UNIVERSITY OF MONTREAL

FINAL REPORT

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WORK PRESENTED TO BRAINHACK SCHOOL 2019 INSTRUCTORS STAFF
DANS LE CADRE DU COURS (NUMÉRO DU COURS)
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References

Caillaud, M. (2019). *CIMAQ et prodrome Alzheimer.* Montreal.

davedittrich. (2019, September 6). *python-secrets 19.9.0*. Récupéré sur Python Software Foundation: https://pypi.org/project/python-secrets/

Final report

High-level summary of the project

Subject must recognize target image and remember its position during the encoding phase.

Associative memory score = correct source / (wrong source + false alarms)) (Caillaud, 2019). Each trial comprises 2 phases:

A) Encoding: series of 8 image each shown in a quadrant.

B) Recall: 7 images (6 new distractor images plus a target image seen during encoding phase. Total images per trial: 8 encoding stimuli + 6 distractors + 1 target = 15).

Possible answers:

True Positive - correct recognition, correct source	**Type 1 Error, False Positive** - correct recognition, incorrect source - incorrect recognition
True Negative - correct rejection	**Type 2 Error, False Negative** - incorrect rejection

Table 1: Associative memory score = correct source / (incorrect source + false positive)

Project definition

Project goal was to program a fully operational memory task experiment in psychology, designed to assess both brain activity metrics (fMRI in this case) and behavioral metrics (associative memory score). Using Python programming language and Psychopy, a psychology experiment conception Python library, the code would randomly select images for each set (encoding, distractors, targets) for every trial. Each trial would self-initialize at the end of the preceding one, and participant's answers would be saved to disk for each trial. The associative memory score would be calculated by a function at the end of each session and returned as output in a Pandas "DataFrame". This project was more of an exploratory project rather than a research project, even though a lot of research was needed to complete it. Thus, no research question nor hypothesis were generated.Computer programming serves as the interface of the two disciplines (psychology for the behavioral data and neuroscience for the fMRI data). For example, it is through computer

programming that one is able to initialise a behavioral task in synchrony with different kind of brain activity measurement devices. A brief description of what is cognitive neuroscience is available in an animated PowerPoint presentation on the GitHub repository (see link in README.md). In the case of Brainhack School, the real main objective has been to learn and develop (computational) cognitive neuroscience related skills, methodology and technologies.

Learning experience

Until following updates, the code will be restricted to the behavioral task (image and position recognition) instead of being suitable for both fMRI and behavioral experiments. Several aspects were severely modified in order to fit with the main NeuroMod project (more work still needed). The pipeline to select the image sets for each condition (encoding, target and recall) randomly across each trial for each session and subject has proven challenging. After repeating the experiment several time, some images seemed to be preferred to others by the image selection pipeline. Some images. Indeed, Python's default module 'random' used to generate random value is only able to generate pseudo-random values. Instead, the module 'secrets' (davedittrich, 2019) was used, as it is generating cryptographically secure random numbers, which can be used to generate passwords and other confidential operations. With 'secrets', the random values are sourced from the system's best randomness source (thus quality of randomization depends on the OS used). The function meant to return associative memory score as output in a data frame still needs to be implemented. Also, the code will need to be edited for readability (some lines exceed the Python Software Foundation's 78 characters per line recommended limit). Some variables could be written in a simpler way in an upcoming update.

Results

For now, the project is a working prototype of the CIMA-Q memory task. Each trial runs smoothly, only the associative memory score of each participant cannot be computed yet. A GIF file showing the unfolding of a 2 trials session is available on the repository. The code for the experiment demo and each pre-processed image for every image category used during the experiment can be found in the same repository. A brief presentation on what is cognitive neuroscience (intended for general public) is also available. In the case other image categories are needed, one can download any category from the 10 000-image database by following the link in the README.md file. The square_resize.py function can also be used to resize images into square aspect-ratio of any size.

Although more work is needed on the image pre-processing pipeline (some images rotate orientation after being resized), it is operational. Only 3 categories are available on GitHub to avoid excessive repository size. The code of the main frame for NeuroMod's memory task can be found by following the respective link in the README.md file. It is planned to bring several adjustments to the memory task code in upcoming updates to fit with the main frame.