Python Project Report

Daniil Sergeyenko 212925853

Introduction

This project investigates the neural correlates of different emotions, specifically examining whether opposing emotional states (positive versus negative) demonstrate mutual suppression in brain activation patterns. The project utilized open-source fMRI data from 40 participants collected in India.

Methods

The data was preprocessed by the original authors before uploading. This includes cleaning and artifact removal. The pipeline is function-based for easy reusability with different research questions on the same dataset. The current pipeline is intended to be used as a backbone and as a preliminary investigation for specific ROIs to be used in future projects on the same data. A checkpoint saving/loading prevents redundant repetition of processing in case a point change is to be made.

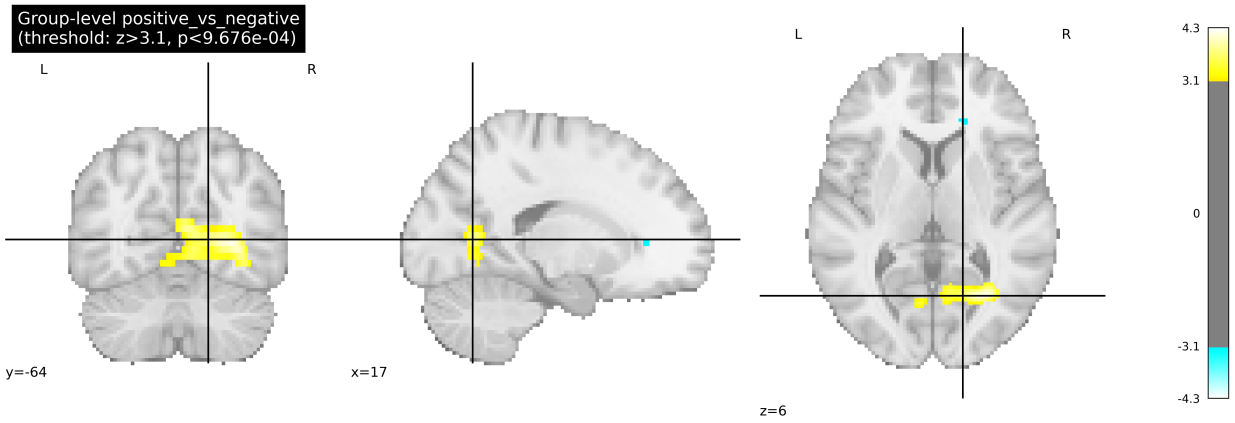
The original data specifies four different emotions groups in addition to a baseline ‘neutral’, which I shrunk down to two; positive and negative plus the baseline. A full-brain functional BOLD score contrasts are compared between the three groups. Each event in the original data is 30 seconds long with 30 seconds rest in between. For simplicity I averaged the functional score of each epoch. Further averaging took place when combining the two different emotions in each group: positive and negative. Such contrasts are calculated within all 40 participants and then between to increase the statistical power. Due to a good amount of averaging I felt confident in using basic t-tests with a standard threshold of $z > 3.1$ and between group fwhm smoothing of 8 for the final analysis.

Results

As might be expected, when comparing contrasts of the positive and negative groups to the baseline we see very similar activation patterns. After all each group is the sum of two different emotions. We see the strongest activation in the prefrontal cortex (specifically the dorso-lateral prefrontal cortex), anterior cingulate and basal ganglia.

Comparison against baseline:

Notice the reduced activity at the deep occipital/parietal lobes in the negative/neutral contrast, as we see it again more significantly in the positive/negative contrast:



Indeed, as the research question suspected there is a significant difference between the activation pattern of the positive group versus the negative group. Namely, an increase in activation in the deep occipito-parietal areas and the anterior cingulate – respectively.

Significance

This analysis provides several important insights into the neural basis of emotional processing, particularly in the anterior cingulate, dlPFC, and deep occipito-parietal areas. These regions, notably associated with Default Mode Network (DMN) function, show differential activation patterns between positive and negative emotional states. These areas are also known to be involved in theory of mind (TOM) which makes sense considering that the emotion invoking scenes the participants saw were of other people. The results were compared to landmark studies by Menon Et. Al. and Satpute Et. Al. in order to test their validity. Detailed images are in the attached .pptx I presented to David and Hemda.

Further analysis of the same data can focus on the regions of interest that were highlighted in this preliminary design. Combined with and advanced GLM method, a far superior resolution of activation patterns could be produced. Also, the four emotional groups could be analyzed separately and provide even better neural distinction between emotions.

Bibliography

Menon, V. (2011). Large-scale brain networks and psychopathology: A unifying triple network model. *Trends in Cognitive Sciences*, *15*(10), 483–506. https://doi.org/10.1016/j.tics.2011.08.003

Satpute, A. B., & Lindquist, K. A. (2019). The Default Mode Network's Role in Discrete Emotion. *Trends in Cognitive Sciences*, *23*(10), 851–864. https://doi.org/10.1016/j.tics.2019.07.003