Courtois NeuroMod

Release 2020-beta

Courtois NeuroMod team

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Note: This documentation corresponds to the cneuromod-2022 alpha release.

The Courtois project on Neural Modelling (cneuromod) aims at training artificial neural networks using extensive experimental data on individual human brain activity and behaviour. Six subjects (three women, three men) are getting scanned weekly for five years, for a total of 500 hours of functional data per subject, including functional localizers (vision, language, memory, emotion), movies and video game play. Functional neuroimaging data are collected with both functional magnetic resonance imaging, magnetoencephalography and a variety of sensors (including electrodermal activity and occulometry).

The cneuromod project is funded by a donation of the Courtois foundation. Courtois NeuroMod data are freely shared with the scientific community to advance research at the interface of neuroscience and artificial intelligence. Access to to the data is based on a registered access model, requiring a short scientific project description and institutional signature of a data transfer agreement. An overview of the project is available on the cneuromod website and the technical documentation of the latest release is accessible here.

CHAPTER

ONE

DATASETS

1.1 BIDS

All functional and anatomical data has been formatted in BIDS, for more information visit the Brain Imaging Data Structure documentation site. Some of the files do not follow the main BIDS convention:

- Anatomical sequences with multiple contrasts are following BEP001.
- Spinal cord imaging use Body Part tag proposed in BEP025 (`bp-cspine`) to allow to distinguish them from brain anatomical images acquired with the same contrasts.

Note that BIDS session names have no meaning apart from being data acquired in the same session. The number of runs, the tasks and their order within each session will not match from one participant to another. Note that a few session indices are skipped if the whole session was discarded for various scanning issues.

1.2 Participants

Six healthy participants (aged 31 to 47 at the time of recruitment in 2018), 3 women (`sub-03`, `sub-04` and `sub-06`) and 3 men (`sub-01`, `sub-02` and `sub-05`) consented to participate in the Courtois Neuromod Project for at least 5 years. Three of the participants reported being native francophone speakers (`sub-01`, `sub-02` and `sub-04`), one as being a native anglophone (`sub-06`) and two as bilingual native speakers (`sub-03` and `sub-05`). All participants reported the right hand as being their dominant hand and reported being in good general health.

Exclusion criteria included visual or auditory impairments that would prevent participants from seeing and/or hearing stimuli in the scanner and major psychiatric or neurological problems. Standard exclusion criteria for MRI and MEG were also applied. Lastly, given that all stimuli and instructions are presented in English, all participants had to report having an advanced comprehension of the English language for inclusion.

1.3 anat

The anatomical dataset includes longitudinal anatomical images of the brain and upper spinal cord at an approximate rate of 4 sessions a year. The primary intended use of this dataset is to monitor the structural stability of the brain of participants for the duration of the study. Many quantitative measures of brain structure can also be derived and included in analyses, such as gray matter morphometry, tractography or measures of myelination.

The MRI sequences are described in more detailed in *`Brain_anatomical_sequences`* and *Spinal cord anatomical sequences*, including pdfs of the Siemens exam cards.

Brain T1w, T2w and DWI were copied from the HCP aging and development protocol for Prisma MRI scanner. Other sequences were selected and optimized by the Courtois NeuroMod team.

All images covering the face were anonymized by zeroing the data in the face, teeth and ears regions with a custom mask warped from the MNI space based on a linear registration of the T1w brain MRI series. This defacing script is available here

1.4 hcptrt

This cneuromod dataset is called HCP test-retest (hcptrt), because participants repeated 15 times the functional localizers developed by the Human Connectome Project, for a total of approximately 10 hours of functional data per subject. The protocol consisted of seven tasks, described below (text adapted from the HCP protocol). Before each task, participants were given detailed instructions and examples, as well as a practice run. A session was typically composed either of two repetitions of the HCP localizers, or one resting-state run and one HCP localizer. The e-prime scripts for preparation and presentation of the stimuli can be found in the HCP database. Stimuli and e-prime scripts were provided by the Human Connectome Project, U-Minn Consortium (Principal Investigators: David Van Essen and Kamil Ugurbil; 1U54MH091657) funded by the 16 NIH Institutes and Centers that support the NIH Blueprint for Neuroscience Research, and by the McDonnell Center for Systems Neuroscience at Washington University. Note that in the cneuromod DataLad, functional runs are named func_sub-<participant>_ses-<sess>_task-<task>_run-<run>, where the <participant> tag includes sub-01 to sub-06. For each functional run, a companion file _events.tsv contains the timing and type of events presented to the subject. Session tags <sess> are 001, 002 etc, and the number and composition of sessions vary from subject to subject. The <task> tags are restingstate, gambling, motor, social, wm, emotion, language and relational, as described below. Tasks that were repeated twice have separate <run> tags (01, 02).

Important: The duration of BOLD series are slightly varying across participants and repetitions. If consistent length is required by analysis, series can be trimmed at the end to match duration, task being aligned to the first TR.

1.4.1 Gambling

gambling duration: approximately 3 minutes. Participants were asked to guess whether a hidden number (represented by a "?" during 1500ms) was above or below 5 (Delgado et al. 2000). They indicated their choice using a button press, and were then shown the actual number. If they guessed correctly they were told they won money (+$1.00, win trial), if they guessed incorrectly they were told they lost money (-$0.50, loss trial), and if the number was exactly 5 they were told that they neither won or lost money ($0, neutral trial). Note that no money was actually given to the participants and, as such, this task may not be an accurate reproduction of the HCP protocol. The conditions were presented in blocks of 8 trials of type reward (6 win trials pseudo randomly interleaved with either 1 neutral and 1 loss trial, 2 neutral trials, or 2 loss trials) or of type punishment (6 loss trials pseudo-randomly interleaved with either 1 neutral and 1 win trial, 2 neutral trials, or 2 win trials). There were four blocks per run (2 reward and 2 punishment), and two runs in total.

1.4.2 Motor

motor duration: approximately 3 minutes. This task was adapted from (Buckner et al. 2011; Yeo et al. 2011). Participants were presented a visual cue, and were asked to either tap their left or right fingers (event types left_hand and right_hand, resp.), squeeze their left or right toes (event types left_foot and right_foot, resp.), or move their tongue to map motor area (event type tongue). Each movement lasted 12 seconds, and in total there were 13 blocks, with 2 of tongue movements, 4 of hand movements (2 right_hand and 2 left_hand), and 4 of foot movements (2 right_foot and 2 left_foot), and three 15 second fixation blocks where participants were instructed not to move anything. There were two runs in total, and 13 blocks per run.

1.4.3 Language processing

`language` duration: approximately 4 minutes. Participants were presented with two types of events. During `story` events, participants listened to an auditory story (5-9 sentences, about 20 seconds), followed by a two-alternative forced-choice question. During `math` events, they listened to a math problem (addition and subtraction only, varies in length), and were instructed to push a button to select the first or the second answer as being correct. The task was adaptive so that for every correct answer the level of difficulty increased. The math task was designed this way to maintain the same level of difficulty between participants. There were 2 runs, each with 4 `story` and 4 `math` blocks, interleaved.

1.4.4 Social cognition

`social` duration: approximately 3 minutes. Participants were presented with short video clips (20 seconds) of objects (squares, circles, triangles) that either interacted in some way (event type `mental`), or moved randomly on the screen (event type `random`) (Castelli et al. 2000; Wheatley et al. 2007). Following each clip, participants were asked to judge whether the objects had a "Mental interaction" (an interaction that appeared as if the shapes were taking into account each other's feelings and thoughts), whether the were "Not Sure", or if there was "No interaction". Button presses were used to record their responses. In each of the two runs, participants viewed 5 `mental` videos and 5 `random` videos, and had 5 fixation blocks of 15 seconds each.

1.4.5 Relational processing

`relational` duration: approximately 3 minutes. Participants were shown 6 different shapes filled with 1 of 6 different textures (Smith et al. 2007). There were two conditions: relations processing (event type `relational`), and control matching condition (event type `control`). In the `relational` events, 2 pairs of objects were presented on the screen, with one pair at the top of the screen, and the other pair at the bottom. Participants were instructed to decide what dimension differed in the top pair (shape or texture), and then decide if the bottom pair differed, or not, on the same dimension (i.e. if the top pair differed in shape, did the bottom pair also differ in shape). Their answers were recorded by one of two button presses: "a" differ on same dimension; "b" don't differ on same dimension. In the `control` events, participants were shown two objects at the top of the screen, and one object at the bottom of the screen, with a word in the middle of the screen (either "shape" or "texture").They were told to decide whether the bottom object matched either of the top two objects on that dimension (i.e., if the word is "shape", did the bottom object have the same shape as either of the top two objects). Participants responded "yes" or "no" using the button box. For the `relational` condition, the stimuli were presented for 3500 ms, with a 500 ms ITI, and there were four trials per block. In the `control`condition, stimuli were presented for 2800 ms, with a 400 ms ITI, and there were 5 trials per block. In total there were two runs, each with three `relational` blocks, three `control` blocks and three 16-second fixation blocks.

1.4.6 Emotion processing

`emotion` duration: approximately 2 minutes. Participants were shown triads of faces (event type `face`) or shapes (event type `shape`), and were asked to decide which of the shapes at the bottom of the screen matches the target face/ shape at the top of the screen (adapted from Smith et al. 2007). Faces had either an angry or fearful expression. Faces, and shapes were presented in three blocks of 6 trials (3 `face` and 3 `shape`), with each trial lasting 2 seconds, followed by a 1 second inter-stimulus interval. Each block was preceded by a 3000 ms task cue ("shape" or "face"), so that each block was 21 seconds long, including the cue. In total there were two runs, three `face` blocks and three `shape` blocks, with 8 seconds of fixation at the end of each run.

1.4.7 Working memory

`wm` duration: approximately 5 minutes. There were two subtasks: a category specific representation, and a working memory task. Participants were presented with blocks of either places, tools, faces, and body parts. Within each run, all 4 types of stimuli were presented in block, with each block being labelled as a 2-back task (participants needed to indicate if they saw the same image two images back), or a version of a 0-back task (participants were shown a target at the start of the trial and they needed to indicate if the image that they were seeing matched the target). There were thus 8 different event types <stim>_<back>, where <stim> was one of `place`, `tools`, `face` or `body`, and <back> was one of `0back` or `2back`. Each image was presented for 2 seconds, followed by a 500 ms ITI. Stimuli were presented for 2 seconds, followed by a 500 ms inter-task interval. Each of the 2 runs included 8 event types with 10 trials per type, as well as 4 fixations blocks (15 secs).

1.4.8 Resting state

`restingstate` duration: 15 minutes. In every other session, one resting-state fMRI run was acquired, giving 5 runs per participant. Participants were asked to have their eye open, be looking at fixation cross in the middle of the screen and be instructed to not fall asleep. A total of five resting-state fMRI runs were acquired per subject.

1.5 movie10

This dataset includes about 10 hours of functional data for all 6 participants. The python & psychopy scripts for preparation and presentation of the clips can be found in `src/tasks/video.py` of the following github repository. Session tags <sess> were `001`, `002` etc, and the number and composition of sessions varied from subject to subject. The <task> tags used in DataLad corresponded to each movie (`bourne`, `wolf`, `life`, `figures`) and a numerical index of the segments shown as each movie was cut into roughly ten minutes segments presented in separate run. Exact cutting points were manually selected to not interrupt the narrative flow. Fade out to a black screen was added at the end of each clip, and with a few seconds overlap between the end of a clip and the beginning of the next clip. The movie segments can be found under `movie10/stimuli/<movie>/<movie>_seg<seg>.mkv`, and the functional runs are named `func_sub-<participant>_ses-<sess>_task-<movie><seg>`, where the <participant> tag ranges from `sub-01` to `sub-06`. A companion file `_events.tsv` contains the timing and type of conditions presented to the subject.

The participants watched the following movies (cogatlas):

- <task> name `bourne`: The Bourne supremacy. Duration ~100 minutes.
- <task> name `wolf`: The wolf of wall street. Duration ~170 minutes.
- <task> name `figures`: Hidden figures. Duration ~120 minutes. This movie was presented twice, for a total duration of ~240 minutes.
- <task> name `life`: Life Disc one of four: “Challenges of life, reptiles and amphibian mammals”. DVD set was narrated by David Attenborough. Duration, and lasted ~50 minutes. This movie was presented twice, for a total duration of ~100 minutes.

It should be noted that although three of the participants are not native anglophones, all participants watched the movies in English. The three native francophone participants are fluent in English and report regularly watching movies in English.

Important: The duration of BOLD series are slightly varying across participants and repetitions. If consistent length is required for analysis, series can be trimmed at the end to match duration, movie segments being aligned to the first TR.

Important: There are instances of re-scanned segments (due to scan QC fail), these re-scans will be in separate sessions. These should be handled or excluded in analysis requiring continuity of the presentation of the story.

1.6 Friends

This dataset contains functional data acquired while showing participants episodes of the Friends TV show in English. It includes seasons 1-6 for all subjects, except `sub-04` who only completed seasons 1-4 (and a few segments of season 5). Each episode is cut in two segments (a/b) to allow more flexible scanning and give participants opportunities for breaks. There is a small overlap between the segments to allow participants to catch up with the storyline. The task BIDS entity identifies the season, episode and segments (a/b) as such `task-s<eason>e<pisode>[ab]`.

Important: A mistake happened when ripping the first season, causing `s01e01` and `s01e06` to be swapped in name and order of presentation. Files were renamed afterward to match external data such as annotations. However the order of presentation remains, slightly disrupting the storyline presented to the participant.

1.7 harrypotter

This dataset contains a single session per participant (N=5) when they read chapter 9 from chapter 9 of Harry Potter and the Sorcerer's Stone. The text was presented word by word, at a 2Hz pace (each word presented for .5s). This chapter was split over 7 runs of approximate equal length. The stimuli used in this dataset are taken from the experiment reported by Wehbe et al. (2014) for which a separate fMRI dataset (N=9) has been collected and shared.

1.8 shinobi_training

This is a pure behavioral dataset collected while participants trained at home on the videogame Shinobi III The Return of the Ninja Master. A subset of 3 levels of the game was selected for their similarity in terms of core gameplay although some mechanics were specific to each level. These levels were the same than those used in the `shinobi` dataset.

The participants were first introduced to the game by playing the Level-1 at least once. This level introduces the basic game mechanics (moving from left to right, avoid or kill enemies) at an abordable difficulty level for most players. Then, the participants were able to freely choose the level on which they played as well as the training sessions frequency. No training regimen was imposed to the participants making that dataset highly heterogeneous. The dataset consists of sessions of gameplay as collections of `.bk2` files recorded by the gym-retro API.

This dataset can be used to analyze learning or individual game-play styles, and can be investigated in conjunction with the fMRI dataset.

1.9 shinobi

This dataset contains about 10h of gameplay on the videogame Shinobi III The Return of the Ninja Master, for N=4 participants (`sub-01`, `sub-02`, `sub-04` and `sub-06`). Participants used a custom-built fully fiber-optic MRI controller, designed by the team and described in Harel et al. (2022). In each run, participants played 3 levels in cycles and always in the same order. These levels were selected in the game to have fairly homogeneous core game mechanics (see the Sega documentation for more details on game structure):

- `Level-1` corresponded to round 1 of the original game, "Zeed's Resurrection". It included one mini-boss and one boss fight.
- `Level-4` corresponded to the beginning of round 4 of the original game, "Destruction". It included no mini-boss or boss fight.
- `Level-5` corresponded to the beginning of round 5 of the original game, "Electric demon". It included one mini-boss fight and no boss fight.

Participants moved to the next level if they successfully completed a level, or lost three lives. A new level was then initiated unless 10 minutes had elapsed from the start of the run, at which point the run ended. The duration of each run is thus variable to a degree, with a minimum of ten minutes. Due to the fixed order in the cycle, `Level-1` was repeated more often than `Level-4` and `Level-5`.

In this dataset and the related documentation, we use the term `run` to designate a single functional sequence acquisition (per the usual in neuroimaging). The term `repetition` is used to designate the play of a single level (from start to either completion or the loss of three lives). As such, each run contains around 3 to 5 repetitions.

For each functional run, a companion file `_events.tsv` contains the timing and duration of each repetition played, as well as a `_annotated_events.tsv` file that additionally contains richer annotations, including button presses, handcrafted annotations (Kills, Health losses), and frame-wise RAM values. Additional documentation on the available annotations can be found here.

The companion `.bk2` files can be found in the `<participant>/<sess>/gamelogs` folder.

Important: Due to a programming error a certain number of game recording files were lost during acquisition, these repetitions are still listed in the events file but their `stim_file` field is left blank. Choice is left to the user whether to exclude the corresponding fMRI volumes or not for their analysis.

CHAPTER

TWO

ACCESS TO DATA

2.1 Partial data access via Canadian Open Neuroscience Portal (CONP)

Three CNeuroMod subjects (sub-01, sub-03 and sub-05) have chosen to openly share their data via CONP. Data will soon be available here

2.2 Complete CNeuroMod databank via Data Transfer Agreement (DTA)

To access all the data available in the CNeuroMod databank (i.e all 6 subjects) researchers are required to complete a form with a brief description of planned analyses, and complete an inter-institutional data transfer agreement. Links to relevant forms can be found on the access request page. The data transfer agreement must be signed by the researcher responsible for the project as well as a representative of the main academic institution where the research team is affiliated. The application will be evaluated by a data access committee and, if approved, a transfer key will be shared with the research team in order to transfer the data (see *Downloading the dataset* section below).

2.3 Ethics

The Courtois NeuroMod project has been approved by the institutional research ethics board of the CIUSSS du Centre-Sud-de-l'île-de-Montréal. The CIUSSS is a large governmental health organization, and the core NeuroMod team is based at the Research Centre of the Montreal Geriatric Institute (CRIUGM), which is a part of the CIUSSS, and affiliated with the University of Montreal. The consent forms signed by participants and the project description are available below. The formal authorization lettre from the ethics committee is available upon request. The project was most recently renewed by the Comité d'éthique de la recherche — Vieillissement et neuroimagerie (CER-VN) on October 21st, 2022 under the project number CER VN 18-19-22, and title "Extensive characterization of human brain activity under naturalistic stimulations for developing individual artificial neuronal models."

- courtois_neuromod_project_description.pdf: scientific overview of the Courtois NeuroMod project (in English).
- consent_form_english.pdf: the informed consent form signed by participants (English version).
- consent_form_french.pdf: the informed consent form signed by participants (French version).

2.4 Downloading the dataset

All data are made available as a DataLad collection on github in public repositories. DataLad is a tool for versioning a large data structure in a git repository. The dataset can be explored without downloading the data, and it is easy to only download the subset of the data you need for your project. See the DataLad handbook for further information.

We recommend creating an SSH key (if not already present) on the machine on which the dataset will be installed and adding it to github. See the official github instructions on how to create and add a key to your account.

To obtain the data, you need to install a recent version of the DataLad software, available for Linux, OSX and Windows. Note that you need to have valid login credentials to access the NeuroMod git as well as the NeuroMod Amazon S3 fileserver. Once you have obtained these credentials, you can proceed as follows in a terminal:

```
# Install recursively the dataset and subdataset of the current project.
# If using ssh git clone as follow, you can set your public SSH key in the present git␣
↪to ease future updates.
datalad install -r git@github.com:courtois-neuromod/cneuromod.git
# If errors show up relative to .heudiconv subdataset/submodule, this is OK, they are␣
↪not published (will be cleaned up in the future).
cd cneuromod
```

2.4.1 Versioning

By default, this will install the latest stable release of the dataset, which is the recommended version to get for a new analysis. If you are need to work on a specific version (for instance to reproduce a result), you can change to the appropriate tag with.

```
git checkout 2020
```

We now set as environment variable the credentials to the file server. The s3 access_key and secret_key will be provided by the data manager after being granted access to cneuromod by the user access committee.

```
# This needs to be set in your `bash` everytime you want to download data.
export AWS_ACCESS_KEY_ID=<s3_access_key>  AWS_SECRET_ACCESS_KEY=<s3_secret_key>
```

2.4.2 Preprocessed data

For analysis of fMRI data, it is preferable to directly get the preprocessed data (smriprep and fmriprep for now).

```
datalad install git@github.com:courtois-neuromod/cneuromod.processed.git
cd cneuromod.processed
```

You can install the sub-datasets you are interested in (instead of installing all of them) using for instance:

```
datalad get -n smriprep fmriprep/movie10
```

and then get only the files you need (for instance MNI space output):

```
datalad get smriprep/sub-*/anat/*space-MNI152NLin2009cAsym_* # get all anatomical output␣
↪in MNI space
datalad get fmriprep/movie10/sub-*/ses-*/func/*space-MNI152NLin2009cAsym_* # get all␣
↪functional output in MNI space
```

You can add the flag `-J n` to download files in parallel with `n` being the number of threads to use.

The source data used for preprocessing (including raw data) are referenced as sources in the preprocessed dataset following Yoda, so as to track provenance. You can also track the version of the cneuromod dataset you are using by installing it in a datalad dataset created for your project.

2.4.3 Stimuli and event files

You will likely need the events files and stimuli for your analysis which can be obtained from the sourcedata reference sub-datasets, for example:

```
datalad get -r fmriprep/movie10/sourcedata/movie10/stimuli fmriprep/movie10/sourcedata/
↪movie10/*_events.tsv
```

or to get subject specific event files for tasks collecting behavioral responses:

```
datalad get -r fmriprep/movie10/sourcedata/hcptrt/sub-*/ses-*/func/*_events.tsv
```

2.5 Updates

The dataset will be updated with new releases so you might want to get these changes (unless you are currently running analyses, or trying to reproduce results). The main branches of all datasets will always track the latest stable release.

```
# update the dataset recursively
datalad update -r --merge --reobtain-data
```

Once your local dataset clone is updated, you might need to pull new data, as some files could have been added or modified. The `--reobtain-data` flag should automatically pull files that you had already downloaded in case these were modified.

CHAPTER

THREE

MRI

3.1 Image acquisition

3.1.1 Scanner

Magnetic resonance imaging (MRI) for the Courtois neuromod project is being acquired at the functional neuroimaging unit (UNF), located at the "Centre de Recherche de l'Institut Universitaire de Gériatrie de Montréal" (CRIUGM) and affiliated with University of Montreal as well as the CIUSSS du Centre-Sud-de-l'île-de-Montréal. The scanner is a Siemens Prisma Fit, equipped with a 2-channel transmit body coil and a 64-channel receive head/neck coil. Most imaging in the Courtois Neuromod project are composed solely of functional MRI runs. Periodically, an entire session is dedicated to anatomical scans.

3.1.2 Personalized head cases

In order to minimize movement, each participant wears a custom-designed, personalized headcase during scanning, built by Caseforge. The headcases are milled based on a head scan of each participant generated using a handheld 3D scanner, and the shape of the MRI coil. Caseforge mills the personalized headcases in polystyrene foam blocks.

3.1.3 Hearing protection

In order to provide an additional level of hearing protection against repeated exposure to the noise of the MR scanner, as well as optimize the quality of the auditory stimuli, we implemented two custom hearing protection set-ups for CNeuromod participants. The initial custom set-up was composed of the S15 MRI-compatible earphone system (Sensimetric), standard-sized disposable Comply canal tips (Hearing Components, Inc.; advertised Noise Reduction Rating: 29 dB), and modified commercial earmuffs (Stanley Black & Decker Inc; unmodified advertised Noise Reduction Rating: 27 dB). The commercial earmuffs were modified to render them thinner by cutting the inner section of the earmuff (i.e leaving the external cup intact) and re-attaching the foam ring (i.e. foam that seals around the ear) to the modified earmuff. This modification was necessary to enable the earmuffs to fit inside the head coil (i.e Siemen's 64-channel), along with CaseForge headcases and the participants' heads. This version of the custom hearing protection was eventually abandoned due to pressure points it caused on some participants' jaws, particularly individuals with larger heads, and when worn for extended periods of time (i.e 1h+).

This initial hearing protection set-up was used by participants for the following datasets:(`hcptrt`),(`movie10`), (`friends`) seasons 1-4, and (`shinobi`).

The second, and current, custom hearing protection set-up is again composed of the S15 MRI-compatible earphone system (Sensimetrics Corporation), "custom" disposable Comply canal tips (Hearing Components, Inc., advertised Noise Reduction Rating: 29 dB), and headphone replacement memory foam rings (Brainwavz Audio). Additionally, each subject selected their "custom" Comply canal tip from one of two types of styles (original and short), each with

three sizes (slim, standard, large), based on their ideal comfort level (i.e fit based on their ear canal shape) and relative sense of optimal sound protection.

The second version of the custom hearing protection set-up, which is still currently in use, was used by participants for the (`friends`) seasons 5-6 datasets.

3.2 Sequences

3.2.1 Functional sequences

The parameters of the functional MRI sequence relevant for data analysis can be found in the NeuroMod DataLad. The functional acquisition parameters are all identical to the one used in the `hcptrt` dataset. The Siemens exam card can be found here, and is briefly recapitulated below. Functional MRI data was acquired using an accelerated simultaneous multi-slice, gradient echo-planar imaging sequence (Xu et al., 2013) developed at the Center for Magnetic Resonance Research (CMRR) University of Minnesota, as part of the Human Connectome Project (Glasser et al., 2016). The sequence is available on the Siemens PRISMA scanner at UNF through a concept to production (C2P) agreement, and was used with the following parameters: slice acceleration factor = 4, TR = 1.49 s, TE = 37 ms, flip angle = 52 degrees, voxel size = 2 mm x 2 mm x 2 mm, 60 slices, acquisition matrix 96x96. In each session, a short acquisition (3 volumes) with reversed phase encoding direction was run to allow retrospective correction of B0 field inhomogeneity-induced distortion.

3.2.2 Brain anatomical sequences

The parameters of the brain anatomical MRI sequences relevant for data analysis can be found in the NeuroMod DataLad. The acquisition parameters are identical for all anatomical sessions. The Siemens pdf exam card of the anatomical sessions can be found here, and is briefly recapitulated below. A standard (brain) anatomical session started with a 21 s localizer scan, and then included the following sequences:

- T1-weighted MPRAGE 3D sagittal sequence (duration 6:38 min, TR = 2.4 s, TE = 2.2 ms, flip angle = 8 deg, voxel size = 0.8 mm isotropic, R=2 acceleration)
- T2-weighted FSE (SPACE) 3D sagittal sequence (duration 5:57 min, TR = 3.2 s, TE = 563 ms, voxel size = 0.8 mm isotropic, R=2 acceleration)
- Diffusion-weighted 2D axial sequence (duration 4:04 min, TR = 2.3 s, TE = 82 ms, 57 slices, flip angle = 78 deg, voxel size = 2 mm isotropic, phase-encoding P-A, SMS=3 through-plane acceleration, b-max = 3000 s/mm2). The same sequence was run with phase-encoding A-P to correct for susceptibility distortions.
- gradient-echo magnetization-transfer 3D sequence (duration 3:34 min, 28 = ms, TE = 3.3 ms, flip angle = 6 deg, voxel size = 1.5 mm isotropic, R=2 in-plane GRAPPA, MT pulse Gaussian shape centered at 1.2 kHz offset).
- gradient-echo proton density 3D sequence (same parameters as above, without the MT pulse).
- gradient-echo T1-weighted 3D sequence (same parameters as above, except: TR = 18 ms, flip angle = 20 deg).
- MP2RAGE 3D sequence (duration 7:26 min, TR = 4 s, TE = 1.51 ms, TI1 = 700 ms, TI2 = 1500 ms, flip angle 1 = 7 deg, flip angle 2 = 5 deg, voxel size = 1.2 mm isotropic, R=2 acceleration)
- Susceptibility-weighted 3D sequence (duration 4:54 min, TR = 27 ms, TE = 20 ms, flip angle = 15 deg)

.. warning:: T1w, T2w and DWI (from HCP development/aging protocol for Siemens Prisma) and SWI do not have gradient non-linearity correction applied on the scanner. Offline correction can be applied using tools such as gradunwarp, but is not included yet in fMRIPrep pipeline.

3.2.3 Spinal cord anatomical sequences

The parameters of the spinal cord anatomical MRI sequences relevant for data analysis can be found in the BIDS dataset, and included metadata. The acquisition parameters are identical for all anatomical sessions, and follow a community spinal cord standard imaging protocol. The Siemens pdf exam card of the anatomical sessions can be found here, and is briefly recapitulated below. A standard (spinal cord) anatomical session starts with a 21 s localizer scan, and then includes the following sequences:

- T1-weighted 3D sagittal sequence (duration 4:44 min, TR = 2 s, TE = 3.72 ms, flip angle = 9 deg, voxel size = 1.0 mm isotropic, R=2 acceleration)
- T2-weighted 3D sagittal sequence (duration 4:02 min, TR = 1.5 s, TE = 120 ms, flip angle = 120 deg, voxel size = 0.8 mm isotropic, R=3 acceleration)
- Diffusion-weighted 2D axial sequence (cardiac-gated with pulseOx, approximate duration 3 min, TR = 620 ms, TE = 60 ms, voxel size = 0.9 x 0.9 x 0.5 mm, phase-encoding A-P, b-max = 800 s/mm2)
- Gradient-echo magnetization-transfer 3D axial sequence (duration 2:12 min, TR = 35 ms, TE = 3.13 ms, flip angle = 9 deg, voxel size = 0.9 x 0.9 x 0.5 mm, R=2 acceleration, with MT Gaussian pulse)
- Gradient-echo proton-density weighted 3D axial sequence (same parameters as above, without the MT pulse).
- Gradient-echo T1-weighted 3D axial sequence (same parameters as above, except: TR = 15 ms, flip angle = 15 deg).
- gradient-echo ME (duration 4:45 min, TR = 600 ms, effective TE = 14 ms (this is a multi-echo sequence), flip angle = 30 deg, voxel size = 0.9 x 0.9 x 0.5 mm, R=2 acceleration)

3.3 Stimuli

3.3.1 Visual presentation

All visual stimuli were projected using a Epson Powerlite L615U projector. The images were casted through a waveguide onto a blank screen located in the MRI room.

3.3.2 Auditory system

For functional sessions, participant wore MRI compatible S15 Sensimetric headphone inserts, proving high-quality acoustic stimulation and substantial attenuation of background noise. On the computer used for stimuli presentation, a custom impulse response of the headphones is applied with an online finite impulse response filter using the LADSPA DSP to all the presented stimuli.This impulse response was provided by the manufacturer. Sounds was amplified using an AudioSource AMP100V amplifier, situated in the control room. Participants also wear custom sound protection gear (see section on Hearing protection above).

3.3.3 Stimuli presentation

For the HCP-trt dataset, Eprime scripts provided by the Human Connectome project were adapted for our presentation system, and run using Eprime 2.0. For all other tasks, a custom overlay on top of the psychopy library was used to present the different tasks and synchronize task with the scanner trigger pulses. This software also allowed to trigger the start of the eyetracking system, and onset the stimuli presentation. Trigger pulses were also recorded in the AcqKnowledge software. All task stimuli scripts are available through github.

3.4 Physiological measures

3.4.1 Biopac

During all sequences, electrophysiological signals were recorded using a Biopac M160 MRI compatible systems and amplifiers. Measurements were acquired at 1000 Hz. Recodings were synchronized to the MRI scans via trigger pulses. All measurements were recorded and monitored using Biopac's AcqKnowledge sofware.

3.4.2 Plethysmograph

Participant cardiac pulse was measured using an MRI compatible plethysmograph. A Biopac TSD200-MRI photoplethysmogram transducer was placed on the foot or toe of the participants to obtain beat-by-beat estimates of heart rate.

3.4.3 Skin conductance

Skin conductance, was measured using two electrodes, one applied to the sole of the foot and the other to the ankle, to record the participant electrodermal response.

3.4.4 Electrocardiogram

An electrocardiogram (ECG) was used to measure the electrical activity generated by the heart. The ECG was recorded using three MRI compatible electrodes that were placed adjacent to one aother, on the lower left rib cage, just under the heart.

3.4.5 Respiration

Participant's respiration was measured using a custom MRI compatible respiration belt. The respiration system consisted of: a pressure cuff taken from a blood pressure monitor (PhysioLogic blood), a pressure sensor (MPXV5004GC7U, NXP USA Inc), and flexible tubing. The cuff was attached to the participant upper abdomen using Velcro strap, and then connected to the pressure sensor, located outside the scanner room, using tubing passed through a waveguide. The pressure signal was recorded using an analog input on the Biopac system, and monitored using AcqKnowledge software.

3.5 Mock scanner

Some of our datasets required a comparison between genuine in-scanner conditions and "mock" conditions, where the subject was installed in a fake scanner that reproduced the comfort and aspect of an MRI scanner. This mock setup was also located at UNF, and was equipped with a monitor screen for stimulus presentation as well as audio headphones and response devices (keyboard and video game controller).

CHAPTER

FOUR

DERIVATIVES

4.1 sMRIPrep

The anatomical data was preprocessed using sMRIPrep pipeline. It took as input the T1w and T2w of the first 2 sessions of all participants, which were averaged after coregistration.

4.2 fMRIPrep

4.2.1 Overview

The functional data was preprocessed using the fMRIprep pipeline. FmriPrep is an fMRI data preprocessing pipeline that requires minimal user input, while providing error and output reporting. It performs basic processing steps (coregistration, normalization, unwarping, noise component extraction, segmentation, skullstripping etc.) and provides outputs that can be easily submitted to a variety of group level analyses, including task-based or resting-state fMRI, graph theory measures, surface or volume-based statistics, etc. The fMRIprep pipeline uses a combination of tools from well-known software packages, including FSL, ANTs, FreeSurfer and AFNI. For additional information regarding fMRIPrep installation, workflow and outputs, please visit the documentation page. Note that the `slicetiming` option was disabled (i.e. fMRIprep was invoked with the flag `--ignore slicetiming`).

4.2.2 Outputs

The outputs of fMRIprep can be found as sub-datasets of the cneuromod.processed super-dataset. fMRIPrep functional preprocessing was run using the anatomical "fast-track" (flag `--anat-derivatives`) with sMRIPrep output described above, so as to use the same anatomical basis for all functional dataset. The output was generated in `T1w`, `MNI152NLin2009cAsym` and `fsLR-den-91k` spaces as defined by templateflow to respectively enable native space and volumetric or surface-based analyses.

The description of participant, session, task and event tags can be found in the *Datasets* section. Each participant folder (`sub-*`) contains:

- `ses-*/func` containing for each fMRI run of that session file prefixed with:
  - `*_boldref.nii.gz` : a BOLD single volume reference.
  - `*_desc-brain_mask.nii.gz` : the brain mask in fMRI space.
  - `*_desc-preproc_bold.nii.gz` : the preprocessed BOLD timeseries.
  - `*_desc-confounds_timeseries.tsv` : a tabular tsv file, containing a large set of confounds to use in analysis steps (eg. GLM).

4.2.3 Recommended preprocessing strategy

The confounding regressors are correlated, thus it is critical to only use a subset of these regressors. Also note that preprocessed time series have not been corrected for any confounds, but simply realigned in space, and it is therefore also critical to regress some of the available confounds prior to analysis. See the fMRIprep documentation for details on available confound regressors. For python users, we recommend using nilearn and the tool load_confounds_strategy to load confounds from the fMRIprep outputs, using with a standardized strategy. As the NeuroMod data consistently exhibits low levels of motion, we recommend against removing time points with excessive motion (aka scrubbing), and the `minimal` strategy available in nilearn is a reasonable choice. Because of the 2 mm spatial resolution of the fMRI scan, there is substantial impact of thermal noise, and some amount of spatial smoothing is advisable, the extent of it being determined by your hypotheses and analysis.

4.2.4 Pipeline description

Results included in this manuscript come from preprocessing performed using *fMRIPrep* 20.2.5 (@fmriprep1; @fmriprep2; RRID:SCR_016216), which is based on *Nipype* 1.6.1 (@nipype1; @nipype2; RRID:SCR_002502).

Anatomical data preprocessing

: A total of 0 T1-weighted (T1w) images were found within the input BIDS dataset. Anatomical preprocessing was reused from previously existing derivative objects.

Functional data preprocessing

: For each of the 2 BOLD runs found per subject (across all tasks and sessions), the following preprocessing was performed. First, a reference volume and its skull-stripped version were generated by aligning and averaging 1 single-band references (SBRefs). A B0-nonuniformity map (or *fieldmap*) was estimated based on two (or more) echo-planar imaging (EPI) references with opposing phase-encoding directions, with `3dQwarp` @afni (AFNI 20160207). Based on the estimated susceptibility distortion, a corrected EPI (echo-planar imaging) reference was calculated for a more accurate co-registration with the anatomical reference. The BOLD reference was then co-registered to the T1w reference using `bbregister` (FreeSurfer) which implements boundary-based registration [@bbr]. Co-registration was configured with six degrees of freedom. Head-motion parameters with respect to the BOLD reference (transformation matrices, and six corresponding rotation and translation parameters) are estimated before any spatiotemporal filtering using `mcflirt` [FSL 5.0.9, @mcflirt]. First, a reference volume and its skull-stripped version were generated using a custom methodology of *fMRIPrep*. The BOLD time-series were resampled onto the following surfaces (FreeSurfer reconstruction nomenclature): *fsaverage*. The BOLD time-series (including slice-timing correction when applied) were resampled onto their original, native space by applying a single, composite transform to correct for head-motion and susceptibility distortions. These resampled BOLD time-series will be referred to as *preprocessed BOLD in original space*, or just *preprocessed BOLD*. The BOLD time-series were resampled into standard space, generating a *preprocessed BOLD run in MNI152NLin2009cAsym space*. First, a reference volume and its skull-stripped version were generated using a custom methodology of *fMRIPrep*. *Grayordinates* files [@hcppipelines] containing 91k samples were also generated using the highest-resolution `fsaverage` as intermediate standardized surface space. Several confounding time-series were calculated based on the *preprocessed BOLD*: framewise displacement (FD), DVARS and three region-wise global signals. FD was computed using two formulations following Power (absolute sum of relative motions, @power_fd_dvars) and Jenkinson (relative root mean square displacement between affines, @mcflirt). FD and DVARS are calculated for each functional run, both using their implementations in *Nipype* [following the definitions by @power_fd_dvars]. The three global signals are extracted within the CSF, the WM, and the whole-brain masks. Additionally, a set of physiological regressors were extracted to allow for component-based noise correction [*CompCor*, @compcor]. Principal components are estimated after high-pass filtering the *preprocessed BOLD* time-series (using a discrete cosine filter with 128s cut-off) for the two *CompCor* variants: temporal (tCompCor) and anatomical (aCompCor). tCompCor components are then calculated from the top 2% variable voxels within the brain mask. For aCompCor, three probabilistic masks (CSF, WM and combined CSF+WM) are generated in anatomical space. The implementation differs from that of Behzadi et al. in that instead of eroding the masks by 2 pixels on BOLD space, the aCompCor masks are subtracted a mask of pixels that likely contain a volume fraction of GM. This mask is obtained by dilating a GM mask extracted

from the FreeSurfer's *aseg* segmentation, and it ensures components are not extracted from voxels containing a minimal fraction of GM. Finally, these masks are resampled into BOLD space and binarized by thresholding at 0.99 (as in the original implementation). Components are also calculated separately within the WM and CSF masks. For each CompCor decomposition, the *k* components with the largest singular values are retained, such that the retained components' time series are sufficient to explain 50 percent of variance across the nuisance mask (CSF, WM, combined, or temporal). The remaining components are dropped from consideration. The head-motion estimates calculated in the correction step were also placed within the corresponding confounds file. The confound time series derived from head motion estimates and global signals were expanded with the inclusion of temporal derivatives and quadratic terms for each [@confounds_satterthwaite_2013]. Frames that exceeded a threshold of 0.5 mm FD or 1.5 standardised DVARS were annotated as motion outliers. All resamplings can be performed with *a single interpolation step* by composing all the pertinent transformations (i.e. head-motion transform matrices, susceptibility distortion correction when available, and co-registrations to anatomical and output spaces). Gridded (volumetric) resamplings were performed using `antsApplyTransforms` (ANTs), configured with Lanczos interpolation to minimize the smoothing effects of other kernels [@lanczos]. Non-gridded (surface) resamplings were performed using `mri_vol2surf` (FreeSurfer).

Many internal operations of *fMRIPrep* use *Nilearn* 0.6.2 [@nilearn, RRID:SCR_001362], mostly within the functional processing workflow. For more details of the pipeline, see the section corresponding to workflows in *fMRIPrep*'s documentation.

4.2.5 Copyright Waiver

The above boilerplate text was automatically generated by fMRIPrep with the express intention that users should copy and paste this text into their manuscripts *unchanged*. It is released under the CC0 license.

CHAPTER

FIVE

RELEASES

5.1 2022-alpha

Courtois-Neuromod `2022-alpha` release includes the following sub-datasets:

- `anat` : with up to 11 sessions per participant. Updated number of sessions per subject.
- `hcptrt` : 15 repetitions of the HCP tasks including some within-session. Updated event annotations, preprocessing and bug fixes.
- `movie10`: about 10h of movie watching of 4 movies with 2 movies repeated. Updated preprocessing.
- `friends s01-06`: about 60h of Friends TV series watching. This dataset is an addition to the 2022 release.
- `shinobi`: about 10h of playing shinobi. This dataset is an addition to the 2022 release. Behavioural annotations are not included, but will be part of the final 2022 release.
- `harrypotter`: reading Harry Potter in the scanner. This dataset is an addition to the 2022 release.

See the CNeuroMod docs for more details on each dataset. This release also includes continuous integration testing of the validity of each dataset.

5.2 2020

Courtois NeuroMod `2020` release includes the following sub-datasets:

- `anat` : with up to 10 sessions per participant
- `hcptrt` : 15 repetitions of the HCP tasks including some within-session
- `movie10`: about 10h of movie watching of 4 movies with 2 movies repeated
- `friends s1 s2`: about 20h of Friends TV series watching

Compared to the `2020-beta` release, the preprocessing has been updated, and various file organization issues have been fixed.

CHAPTER

SIX

CONTRIBUTING

6.1 How to contribute

The CNeuroMod project is an open and welcoming community. You can get in touch through our twitter, our youtube channel, or our channel in the brainhack mattermost. We welcome contributions ranging from bug fixes, adding annotations or trained models to the datasets, adding pointers to useful externals tools in our documentation, to suggesting designs for new tasks! We ask our community members to respect the following code of conduct.

The CNeuroMod team is dedicated to providing an environment where people are kind and respectful to each other. This could really be the end of that code of conduct, but some forms of harassment and negative behavior are fairly hard to identify at first. Please read carefully through the rest of the document to make sure you avoid them. There is also a section to know what to do and expect if you experience behavior that deviates from this code of conduct.

6.2 Code of conduct

6.2.1 Respecting differences

CNeuroMod community members come from many cultures and backgrounds. We therefore expect community members to be very respectful of different cultural practices, attitudes, and beliefs. This includes being aware of preferred titles and pronouns, as well as using a respectful tone of voice.

While we do not assume CNeuroMod community members know the cultural practices of every ethnic and cultural group, we expect members to recognize and respect differences within our community. This means being open to learning from and educating others, as well as educating yourself.

Harassment includes, but is not limited to:

- Verbal comments that reinforce social structures of domination related to gender, gender identity and expression, sexual orientation, diet (vegetarian, lactose-free, vegan, etc), disability, marital or family status, pregnancy, pregnancy-related conditions, physical appearance, body size, race, age or religion.
- Sexual images in public spaces
- Deliberate intimidation, stalking, or following
- Harassing photography or recording
- Sustained disruption of work
- Inappropriate physical contact
- Unwelcome sexual attention
- Advocating for, or encouraging, any of the above behaviour

6.2.2 Microaggressions

Incidents can take the form of "microaggressions," which is a damaging form of harassment. Microaggressions are the everyday slights or insults which communicate negative messages to target individuals, often based upon their marginalized group membership. The following examples can all be labeled micro-aggressions:

- commenting on a woman's appearance rather than her work
- only directing questions at male colleagues when there are female experts in the room;
- telling someone of colour that they "speak such good English";
- forcefully praising meat to an individual with a vegetarian diet;
- praising alcoholic drinks to an individual who do not consume them.
- Exclusion from a group can be a common nonverbal form of microaggression. Microaggressions can be couched in the form of a "compliment," (e.g. "you're too attractive to be a scientist"). Over time, microagressions can take a great toll on mental and emotional health, and the target's feeling of belonging in science and academia.

6.2.3 Enforcement

Members should seek to pro-actively eliminate behaviors that deviate from our code of conduct. If a member engages in harassing behaviour, the CNeuroMod team will take any actions necessary to keep the community a welcoming environment for all. This includes warning the offender, and potentially expulsion from the spaces administered by the community, as well as revocation to data access. We expect CNeuroMod community members to follow these rules in the CNeuroMod virtual and physical spaces. Members asked to stop any harassing behavior are expected to comply immediately. We think people should follow these rules outside of CNeuroMod too!

6.2.4 Reporting

If someone makes you or anyone else feel unsafe or unwelcome, please report it as soon as possible in person, or in writing to Pierre Bellec pierre.bellec@criugm.qc.ca or Julie Boyle julie.boyle@criugm.qc.ca. The direction will follow up with you to understand the problem, and take the necessary actions to resolve it without your direct involvement. Harassment and other code of conduct violations considerably reduce the value of the CNeuroMod research environment for everyone, and are taken very seriously. We strive to make CNeuroMod a rich and joyful community for everyone, at all time.

CHAPTER

SEVEN

AUTHORS

7.1 Team overview

The Courtois NeuroMod project originated from the laboratory for brain simulation and exploration (SIMEXP), and collaborators are located at the Centre de Recherche de l'Institut de Gériatrie de Montréal (CRIUGM), CIUSSS du Centre-Sud-de-l'île-de-Montréal, as well as the Psychology Departement of University of Montreal (UdeM). The team has grown to include individuals from various institutions, and in particular the Computer Science and Operational Research (DIRO) Department at UdeM and the MILA.

7.2 Funding

The Courtois NeuroMod project was made possible by a 6.3M CAD (2018-23, PI Bellec) donation from the Courtois foundation. These funds are administered by the Fondation Institut Gériatrie Montréal (FIGM), part of CIUSSS du Centre-Sud-de-l'île-de-Montréal, as well as University of Montreal. Courtois NeuroMod also includes support for two separate consortia, called CIMAQ (early identification of Alzheimer's disease), and PRISME (looking for brain correlates of the evolution of symptoms in individuals with psychosis) based at the Institut Universitaire en Santé Mentale de Montréal (IUSMM).

7.3 Team

7.3.1 Core

- Pierre Bellec, Scientific Director (CRIUGM, Psychology, UdeM, Québec, CA).
- Julie A Boyle, Project Manager (CRIUGM, Québec, CA).
- Arnaud Boré, Data manager (CRIUGM, Québec, CA).
- André Cyr, Engineer (UNF & CRIUGM, Québec, CA).
- Basile Pinsard, Data Manager (CRIUGM, Québec, CA).

7.3.2 Modelling

- Guillaume Lajoie, Principal Investigator (Mathematics, UdeM & MILA, Québec, CA).
- François Paugam, PhD Student (CRIUGM & DIRO, UdeM, Québec, CA).
- Yu Zhang, Post-Doctoral Fellow (CRIUGM, IVADO & Psychology, UdeM, Québec, CA).
- Amal Boukhdhir, PhD Student (CRIUGM & DIRO, UdeM, Québec, CA).
- Tristan Glatard, Principal Investigator, Collaborator (Computer Science and Software Engineering, Concordia University, Québec, CA).
- Shima Rastegarnia, Master's Student (CRIUGM & DIRO, UdM, Québec, CA)
- Loic Tetrel, Data Scientist (CRIUGM, Quebec, CA).
- Elizabeth DuPre, PhD Student, Collaborator (McGill University, Québec, CA).

7.3.3 Vision

- Sana Ahmadi, PhD Student (CRIUGM & Concordia, Québec, CA).
- Marie Saint-Laurent, Research Professional (CRIUGM, Québec, CA).
- Martin Hebart, Principal Investigator, Collaborator (Max Planck Institute for Human Cognitive and Brain Sciences, Germany).
- Katja Seeliger, Post-Doctoral Fellow, Collaborator (Max Planck Institute for Human Cognitive and Brain Sciences, Germany).

7.3.4 Memory

- Sylvie Belleville, Principal Investigator (CRIUGM & Psychology, UdeM, Québec, CA).
- François Nadeau, Bachelor Student (Psychology, UdeM, Québec, CA).
- Pravish Sainath, Master's student (DIRO, UdeM & MILA, Québec, CA)

7.3.5 Emotions

- Pierre Rainville, Principal Investigator (CRIUGM & Stomatology, UdeM, Québec, CA).
- François Lespinasse, Master's Student (Psychology, UdeM, Québec, CA).

7.3.6 Language

- Simona Brambati, Principal Investigator (CRIUGM & Psychology, UdeM, Québec, CA).
- Valentina Borghesani, Post-Doctoral Fellow (CRIUGM, IVADO & Psychology, UdeM, Québec, CA)
- Leila Wehbe, Principal Investigator, Collaborator (Carnegie Mellon University, USA).
- Mariya Toneva, PhD student, Collaborator (Carnegie Mellon University, USA).

7.3.7 Audition

- Adrian Fuente, Collaborator (CRIUGM & Audiology, UdeM, Québec, CA).
- Nicolas Farrugia, Collaborator (IMT Atlantique, France).
- Maëlle Freteault, PhD student (IMT Atlantique, France & Psychology, UdeM, Québec, CA).
- Peer Herholz, Post-Doctoral Fellow, Collaborator (McGill University, Québec, CA).
- Eddy Fortier, Msc student (Psychology, UdeM, Québec, CA).

7.3.8 Video games

- Maximilien Le Clei, Research Professional (CRIUGM & DIRO, UdeM & MILA, Québec, CA).
- Anirudha Kemtur, Master's Student (CRIUGM & DIRO, UdeM & MILA, Québec, CA).
- Karim Jerbi, Principal Investigator (CRIUGM & Psychology, UdeM, Québec, CA).
- Yann Harel, PhD Student (Psychology, UdeM).

7.3.9 MRI sequences

- Julien Cohen-Adad, Principal Investigator (CRIUGM & Polytechnique Montréal).
- Agâh Karakuzu, PhD Student (Polytechnique Montréal).

7.3.10 Other collaborators

- Tamara Vanderwal (University of British Columbia, Vancouver, CA).
- Christopher Steele (Concordia University, Québec, CA).
- Jean-Baptiste Poline (McGill University, Québec, CA).

7.4 Alumni

- Eva Alonso Ortiz, Post-Doctoral Fellow (Polytechnique Montréal).
- Norman Kong, Bachelor Student (McGill, Québec, CA).
- Samie-Jade Allard, Bachelor Student (Psychology, UdeM, Québec, CA).
- Jonathan Armoza, Research Associate (CRIUGM, Québec, CA & NYU, US).
- James Martin Floreani, Summer Intern 2019 (École Polytechnique, France).
- Paul-Henri Mignot, Research Associate 2018-19 (CRIUGM & IMT Atlantique, France).

CHAPTER

EIGHT

HOW TO ACKNOWLEDGE

We kindly ask that all publications using the cneuromod data include the following paragraph in their acknowledgement section:

> The Courtois project on neural modelling was made possible by a generous donation from the Courtois foundation, administered by the Fondation Institut Gériatrie Montréal at CIUSSS du Centre-Sud-de-l'île-de-Montréal and University of Montreal. The Courtois NeuroMod team is based at "Centre de Recherche de l'Institut Universitaire de Gériatrie de Montréal", with several other institutions involved. See the cneuromod documentation for an up-to-date list of contributors (https://docs.cneuromod.ca).

In addition, we encourage you to include the name of the cneuromod data release used in the analysis (e.g. cneuromod-2020), as well as any relevant excerpt from this documentation. Although some journals flag reproductions of technical documentation as plagiarism, using a standardized wording help consistency and reproducibility in the literature. Please reproduce this documentation verbatim to the greatest extent possible, and justify to the editor that this practice does not fall under plagiarism. Note that multiple versions of the documentation exist, one for each cneuromod release, so please make sure to use excerpts from the correct version of the documentation, matching the data release used in the analysis.

8.1 Reference

Link to the OHBM 2020 poster here

Link to the OHBM 2020 abstract here

Boyle, J.A., Pinsard, B., et al. (June 2020). The Courtois project on neuronal modelling - 2020 data release. Poster 1939 was presented at the 2020 Annual Meeting of the Organization for Human Brain Mapping, held virtually.