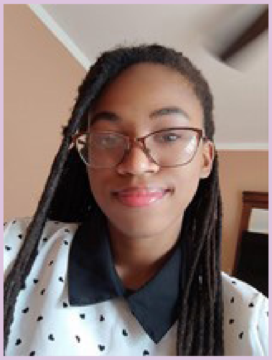
Simons Center MSRP Summer students



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Project: Using deep neural network (DNN)-based encoding models to reveal functional dissociations with the human visual scene processing network

Keywords: fMRI, Machine Learning, Cognitive Neuroscience, Vision, data analysis, DNN-encoding models

As a student in the Kanwisher Laboratory, my research focused on understanding the functional roles of two brain regions involved in visual processing, namely the parahippocampal place area (PPA) and the occipital place area (OPA). These regions are known to respond selectively to visual scenes as compared to other stimuli, but their specific functions have not been fully explored.

Tsehai and Nancy Kanwisher.
Photo courtesy of Mandana Sassanfar

To investigate this, I adopted a data-driven approach and trained deep neural network-based encoding models to understand the unique characteristics of the PPA and OPA. Using functional magnetic resonance imaging (fMRI), I found that these models accurately predicted responses to new stimuli held-out from the training data in both the PPA and OPA.

The findings were highly specific to each brain region, as the model-PPA performed better in predicting PPA data than OPA data, and vice versa for the model-OPA. This demonstrated the predictive power and specificity of the encoding models for each region.

Tsehai presenting at the MSRP Poster Session.
Photo courtesy of Mandana Sassanfar

I used the encoding models to generate hypotheses further to explore the functional differences between the PPA and OPA. By analyzing predictions on a large dataset of 1.5 million images, I found that scenes strongly drove both the PPA and OPA, providing strong validation for their scene selectivity.

Additionally, the models helped identify specific image features that differentiated the activation patterns of the PPA and OPA. Images with clear rectangular spatial layouts strongly activated the PPA, while images depicting the inside of airplanes or buses with ordered, repeating objects and a clear navigational path activated the OPA.

Moving forward, I plan to test these model-predicted images in the brain with fMRI to validate and further explore the findings. This research has provided computationally-precise models of the PPA and OPA, shedding new light on the functional distinctions between these brain regions involved in visual scene processing.