**Research question**

**Hypothesis 1A:** For neural data we have the MEG data where participants viewed realistic images (shown below). Using an image oriented neural network (NN) the plan is to train it separately on the following groups of images and obtain the embeddings: **(i)** the original image as is, **(ii)** the foreground object only and **(iii)** the background of the image. The goal is to then compare (using a similarity score) the NN embeddings to the MEG data to determine which group is most similar to the neural data. The hypothesis is that the original image embedding of the NN is the most similar to the MEG data, with the object only image being close in similarity and the background image being last in similarity. The ultimate goal with this hypothesis is to see how dissimilar the background embeddings from the NN are to the MEG data as this could indicate how much the participant is focusing on the non focal parts of the image.

**Hypothesis 1B:** In the event that the foreground or background only NN embeddings are most similar to the MEG data, the intention is to determine the ratio of foreground to background in the image to get an indication of whether these embeddings are more similar because they comprise a larger portion of the image. This could give us an indication that the focal object of the image is not of most prominence, but instead what the image is mostly composed of e.g. background.

**Hypothesis 2:** This is an optional hypothesis if I have time after implementing the above hypotheses or if they do not produce fruitful results. Using a generative neural network the goal is to use the embeddings from the three trained NNs above (i original, ii foreground, iii background) and to generate new images. The hypothesis would be that the NN should produce generated images similar to those it was trained on i.e. trained on background images the NN should generate mostly background images.


**Dataset**

The dataset comprises of magnoencephalography (MEG) data obtained from 4 participants with 272 channels each. During the study participants looked at sample images such as those indicated above. There were a total of 22,248 images from the THINGS dataset including 1,854 different object categories and the first 12 images from each of those categories were used as stimuli and presented once to each participant. Interleaved between stimuli images, which were presented for 0.5s, there was a grey fixation image, presented for $1 \pm 0.2s$. All stimuli images had a fixation crosshair overlaid on the center of

the image. There was a separate dataset of 200 images that were presented several times to participants and used as a test set for model evaluation.

**Proposed method**

The methods used in this project included MEG data, an image classification neural network such as AlexNet or VGG, and optionally an image generation network.

**Expected results**

For hypothesis 1A the expectation is that the original image NN embeddings should be most similar to the MEG data. If that is not the case and either the foreground or background embeddings are the most similar, as in hypothesis 1B, the expectation is that images with a more prominent/ interesting background or foreground would be the cause the for embeddings being more similar to the MEG data. This is because though the object is the focus of the image and participants are instructed to fixate in the center at the crosshair, if the majority of the image is background the participant may be taking in involuntary peripheral information. For hypothesis 2 the NN is expected to generate images similar to the dataset it is trained on.

**Contingency for unexpected results**

Plan 1: In the event there is no difference between the model representation of the background, foreground and original images an additional investigation will be done. A probe into whether background images with more context i.e. scenery such as the cactus and canoe images when separated and compared to the images with less background i.e. clove and coconut whether there will be a significant difference. In this event a case could be made for participants not particularly focusing more on the object versus the background, but on how interesting the totality of the image is.

Plan 2: If the above does not pan out, there was an additional 100 synthetic impossible images presented to the participants. This dataset could be used in comparison to the realistic images mentioned above. In this instance the realistic MEG data would be compared to the impossible MEG data to obtain a distance score. The same would be done for the neural nets, the embeddings from the impossible images would be compared to the realistic images to obtain a distance score. The research outcome would be to determine whether both groups have a comparable distance score when comparing realistic versus impossible images.

**Reference**

Martin N Hebart, Oliver Contier, Lina Teichmann, Adam H Rockter, Charles Y Zheng, Alexis Kidder, Anna Corriveau, Maryam Vaziri-Pashkam, Chris I Baker (2023) THINGS-data, a multimodal collection of large-scale datasets for investigating object representations in human brain and behavior eLife 12:e82580. https://doi.org/10.7554/eLife.82580