				1	1
CA105	U				1	
CA106	U			1	1	1
CA107	U			1	1	1
CA108	U				1	
CA109	U			1	1	1
CA110	U				1	1
CA111	U				1	1
CA112	U			1	1	1

In each subject's folder, the demographic information of that subject and the various sets of data acquired for Experiment 1 are provided. As an example, for a subject with the ID of CA103, the MR session, Eye tracker and MEEG datasets are listed as the below figure.

Custom Field Sets

Additional Demographics

Form UUID:7c721510-adcd-40df-9168-abf203f71005

Additional Demographics

Gender	Female	**Hand Dominance**	Right
Year of Birth	-	**Handedness level**	-
Race	-	**Are you colorblind?**	No
Eye Dominance	Right	**Year when subject revoked within consortium**	-
Eyedominance Description	-	**Year when subject revoked open access**	-
Primary Language	German	**Additional comments**	-

Experiments

Date	Experiment	Project	Label
1900-Jan-01	MR Session	Curated MEEG EXP1	CA103_MR_0
	EyeTracker	Curated MEEG EXP1	CA103_ET_1
	MEEG	Curated MEEG EXP1	CA103_MEEG_1

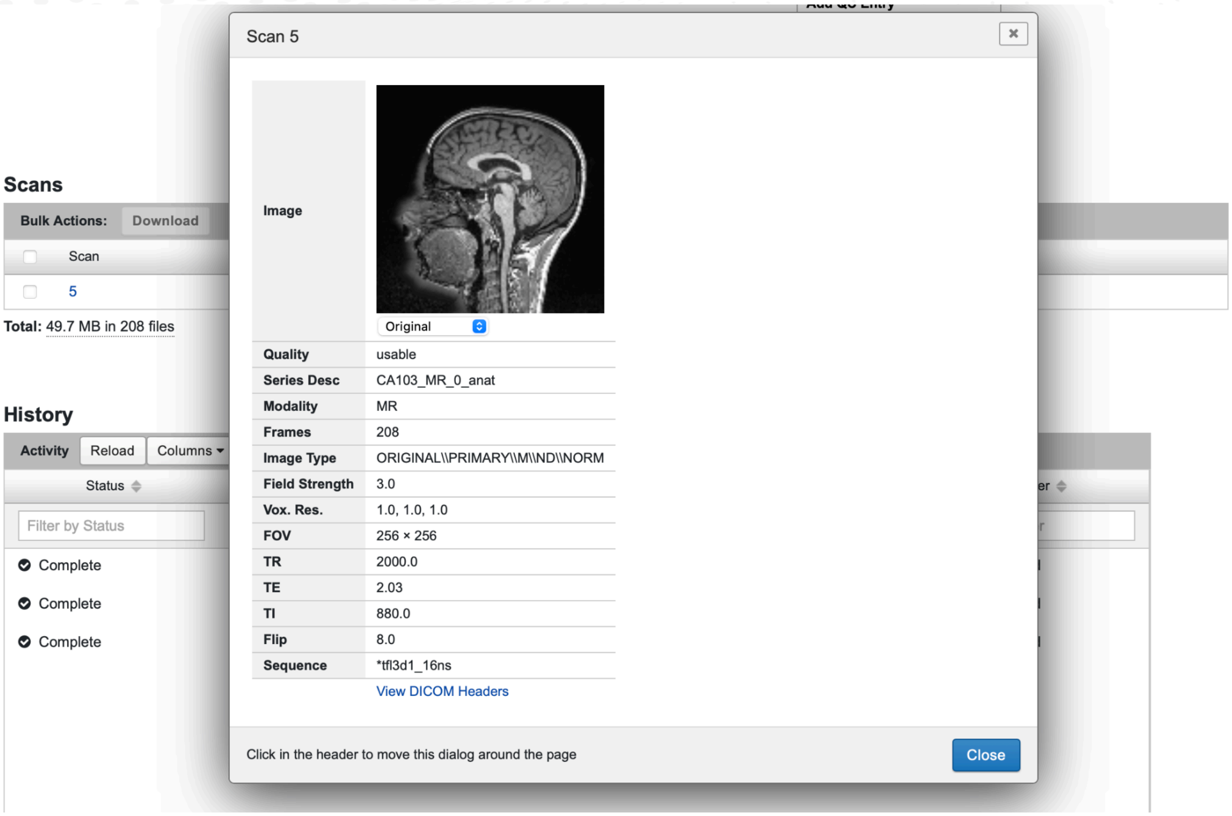
In the MR session folder, you can view and access the MR scan of the subject along with the related imaging parameters.

Scans

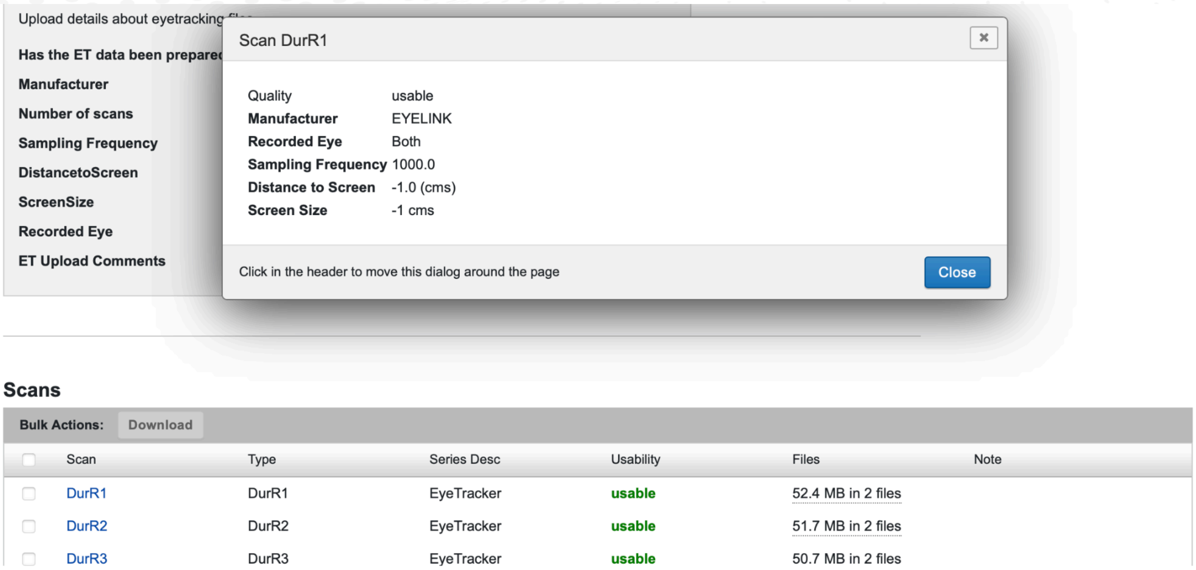
Bulk Actions: Download

Scan	Type	Series Desc	Usability	Files	Note
5	CA103_MR_0_anat	CA103_MR_0_anat	usable	49.7 MB in 208 files	

Total: 49.7 MB in 208 files



In the Eye tracker folder, the eye tracking data of different runs and some details related to them, including the recorded eye, sampling frequency, distance to screen and screen size are available.



Under the folder of MEEG, there are some tabs on the top where you can find information regarding the Case Report Form, Exit Questionnaire, experiment checklist form, data details within the BIDS framework, and at the bottom, you can download different runs of MEG data.

Behavior Exit Questionnaire EXP1 | Cogitate checklist EXP1 | BIDS EEG Coordinate System

BIDS Specification EEG | BIDS MEEG Coordinate System | BIDS Specification MEEG

Upload Form MEEG

Form UUID:7c185942-0d1b-4a29-8b12-f2b9d4f7707e

Upload form for MEEG files.

Has the MEEG data been prepared for upload?	-
Number of scans	-
Sampling Frequency	-
Powerline Frequency	-
Highpass Filter Cutoff Frequency	-
Digitized Landmarks	-
Digitized Head Points	-
Lowpass Filter Cutoff Frequency	-
Dewar Position	-
Recording Duration	-
Number of channels	-
MEG Channel Count	-
Highpass Software Filter	-
Lowpass Software Filter	-
MEG Coordinate System	-
MEEG Upload Comments	-

Scans

Bulk Actions: Download

Scan	Type	Series Desc	Usability	Files	Note
DurR1	DurR1	FIF	usable	1.1 GB in 1 files	
DurR2	DurR2	FIF	usable	1.1 GB in 1 files	
DurR3	DurR3	FIF	usable	1.0 GB in 1 files	
DurR4	DurR4	FIF	usable	1.0 GB in 1 files	
DurR5	DurR5	FIF	usable	1.0 GB in 1 files	
RestinEO	RestinEO	FIF	usable	428.8 MB in 1 files	
Rnoise	Rnoise	FIF	usable	251.2 MB in 1 files	

Total: 6.0 GB in 7 files

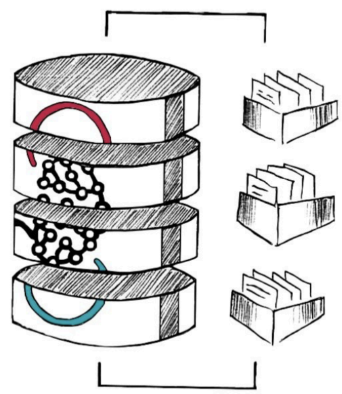
Naming Convention on XNAT

The data on XNAT is organized into subjects and sessions under a given project. The subjects are identified using the format “CX???” and the sessions follow the format CX???_MODALITY_VISIT_PARADIGMRUN e.g. CA103_MEEG_1_DurR1 indicated MEEG measurement for subject ID CA103 during the first visit with Dur experimental paradigm run 1 (R1).

2. Bundles

This approach involves providing a collection of links to the prepared bundles of the data and accompanying metadata, which are available in zip format. These links grant users the ability to download specific modalities, example datasets, or the complete dataset.

Data bundles



Experiment 1 - *Sample datasets*

Data Bundle	Format	Size (GB)	Download time	Download
All fMRI, MEG, iEEG, Behav, ET	Raw	212	00:30:21	Download
fMRI + Behav + ET	Raw	110	00:30:21	Download
MEG + Behav + ET	Raw	71	00:10:09	Download
iEEG + Behav + ET	Raw	31	00:04:26	Download

Experiment 1 - *Full datasets*

Data Bundle	Format	Size (GB)	Download time	Download
All fMRI, MEG, iEEG, Behav, ET	Raw	212	00:30:21	Download
fMRI + Behav + ET	Raw	110	00:30:21	Download
MEG + Behav + ET	Raw	71	00:10:09	Download
iEEG + Behav + ET	Raw	31	00:04:26	Download
Behav + ET	Raw	15	00:02:08	Download

Here is a brief explanation about how to access the data bundles:

Step 1: Create a Data User Account

Access to the data bundles requires a quick and easy registration process.

a. Provide user information, including name and email address.
b. Read and accept the Terms of Use and GDPR Requirements (General Data Protection Regulation).
c. Once you register, you will receive four (4) emails to the email account you registered with. In some cases, checking your junk mail may be necessary.
    i. ***Welcome email***: general information
    ii. ***Data User Account Verification email:*** Within the verification email, you must click on the 'verify my account' option to finalize step 1 of creating a data user account in order to gain access to all current and future data releases.
    iii. ***Resource Material***: A handy email that contains all the important links that serve as reference materials to Cogitate data.
    iv. ***Mailing List Subscription:*** In order to stay up-to-date and informed about news related to COGITATE data releases, you must activate your email subscription (this is in compliance with GDPR requirements).

Tip: The registration procedure needed for accessing the data bundles is a separate step than what is required to access XNAT.

Step 2: Login and logout of your Data User account

a. To **login** to your account, go to the Login button on the top right of the page. Enter your email and password used when registering. You should now have access to the Cogitate Data User main page and Data Bundles.
b. To **log out** of your account, go to the top navigation bar and hover of Data. In the dropdown menu, click on Data User Account. A panel will open on the right side of the screen - click on Account Settings in the bottom of that panel. Then the option to Sign out will appear under your username. Click on Sign out.

Tip: The Login button will remain as 'Login' even after signing in to your account. The only way of knowing whether you are logged in or out, is by clicking on Data User Account, under the Data heading or being able to download data (i.e. indicating you are in fact, logged in)

Step 3: How To Download the Data

a. Login to your account
b. Scroll down and click on the "Access Data Bundles"
c. Click on the download button next to each dataset

Naming Convention for Bundles

Raw data bundles follow the below naming convention. The project root directory consists of subdirectories named after the subject's ID which is of the format "CX???". The subject directories consist of various sub directories as described below. Except for the metadata directory the sessions follow the pattern subject-ID_PARADIGM_MODALITY. If the modality data is paradigm agnostic, e.g. MR, CT then the paradigm is left blank.

We currently have two paradigms in the data EXP1 indicating the experiment described and FingerLoc for the finger localiser. The session directories further contains individual scans following the format CX???_MODALITY_1_DurR1.EDF.

The metadata subdirectory further consists of various assessments and questionnaires that provide valuable information.

Experiment 1: Directory Structure of Data Bundles

Raw Data

Raw data files are organized hierarchically: Experiment modality --> Subjects --> data folders
The available modalities are: M-EEG.
The metadata related to each level of the hierarchy is contained in a mandatory folder called 'metadata'.
Each data folder follows a naming convention {subject_context_modality\[_modifier]} the section of the names are separated by underscores. This naming convention aims at making it easy to identify the data files that relate to the same moment in time and that were acquired simultaneously.

- subject -> this refers the the subject ID
- context -> the task or context. This section is optional and can be empty, e.g. if a subject had a standalone MR scan the context is left blank, resulting in a double underscorlike in the case of the CT scan or MR scan in the above example
- modality -> or type of data collected

The Cogitate consortium collected several types of data/metadata during the experiments:

- BEH: behavioral events
- ET: Eye tracking data
- MR: Magnetic resonance data (anatomical scans)
-
- MEEG: Magneto-Electroencephalographic data
- EXQU: Exit Questionnaire
- CRF: Case Report Form

All metadata related to the subject can be found under the aptly named 'metadata' folder under the subject folder (this refers mainly to the EXQU and CRF files).
The remaining metadata for the experiment as well as the demographic information on the subjects can be found in the metadata folder above the subject.
This folder includes experiment wide metadata in json format and a csv table with the demographic data of all subjects:

- devices: A list of devices used to collect the data
- protocols: a link to the Standard Operating Procedure (SOP) document used for the data collection
- subjects_demographics: the full set of subjects and their metadata for the specific experiment modality
- tasks_**taskname**: a description of the behavioral task or context with which we named the data bundles.
- wirings: a pdf file showing how the **devices** are connected to each other depicting the experimental setup.

Raw M-EEG Data Directory Structure

```
COG_MEEG_EXP1_RELEASE/
    ├── metadata/                              # Experiment modality level metadata folder
    │     ├── devices_MEEG.json                # List of devices used to collect the data
    │     ├── protocols_MEEG.json              # A link to the Standard Operating Procedures (SOP)
    │     ├── subjects_demographics_MEEG.json  # Demographic information of MEEG subjects
    │     ├── tasks_EXP1.json                  # Description of the 1st Cogitate task
    │     ├── tasks_RestinEO.json              # Description of the Resting state task
    │     ├── tasks_Rnoise.json                # Description of the Rnoise task
    │     └── wirings_MEEG.PDF                 # Wiring diagram of devices_MEEG.json connections
    └── CB036                                  # Subject folder
          ├── metadata/                        # Subject level metadata folder
          │     ├── CB036_EXP1_CRF.json        # Subject Case Report Form (CRF)
          │     └── CB036_EXP1_EXQU.json       # Subject Exit Questionnaire responses
          ├── CB036_EXP1_BEH/                  # Behavioral Events data collected during EXP1
          ├── CB036_EXP1_LPTTriggers/          # Trigger data for synchronization
          ├── CB036_EXP1_MEEG/                 # MEEG data collected during EXP1 (fif)
          ├── CB036_EXP1_ET/                   # Eye Tracking data collected during EXP1 (asc)
          ├── CB036_RestinEO_MEEG/             # MEEG data collected during RestingEO task (fif)
          ├── CB036_RestinEO_ET/               # Eye Tracking data collected during RestingEO task
          ├── CB036_Rnoise_MEEG/               # MEEG data collected during Rnoise task (fif)
          └── CB036__MR/                       # MR anatomical scan data (fif)
```

BIDS Format

BIDS M-EEG Data Directory Structure

```
COG_MEEG_EXP1_BIDS_RELEASE/
|-- dataset_description.json                   # Contains information on BIDS version, type of
dataset
|-- derivatives                                # Contains processed or derived data generated from
raw data
|   |-- dicom2nifti                            # Converted NIFTI files generated from DICOM files of
anatomical data
|   |   |-- sub-CA103
|   |   |   `-- ses-0
|   |   |       `-- anat
|   |   |           |-- CA103_MR_0_anat.nii.gz
|   |   |           `-- T1_defaced.png
|   |-- fs
|   |   |-- fsaverage
|   |   |-- sub-CA103
|   |   |   |-- label
|   |   |   |   |-- aparc.annot.a2009s.ctab
|   |   |   |   |-- aparc.annot.ctab
|   |   |   |   |-- aparc.annot.DKTatlas.ctab
|   |   |   |   |-- BA_exvivo.ctab
|   |   |   |   |-- BA_exvivo.thresh.ctab
|   |   |   |   |-- lh.aparc.a2009s.annot
|   |   |   |   |-- lh.aparc.annot
|   |   |   |   |-- lh.aparc.DKTatlas.annot
|   |   |   |   |-- lh.BA1_exvivo.label
|   |   |   |   |-- lh.BA1_exvivo.thresh.label
|   |   |   |   |-- lh.BA2_exvivo.label
|   |   |   |   |-- lh.BA2_exvivo.thresh.label
|   |   |   |   |-- lh.BA3a_exvivo.label
```

```
|   |   |   |   |-- lh.BA3a_exvivo.thresh.label
|   |   |   |   |-- lh.BA3b_exvivo.label
|   |   |   |   |-- lh.BA3b_exvivo.thresh.label
|   |   |   |   |-- lh.BA44_exvivo.label
|   |   |   |   |-- lh.BA44_exvivo.thresh.label
|   |   |   |   |-- lh.BA45_exvivo.label
|   |   |   |   |-- lh.BA45_exvivo.thresh.label
|   |   |   |   |-- lh.BA4a_exvivo.label
|   |   |   |   |-- lh.BA4a_exvivo.thresh.label
|   |   |   |   |-- lh.BA4p_exvivo.label
|   |   |   |   |-- lh.BA4p_exvivo.thresh.label
|   |   |   |   |-- lh.BA6_exvivo.label
|   |   |   |   |-- lh.BA6_exvivo.thresh.label
|   |   |   |   |-- lh.BA_exvivo.annot
|   |   |   |   |-- lh.BA_exvivo.thresh.annot
|   |   |   |   |-- lh.cortex.label
|   |   |   |   |-- lh.entorhinal_exvivo.label
|   |   |   |   |-- lh.entorhinal_exvivo.thresh.label
|   |   |   |   |-- lh.MT_exvivo.label
|   |   |   |   |-- lh.MT_exvivo.thresh.label
|   |   |   |   |-- lh.perirhinal_exvivo.label
|   |   |   |   |-- lh.perirhinal_exvivo.thresh.label
|   |   |   |   |-- lh.V1_exvivo.label
|   |   |   |   |-- lh.V1_exvivo.thresh.label
|   |   |   |   |-- lh.V2_exvivo.label
|   |   |   |   |-- lh.V2_exvivo.thresh.label
|   |   |   |   |-- rh.aparc.a2009s.annot
|   |   |   |   |-- rh.aparc.annot
|   |   |   |   |-- rh.aparc.DKTatlas.annot
|   |   |   |   |-- rh.BA1_exvivo.label
|   |   |   |   |-- rh.BA1_exvivo.thresh.label
|   |   |   |   |-- rh.BA2_exvivo.label
|   |   |   |   |-- rh.BA2_exvivo.thresh.label
|   |   |   |   |-- rh.BA3a_exvivo.label
|   |   |   |   |-- rh.BA3a_exvivo.thresh.label
|   |   |   |   |-- rh.BA3b_exvivo.label
|   |   |   |   |-- rh.BA3b_exvivo.thresh.label
|   |   |   |   |-- rh.BA44_exvivo.label
|   |   |   |   |-- rh.BA44_exvivo.thresh.label
|   |   |   |   |-- rh.BA45_exvivo.label
|   |   |   |   |-- rh.BA45_exvivo.thresh.label
|   |   |   |   |-- rh.BA4a_exvivo.label
|   |   |   |   |-- rh.BA4a_exvivo.thresh.label
|   |   |   |   |-- rh.BA4p_exvivo.label
|   |   |   |   |-- rh.BA4p_exvivo.thresh.label
|   |   |   |   |-- rh.BA6_exvivo.label
|   |   |   |   |-- rh.BA6_exvivo.thresh.label
|   |   |   |   |-- rh.BA_exvivo.annot
|   |   |   |   |-- rh.BA_exvivo.thresh.annot
|   |   |   |   |-- rh.cortex.label
|   |   |   |   |-- rh.entorhinal_exvivo.label
|   |   |   |   |-- rh.entorhinal_exvivo.thresh.label
|   |   |   |   |-- rh.MT_exvivo.label
|   |   |   |   |-- rh.MT_exvivo.thresh.label
|   |   |   |   |-- rh.perirhinal_exvivo.label
|   |   |   |   |-- rh.perirhinal_exvivo.thresh.label
|   |   |   |   |-- rh.V1_exvivo.label
|   |   |   |   |-- rh.V1_exvivo.thresh.label
|   |   |   |   |-- rh.V2_exvivo.label
```

```
|   |   |   |   `-- rh.V2_exvivo.thresh.label
|   |   |   |-- mri
|   |   |   |   |-- aparc.a2009s+aseg.mgz
|   |   |   |   |-- aparc+aseg.mgz
|   |   |   |   |-- aparc.DKTatlas+aseg.mgz
|   |   |   |   |-- aseg.auto.mgz
|   |   |   |   |-- aseg.auto_noCCseg.label_intensities.txt
|   |   |   |   |-- aseg.auto_noCCseg.mgz
|   |   |   |   |-- aseg.mgz
|   |   |   |   |-- aseg.presurf.hypos.mgz
|   |   |   |   |-- aseg.presurf.mgz
|   |   |   |   |-- brain.finalsurfs.mgz
|   |   |   |   |-- brainmask.auto.mgz
|   |   |   |   |-- brainmask.mgz
|   |   |   |   |-- brain.mgz
|   |   |   |   |-- ctrl_pts.mgz
|   |   |   |   |-- filled.mgz
|   |   |   |   |-- lh.ribbon.mgz
|   |   |   |   |-- mri_nu_correct.mni.log
|   |   |   |   |-- mri_nu_correct.mni.log.bak
|   |   |   |   |-- norm.mgz
|   |   |   |   |-- nu.mgz
|   |   |   |   |-- orig
|   |   |   |   |   `-- 001.mgz
|   |   |   |   |-- orig.mgz
|   |   |   |   |-- orig_nu.mgz
|   |   |   |   |-- rawavg.mgz
|   |   |   |   |-- rh.ribbon.mgz
|   |   |   |   |-- ribbon.mgz
|   |   |   |   |-- segment.dat
|   |   |   |   |-- T1.mgz
|   |   |   |   |-- talairach.label_intensities.txt
|   |   |   |   |-- talairach.log
|   |   |   |   |-- talairach_with_skull.log
|   |   |   |   |-- transforms
|   |   |   |   |   |-- bak
|   |   |   |   |   |-- cc_up.lta
|   |   |   |   |   |-- talairach.auto.xfm
|   |   |   |   |   |-- talairach.auto.xfm.lta
|   |   |   |   |   |-- talairach_avi.log
|   |   |   |   |   |-- talairach_avi_QA.log
|   |   |   |   |   |-- talairach.lta
|   |   |   |   |   |-- talairach.m3z
|   |   |   |   |   |-- talairach_with_skull.lta
|   |   |   |   |   |-- talairach.xfm
|   |   |   |   |   `-- talsrcimg_to_711-2C_as_mni_average_305_t4_vox2vox.txt
|   |   |   |   |-- wm.asegedit.mgz
|   |   |   |   |-- wm.mgz
|   |   |   |   |-- wmparc.mgz
|   |   |   |   `-- wm.seg.mgz
|   |   |   |-- scripts
|   |   |   |   |-- build-stamp.txt
|   |   |   |   |-- lastcall.build-stamp.txt
|   |   |   |   |-- patchdir.txt
|   |   |   |   |-- pctsurfcon.log
|   |   |   |   |-- pctsurfcon.log.old
|   |   |   |   |-- ponscc.cut.log
|   |   |   |   |-- recon-all.cmd
|   |   |   |   |-- recon-all.done
```

```
|   |   |   |   |-- recon-all.env
|   |   |   |   |-- recon-all.local-copy
|   |   |   |   |-- recon-all.log
|   |   |   |   `-- recon-all-status.log
|   |   |   |-- stats
|   |   |   |   |-- aseg.stats
|   |   |   |   |-- lh.aparc.a2009s.stats
|   |   |   |   |-- lh.aparc.DKTatlas.stats
|   |   |   |   |-- lh.aparc.pial.stats
|   |   |   |   |-- lh.aparc.stats
|   |   |   |   |-- lh.BA_exvivo.stats
|   |   |   |   |-- lh.BA_exvivo.thresh.stats
|   |   |   |   |-- lh.curv.stats
|   |   |   |   |-- lh.w-g.pct.stats
|   |   |   |   |-- rh.aparc.a2009s.stats
|   |   |   |   |-- rh.aparc.DKTatlas.stats
|   |   |   |   |-- rh.aparc.pial.stats
|   |   |   |   |-- rh.aparc.stats
|   |   |   |   |-- rh.BA_exvivo.stats
|   |   |   |   |-- rh.BA_exvivo.thresh.stats
|   |   |   |   |-- rh.curv.stats
|   |   |   |   |-- rh.w-g.pct.stats
|   |   |   |   `-- wmparc.stats
|   |   |   |-- surf
|   |   |   |   |-- lh.area
|   |   |   |   |-- lh.area.mid
|   |   |   |   |-- lh.area.pial
|   |   |   |   |-- lh.avg_curv
|   |   |   |   |-- lh.curv
|   |   |   |   |-- lh.curv.pial
|   |   |   |   |-- lh.defect_borders
|   |   |   |   |-- lh.defect_chull
|   |   |   |   |-- lh.defect_labels
|   |   |   |   |-- lh.inflated
|   |   |   |   |-- lh.inflated.H
|   |   |   |   |-- lh.inflated.K
|   |   |   |   |-- lh.inflated.nofix
|   |   |   |   |-- lh.jacobian_white
|   |   |   |   |-- lh.orig
|   |   |   |   |-- lh.orig.nofix
|   |   |   |   |-- lh.pial
|   |   |   |   |-- lh.qsphere.nofix
|   |   |   |   |-- lh.smoothwm
|   |   |   |   |-- lh.smoothwm.BE.crv
|   |   |   |   |-- lh.smoothwm.C.crv
|   |   |   |   |-- lh.smoothwm.FI.crv
|   |   |   |   |-- lh.smoothwm.H.crv
|   |   |   |   |-- lh.smoothwm.K1.crv
|   |   |   |   |-- lh.smoothwm.K2.crv
|   |   |   |   |-- lh.smoothwm.K.crv
|   |   |   |   |-- lh.smoothwm.nofix
|   |   |   |   |-- lh.smoothwm.S.crv
|   |   |   |   |-- lh.sphere
|   |   |   |   |-- lh.sphere.reg
|   |   |   |   |-- lh.sulc
|   |   |   |   |-- lh.thickness
|   |   |   |   |-- lh.volume
|   |   |   |   |-- lh.w-g.pct.mgh
|   |   |   |   |-- lh.white
```

```
|   |   |   |   |-- lh.white.H -> lh.white.preaparc.H
|   |   |   |   |-- lh.white.K -> lh.white.preaparc.K
|   |   |   |   |-- lh.white.preaparc
|   |   |   |   |-- lh.white.preaparc.H
|   |   |   |   |-- lh.white.preaparc.K
|   |   |   |   |-- rh.area
|   |   |   |   |-- rh.area.mid
|   |   |   |   |-- rh.area.pial
|   |   |   |   |-- rh.avg_curv
|   |   |   |   |-- rh.curv
|   |   |   |   |-- rh.curv.pial
|   |   |   |   |-- rh.defect_borders
|   |   |   |   |-- rh.defect_chull
|   |   |   |   |-- rh.defect_labels
|   |   |   |   |-- rh.inflated
|   |   |   |   |-- rh.inflated.H
|   |   |   |   |-- rh.inflated.K
|   |   |   |   |-- rh.inflated.nofix
|   |   |   |   |-- rh.jacobian_white
|   |   |   |   |-- rh.orig
|   |   |   |   |-- rh.orig.nofix
|   |   |   |   |-- rh.pial
|   |   |   |   |-- rh.qsphere.nofix
|   |   |   |   |-- rh.smoothwm
|   |   |   |   |-- rh.smoothwm.BE.crv
|   |   |   |   |-- rh.smoothwm.C.crv
|   |   |   |   |-- rh.smoothwm.FI.crv
|   |   |   |   |-- rh.smoothwm.H.crv
|   |   |   |   |-- rh.smoothwm.K1.crv
|   |   |   |   |-- rh.smoothwm.K2.crv
|   |   |   |   |-- rh.smoothwm.K.crv
|   |   |   |   |-- rh.smoothwm.nofix
|   |   |   |   |-- rh.smoothwm.S.crv
|   |   |   |   |-- rh.sphere
|   |   |   |   |-- rh.sphere.reg
|   |   |   |   |-- rh.sulc
|   |   |   |   |-- rh.thickness
|   |   |   |   |-- rh.volume
|   |   |   |   |-- rh.w-g.pct.mgh
|   |   |   |   |-- rh.white
|   |   |   |   |-- rh.white.H -> rh.white.preaparc.H
|   |   |   |   |-- rh.white.K -> rh.white.preaparc.K
|   |   |   |   |-- rh.white.preaparc
|   |   |   |   |-- rh.white.preaparc.H
|   |   |   |   `-- rh.white.preaparc.K
|   |   |   |-- tmp
|   |   |   |-- touch
|   |   |   |   |-- aparc.a2009s2aseg.touch
|   |   |   |   |-- aparc.DKTatlas2aseg.touch
|   |   |   |   |-- apas2aseg.touch
|   |   |   |   |-- asegmerge.touch
|   |   |   |   |-- ca_label.touch
|   |   |   |   |-- ca_normalize.touch
|   |   |   |   |-- ca_register.touch
|   |   |   |   |-- conform.touch
|   |   |   |   |-- cortical_ribbon.touch
|   |   |   |   |-- em_register.touch
|   |   |   |   |-- fill.touch
|   |   |   |   |-- inorm1.touch
```

```
|   |   |   |   |-- inorm2.touch
|   |   |   |   |-- lh.aparc2.touch
|   |   |   |   |-- lh.aparcstats2.touch
|   |   |   |   |-- lh.aparcstats3.touch
|   |   |   |   |-- lh.aparcstats.touch
|   |   |   |   |-- lh.aparc.touch
|   |   |   |   |-- lh.avgcurv.touch
|   |   |   |   |-- lh.curvstats.touch
|   |   |   |   |-- lh.final_surfaces.touch
|   |   |   |   |-- lh.inflate1.touch
|   |   |   |   |-- lh.inflate2.touch
|   |   |   |   |-- lh.inflate.H.K.touch
|   |   |   |   |-- lh.jacobian_white.touch
|   |   |   |   |-- lh.pctsurfcon.touch
|   |   |   |   |-- lh.pial_surface.touch
|   |   |   |   |-- lh.qsphere.touch
|   |   |   |   |-- lh.smoothwm1.touch
|   |   |   |   |-- lh.smoothwm2.touch
|   |   |   |   |-- lh.sphmorph.touch
|   |   |   |   |-- lh.sphreg.touch
|   |   |   |   |-- lh.surfvolume.touch
|   |   |   |   |-- lh.tessellate.touch
|   |   |   |   |-- lh.topofix.touch
|   |   |   |   |-- lh.white.H.K.touch
|   |   |   |   |-- lh.white_surface.touch
|   |   |   |   |-- nu.touch
|   |   |   |   |-- relabelhypos.touch
|   |   |   |   |-- rh.aparc2.touch
|   |   |   |   |-- rh.aparcstats2.touch
|   |   |   |   |-- rh.aparcstats3.touch
|   |   |   |   |-- rh.aparcstats.touch
|   |   |   |   |-- rh.aparc.touch
|   |   |   |   |-- rh.avgcurv.touch
|   |   |   |   |-- rh.curvstats.touch
|   |   |   |   |-- rh.final_surfaces.touch
|   |   |   |   |-- rh.inflate1.touch
|   |   |   |   |-- rh.inflate2.touch
|   |   |   |   |-- rh.inflate.H.K.touch
|   |   |   |   |-- rh.jacobian_white.touch
|   |   |   |   |-- rh.pctsurfcon.touch
|   |   |   |   |-- rh.pial_surface.touch
|   |   |   |   |-- rh.qsphere.touch
|   |   |   |   |-- rh.smoothwm1.touch
|   |   |   |   |-- rh.smoothwm2.touch
|   |   |   |   |-- rh.sphmorph.touch
|   |   |   |   |-- rh.sphreg.touch
|   |   |   |   |-- rh.surfvolume.touch
|   |   |   |   |-- rh.tessellate.touch
|   |   |   |   |-- rh.topofix.touch
|   |   |   |   |-- rh.white.H.K.touch
|   |   |   |   |-- rh.white_surface.touch
|   |   |   |   |-- rusage.mri_ca_register.dat
|   |   |   |   |-- rusage.mri_em_register.dat
|   |   |   |   |-- rusage.mri_em_register.skull.dat
|   |   |   |   |-- rusage.mris_fix_topology.lh.dat
|   |   |   |   |-- rusage.mris_fix_topology.rh.dat
|   |   |   |   |-- rusage.mris_inflate.lh.dat
|   |   |   |   |-- rusage.mris_inflate.rh.dat
|   |   |   |   |-- rusage.mris_register.lh.dat
```

```
|   |   |   |   |-- rusage.mris_register.rh.dat
|   |   |   |   |-- rusage.mris_sphere.lh.dat
|   |   |   |   |-- rusage.mris_sphere.rh.dat
|   |   |   |   |-- rusage.mri_watershed.dat
|   |   |   |   |-- segstats.touch
|   |   |   |   |-- skull.lta.touch
|   |   |   |   |-- skull_strip.touch
|   |   |   |   |-- talairach.touch
|   |   |   |   |-- wmaparc.stats.touch
|   |   |   |   |-- wmaparc.touch
|   |   |   |   `-- wmsegment.touch
|   |   |   `-- trash
|-- participants.json                         # Participants demography in json format
|-- participants.tsv                          # Participants demography in tsv format
|-- README                                    # References for how to convert M-EEG data to BIDS
format
|-- sub-CA103                                 # Subject folder
|   `-- ses-1                                 # Session/visit 1 (Experiment 1)
|       |-- anat                      # Anatomical data folder
|       |   |-- sub-CA103_ses-1_T1w.json  # Anatomical landmark coordinates for LPA: Left Preauricular
Point, NAS: Nasion, RPA: Right Preauricular Point
|       |   `-- sub-CA103_ses-1_T1w.nii.gz        # T1-weighted anatomical data
|       |-- meg                               # MEG data folder
|       |   |-- sub-CA103_ses-1_acq-calibration_meg.dat  # Generic data file containing raw or
unprocessed data acquired during a calibration session
|       |   |-- sub-CA103_ses-1_acq-crosstalk_meg.fif    # MEG data recorded during the crosstalk
session
|       |   |-- sub-CA103_ses-1_coordsystem.json # Contains information on MEG coordinate system,
units, head coil and anatomical landmark coordinates
|       |   |-- sub-CA103_ses-1_task-dur_run-01_channels.tsv     # Contains information on the channel
names, types, units, sampling rate, status, and frequency cutoffs of the filter applied to the recorded
data
|       |   |-- sub-CA103_ses-1_task-dur_run-01_events.json      # Contains information about the
events/stimuli presented during Experiment 1, run 1 such as the event onset time, event code (trigger
code), and event's category
|       |   |-- sub-CA103_ses-1_task-dur_run-01_events.tsv       # Contains the same information as
json file in tsv format
|       |   |-- sub-CA103_ses-1_task-dur_run-01_meg.fif          # Contains the raw/preprocessed MEG
data for Experiment 1/session 1, run 1
|       |   |-- sub-CA103_ses-1_task-dur_run-01_meg.json
|       |   |-- sub-CA103_ses-1_task-dur_run-02_channels.tsv
|       |   |-- sub-CA103_ses-1_task-dur_run-02_events.json
|       |   |-- sub-CA103_ses-1_task-dur_run-02_events.tsv
|       |   |-- sub-CA103_ses-1_task-dur_run-02_meg.fif
|       |   |-- sub-CA103_ses-1_task-dur_run-02_meg.json
|       |   |-- sub-CA103_ses-1_task-dur_run-03_channels.tsv
|       |   |-- sub-CA103_ses-1_task-dur_run-03_events.json
|       |   |-- sub-CA103_ses-1_task-dur_run-03_events.tsv
|       |   |-- sub-CA103_ses-1_task-dur_run-03_meg.fif
|       |   |-- sub-CA103_ses-1_task-dur_run-03_meg.json
|       |   |-- sub-CA103_ses-1_task-dur_run-04_channels.tsv
|       |   |-- sub-CA103_ses-1_task-dur_run-04_events.json
|       |   |-- sub-CA103_ses-1_task-dur_run-04_events.tsv
|       |   |-- sub-CA103_ses-1_task-dur_run-04_meg.fif
|       |   |-- sub-CA103_ses-1_task-dur_run-04_meg.json
|       |   |-- sub-CA103_ses-1_task-dur_run-05_channels.tsv
|       |   |-- sub-CA103_ses-1_task-dur_run-05_events.json
|       |   |-- sub-CA103_ses-1_task-dur_run-05_events.tsv
|       |   |-- sub-CA103_ses-1_task-dur_run-05_meg.fif
```

```
|       |   |-- sub-CA103_ses-1_task-dur_run-05_meg.json
|       |   |-- sub-CA103_ses-1_task-noise_channels.tsv
|       |   |-- sub-CA103_ses-1_task-noise_meg.fif
|       |   |-- sub-CA103_ses-1_task-noise_meg.json
|       |   |-- sub-CA103_ses-1_task-rest_channels.tsv
|       |   |-- sub-CA103_ses-1_task-rest_meg.fif
|       |   `-- sub-CA103_ses-1_task-rest_meg.json
|       `-- sub-CA103_ses-1_scans.tsv
```

Support and Report Bugs

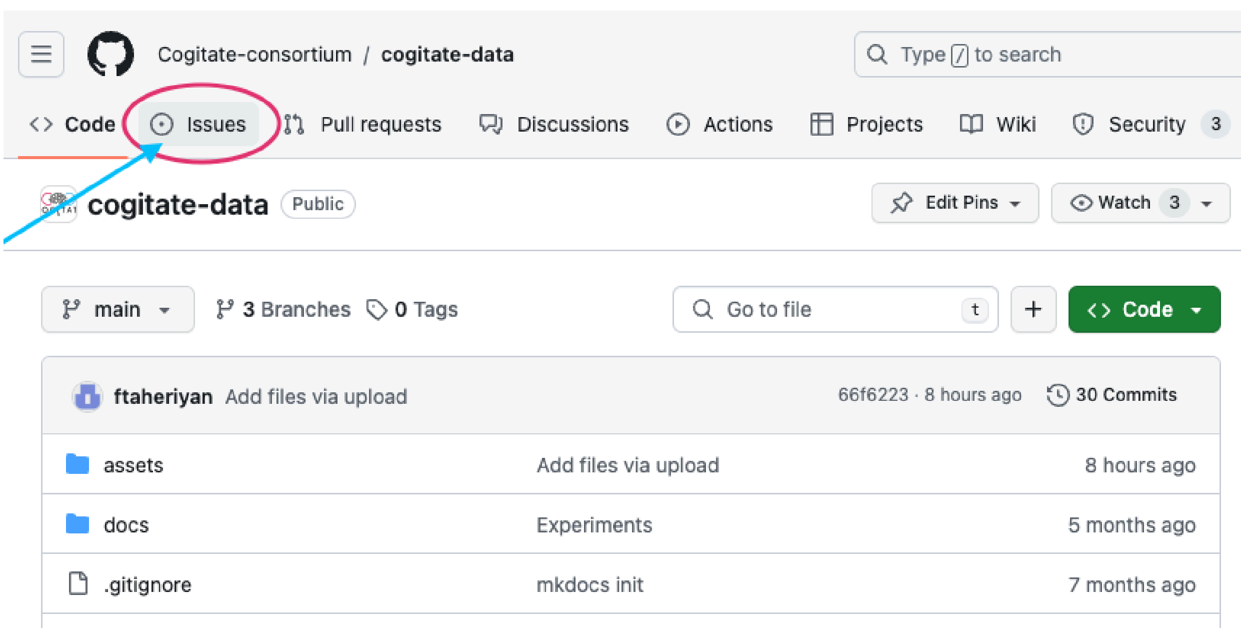
There are various ways the COGITATE team can support you as a Data User, depending on the type of help you are seeking.

For general questions, email us at: cogitate-support@ae.mpg.de

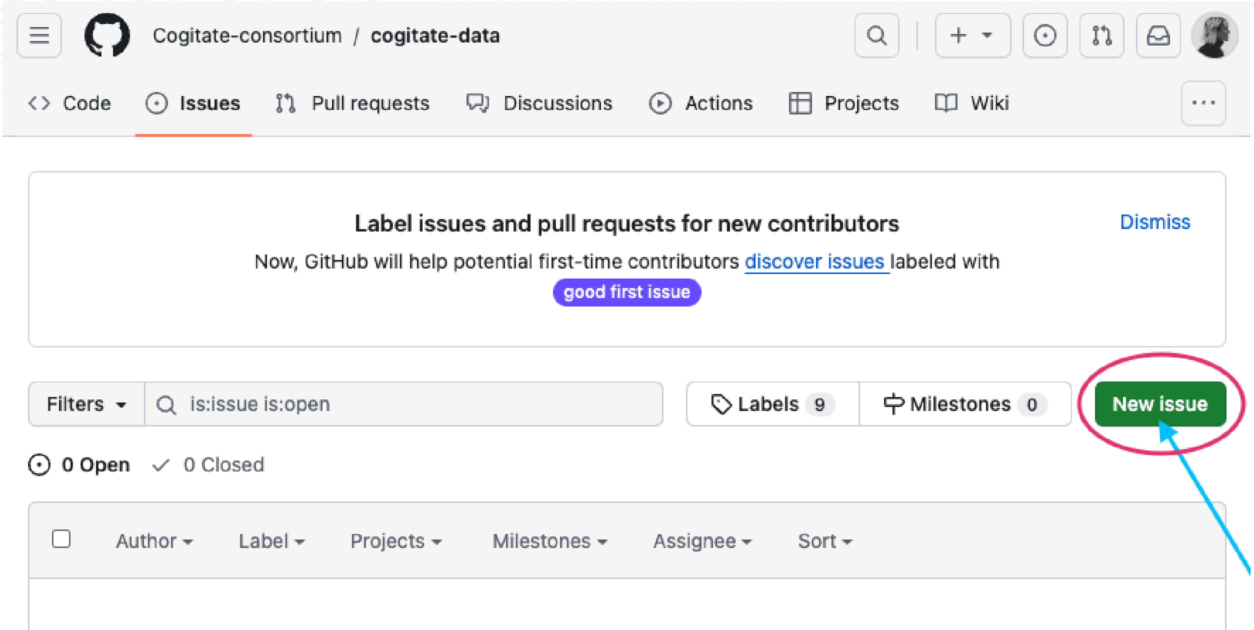
For reporting issues or bugs:

1. Visit github.com/cogitate-consortium/cogitate-data/issues and ensure you are logged into your GitHub account
    a. Don't have a GitHub account? Create one here.

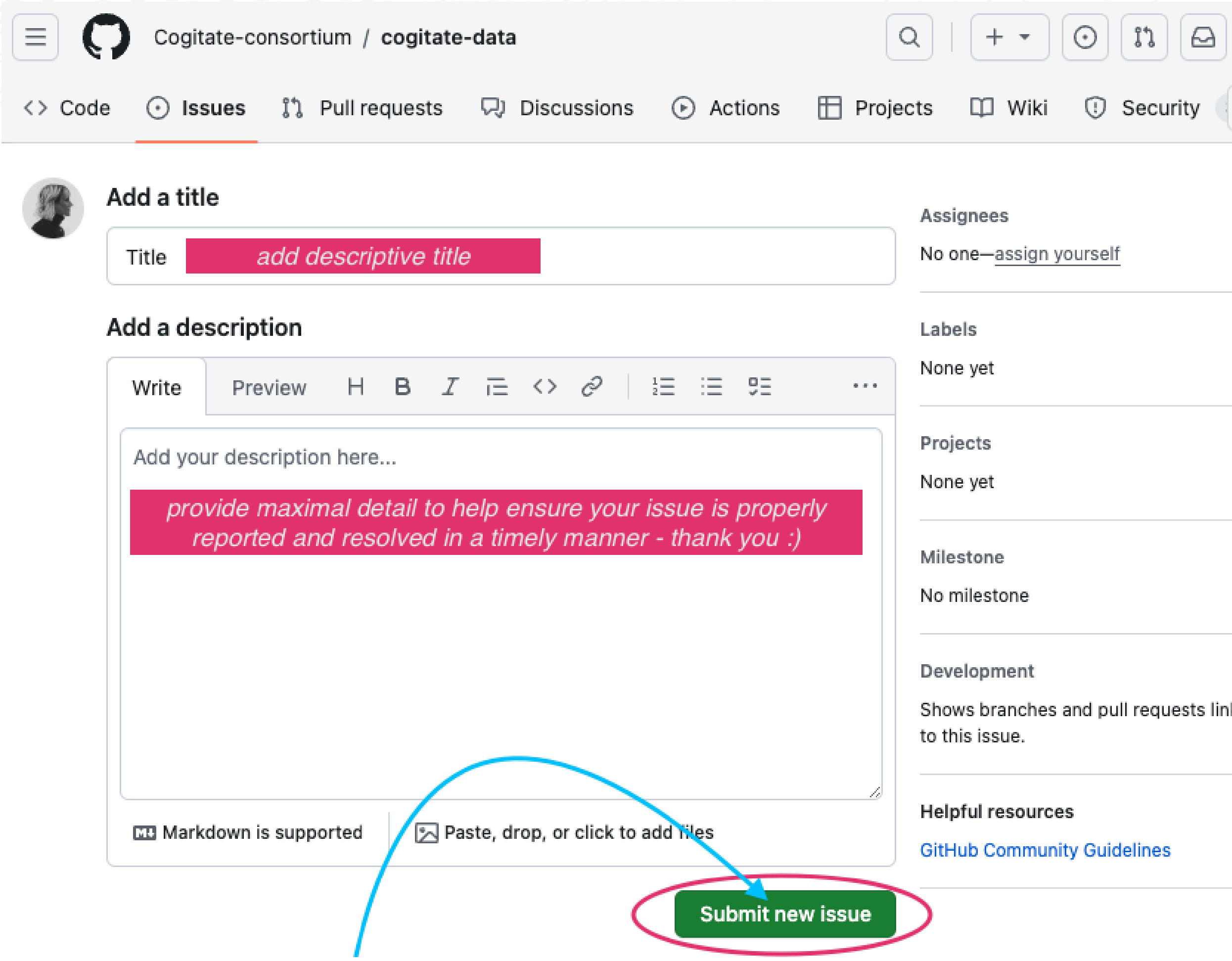
2. Click on **Issues**



3. Create **New Issue**
    a. provide maximal details possible



4. Click Submit new issue.



5. Your issue will be logged with our Data Release team and dealt with in a timely manner.

Links and Reference Materials

COGITATE Website	https://www.arc-cogitate.com/
COGITATE Main Scientific Paper	https://doi.org/10.1371/journal.pone.0268577
COGITATE - Preregistration v4 - December 2022	https://osf.io/gm3vd
GitHub Repository	https://github.com/Cogitate-consortium
COGITATE Wiki	https://cogitate-consortium.github.io/cogitate-data/
Subjects Demography	https://s.gwdg.de/lzAOKg

YouTube Demos	COGITATE Experiment 1 HOW TO create a COGITATE Data User account HOW TO login and logout of your COGITATE Data User account HOW TO Download a COGITATE Data Bundle
XNAT Support	https://wiki.xnat.org/documentation/

Modality	Place of Acquisition	Number of Subjects	Reference Materials
M-EEG	University of Birmingham, Center for Human Brain Health (CHBH)	102	M-EEG Wiring Diagram M-EEG Experiment 1 Code M-EEG SOP
	Peking University (PKU)		
fMRI	Donders Center for Cognitive Neuroimaging (DCCN)	120	
	Yale Magnetic Resonance Research Center (MRRC)		
ECoG (iEEG)	Harvard University at Boston Children's Hospital	34	
	New York University Langone (NYU)		
	University of Wisconsin		

Appendices

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Experimental design:

Yoav Roll, Alex Lepauvre, Aya Khalaf, and Katarina Bentz, Felix Bernoully

Konstantinos Vasileiadis, Aris Semertzidis, Nikos Gregos

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fMRI

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- Yale (Hal Blumenfeld, Aya Khalaf, Abdel Sharaf)

M-EEG
- Birmingham (Oscar Ferrante, Ole Jensen, Dorottya Hetenyi, Tara Ghafari)
- PKU (Ling Liu, Huan Luo, Shujun Yang)

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- Rony Hirschhorn (Tel Aviv University)
- Urszula Gorska (WI)
- Csaba Kozma (WI)
- Liad Mudrik (Tel Aviv University)
- Michael Pitts (Reed College)

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COGITATE's Data Release Team: Niccolò Bonacchi, Tanya Brown, Kyle Kahraman, Lucia Melloni, Praveen Sripad, Fatemeh Taheriyan

Flywheel Cloud Services (XNAT): Mohana Ramaratnam , James Dickson, Angela Farrar, Dan Marcus, Blake Griggs

Appendix 1. Screening Form

This questionnaire should be filled by the participant before the experiment. It asks for some information such as name, weight (kg), email, data of birth and phone number of the subject following by a couple of questions including:

- Have you participated in a MEG study before?
- Do you suffer from any medical condition that may be relevant (e.g. epilepsy, diabetes, asthma)?
- Do you suffer from claustrophobia?
- Have you been formally diagnosed with attention deficit (hyperactivity) disorder (AD(H)D)?
- Have you been formally diagnosed with autism spectrum disorder (ASD)?
- Other information (e.g. spectacle prescription)

Appendix 2. Case Report Form

This form is for reporting any issues that might have happened during the experiment. After the end of the experiment and saving the data, the operator should fill out this form.

M-EEG Case Report Form

For M-EEG modality, the below items are asked for different sections of the data acquisition (Data for Empty Room, Resting-state, run 1, …, run 5) in the Case Report Form:

- Eye tracking not working
- Eye tracking showing bad patterns
- Problems in task performance
- Strong head motion
- Strong body motion
- Trigger monitoring
- Bad MEG sensors
- Bad EEG sensors
- Notes: explaining about the issue in a more detail

Appendix 3. Exit Questionnaire

This Form should be filled by the participant after the experiment and asks the below questions:

- How difficult was it to stay focused for the entire duration of the experiment?
- Did you notice that the stimuli duration varied?
- When stimuli were presented for a short period of time, were you able to focus on them for as long as they were presented?
- When stimuli were presented for a medium period of time, were you able to focus on them for as long as they were presented?
- When stimuli were presented for a long period of time, were you able to focus on them for as long as they were presented?
- Was it difficult to keep the targets in memory for the entirety of a block?
- For each stimulus category, how hard was it to recognize them among the other stimuli? [Faces]
- For each stimulus category, how hard was it to recognize them among the other stimuli? [Object]
- For each stimulus category, how hard was it to recognize them among the other stimuli? [Letters]
- For each stimulus category, how hard was it to recognize them among the other stimuli? [Symbols]
- Were specific stimuli orientations harder to recognize than others?
- If yes, which ones?

- What did you think of the block length?
- Would the task have been easier if the stimulus duration didn't vary so much?
- Do you have any additional comments to share?

Glossary

Term	Definition
Wiring Diagram	A diagram that shows how different devices or sensors were connected
Standard Operating Procedure (SOP)	A document that outlines the steps or procedures to be followed for each modality
GDPR (General Data Protection Regulation)	A comprehensive data protection and privacy regulation in the European Union (EU) and the European Economic Area (EEA) - It offers instructions on leveraging the data of the users who register to download COGITATE data
HIPAA (Health Insurance Portability & Accountability Act)	Standards for the protection of sensitive patient health information - HIPAA is used to identify and remove personal identifiers in the curation process
BIDS (Brain Imaging Data Structure)	A standard format for organizing and describing neuroimaging data - This is one of the formats of the released COGITATE datasets
XNAT (Extensible Neuroimaging Archive Toolkit)	An open-source software platform designed for managing, sharing, and analyzing neuroimaging and related data in research settings - This is the platform used for COGITATE project to store the data and facilitate accessing it for the users

References

1. Tarr, M. J. (1996). The Object Databank. Carnegie Mellon University, http://wiki.cnbc.cmu.edu/Objects.
2. Willenbockel, V., Sadr, J., Fiset, D., Horne, G. O., Gosselin, F., & Tanaka, J. W. (2010). Controlling low-level image properties: the SHINE toolbox. Behavior Research Methods, 42(3), 671-684.
3. https://www.hhs.gov/hipaa/for-professionals/compliance-enforcement/index.html
4. https://doi.org/10.1371/journal.pone.0268577
5. https://osf.io/gm3vd