Background:

Brain activity patterns can be predicted based on the types of images shown

Question: Do brain activity patterns for visual input processing depend solely on the static visual content of the videos, or audio input as well as the dynamics of the visual input (or some other features)?

Possible features:

1. Sound
2. Speed
3. Motion
4. Direction
5. Distance?
6. Brightness?

Applying the findings of the k dataset whether threshold of sound is possible to predict what kind of videos the subject is watch

Would there be a significant change in brain activity

Hypothesis: Given visual information, would brain activity be significantly different in the visual processing areas (e.g. V1, V2, V3) in the presence of sound information?

Context: In the Kay dataset paper, https://www.nature.com/articles/nature06713, the authors extract features from brain activity in subjects viewing categorized images, then mapping those features to categories with a model. They then let the subjects view images in a blinded experiment, then try to have the model reverse-predict the category of images being viewed just by looking at the brain activity.

Here, we try to take the findings one step further, including sound information as a variable. Specifically, given the same **semantic category** of videos, we compare *brain activity differences* in the visual processing areas when subjects are looking at videos with audio above a threshold vs. audio below a threshold (e.g. volume, frequency etc.).

Project Proposal

Scientific Background: The neuroscience community generally accepts the Massive Modularity Hypothesis as the theory behind the organization and operation of the human brain, that it is functionally modular & discrete in nature, such that each discrete region of the brain specializes in a certain task. However, the hypothesis is subject to criticism, one of the arguments being that all parts of the brain are highly connected, showing little signs of isolation, even between interneurons in one specialized region with that of another specialized region. Therefore, we are interested in whether neurons that are perceived to belong to localized “specialist” regions are also used to perform computations outside of their specialty. Namely, we study the question of whether audio information is processed in the visual cortex.

Scientific Question: Given visual information, would brain activity be significantly different in the visual processing areas (e.g. V1, V2, V3) in the presence of sound information? Are there significant connectivity between the auditory nuclei and visual processing nuclei, which affects visual processing?

Approach: Using the Algonauts dataset, first we categorize the videos into 2 variable groups pertaining to the hypothesis: audio > threshold vs. audio < threshold, where the metric is yet to be decided (e.g. volume, frequency spectrum power etc.), but should be one that has experimentally been proven as a significant stimuli to the auditory cortex.
Then, we further categorize those videos into their respective semantic categories (e.g. human, train, animal etc.). By using fMRI brain activity of a given subject-category combination as a baseline, we determine if the fMRI brain activity of the same subject-category would be significantly different if the video has sound properties > threshold. Specifically, we concentrate on 9 ROI from the Algonauts dataset (i.e. V1, V2, V3, V4, LOC, EBA, FFA, STS, PPA).

Open Questions:

1) What would be the implications of our findings? That is, if we find that audio information is indeed also processed in the so-called visual nuclei, what are the potential effects on current beliefs about brain modularity?
2) Is the Algonauts dataset the best current choice for our hypothesis? Can we find a dataset with more appropriate control variables? Preferably, one that has subjects watching the <u>same video on different sessions where audio is on vs. where audio is off.</u>

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