Assignment-1:

Title: Using the lookalike-objects dataset, characterize the representational profile in ventrotemporal regions (V1, VTC_post, and VTC_ant) with regard to specific animal and tool identities. Do the activation patterns associated with the 9 lookalike objects generalize to its corresponding animal (e.g. whether cow-shaped mug is represented similarly to a real cow, etc.) and/or to its corresponding object identity (cow-shaped mug to the mug, etc.)?

Introduction: A key component of cognitive neuroscience is comprehending the neural representation of items in the human brain. Humans can successfully navigate and interact with their surroundings when they are able to discern between an object's identity and appearance. This research attempts to separate brain representations that represent an object's appearance from representations that represent its identity (animacy and function). In particular, we examine whether activation patterns linked to similar things extend to animals and/or inanimate objects in the ventrotemporal areas of the brain (V1, VTC_post, and VTC_ant).

Distinct subregions of the ventrotemporal cortex (VTC), which processes distinct aspects of visual input, are known to be involved in object recognition. Based on earlier studies, it appears that the VTC's anterior (VTC_ant) and posterior (VTC_post) regions have different functions when it comes to distinguishing between alive and inanimate items. Furthermore, the primary visual cortex (V1) serves as the first cortical area to process visual information, laying the groundwork for more intricate object recognition procedures in higher-order visual areas.

Nine object triads—each having an animal, an inanimate object, and a lookalike object that mimics the animal but retains the identity and functionality of the inanimate object—make up the specifically created stimulus set used in our study. Our goal is to establish whether the activation patterns triggered by lookalike objects extend to their equivalent animals and/or inanimate objects, and to define the representational profiles in the VTC and V1 areas using a 9-way multiclass decoding approach.

We used a one-vs-one classification (OvO) method in the first section of our research to interpret patterns of brain activity. To ascertain whether these patterns might be used generally, we evaluated their importance. According to our research, VTC regions—anterior and posterior—show substantial generalization to similar animals, while V1 does not. On the other hand, substantial generalization to inanimate things is shown in all three regions, including V1.

These findings point to different functions for VTC and V1 in the perception of object identification and appearance. Higher-order representations that distinguish between living and non-living items on the basis of both identity and appearance seem to include VTC regions more. V1 is more sensitive to the fundamental aspects of vision that enable the identification of inanimate things, in contrast.

Through the investigation of these neurological systems, our work advances our knowledge of how the human brain interprets complicated visual stimuli and makes the distinction between identity and appearance. This information could help create artificial intelligence systems that replicate human vision and have ramifications for the development of more complex object recognition models.

Methodology:
Multiclass classification Method

The method of classifying brain activity patterns related to the objects that looked alike was a multiclass (9-way) decoding approach. To decipher the brain responses, a One-vs-One (OvO) classification technique was specifically used. This approach entails training classifiers to discern between every pair of classes, guaranteeing a strong assessment of the brain activity patterns' ability to generalize to various stimuli.

ROI Evaluation

Three important areas of interest (ROIs) in the ventrotemporal cortex and primary visual cortex were the focus of the analysis:Primary Visual Cortex (V1), Anterior Ventrotemporal Cortex (VTC_ant), and Posterior Ventrotemporal Cortex (VTC_post)

Results:

Our multiclass classification research yielded valuable insights into the processing of object appearance and identity by distinct ventrotemporal cortical regions (V1, VTC_ant, and VTC_post). In comparison to the related animals and inanimate items, we assessed the relevance of the brain activity patterns linked to lookalike objects.

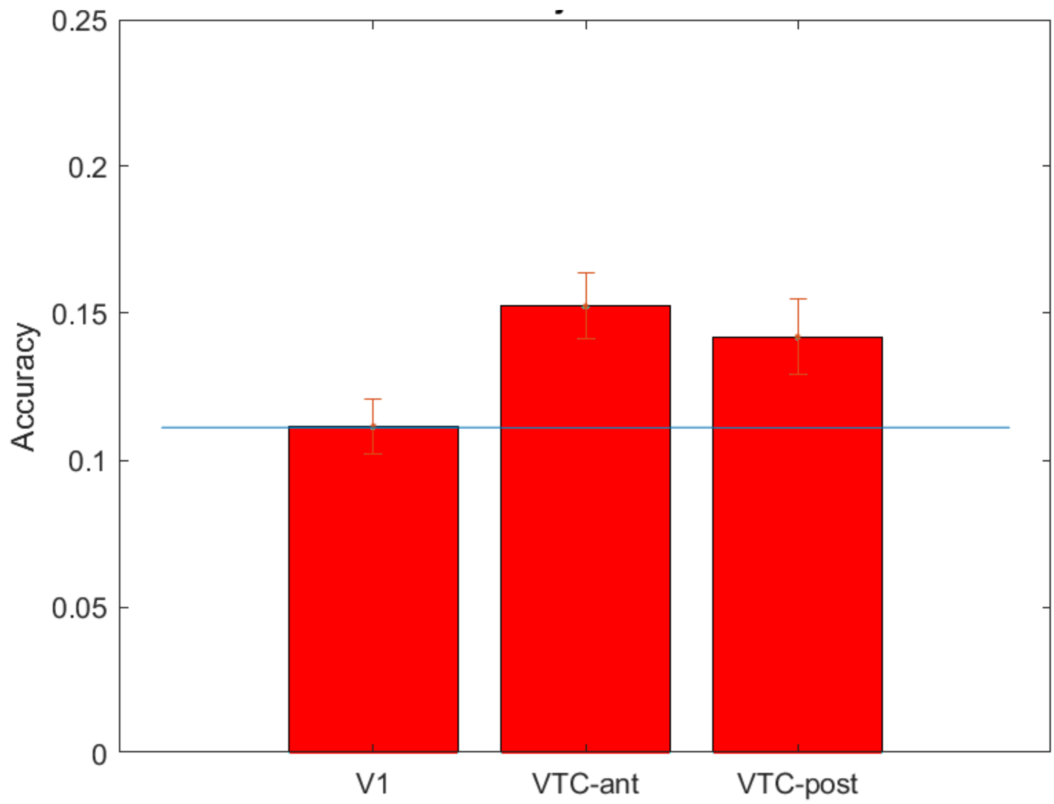

Figure-1: One vs One classification(OvO) for trained on lookalike objects and tested on animals

When trained on similar objects and evaluated on corresponding animals, the classification accuracy for V1 did not significantly differ (p = 0.4839). This suggests that V1 does not considerably transfer the neural patterns from objects that resemble one another to the associated animals. V1, which is mostly engaged in early visual processing, might not be able to distinguish between actual animals and lookalike objects based on higher-order visual traits.

ROI	Significant or not	P-value	Alpha level
V1	0	0.4839	0.05
VTC_ant	1	0.0018	0.05
VTC_post	1	0.0167	0.05

Figure-2: Significance Test for Trained on lookalike objects and tested on animals

At p = 0.0018, the classification accuracy for VTC_ant was statistically significant. This implies that the neural patterns from lookalike objects are successfully generalized to their equivalent animals by VTC_ant. Higher-order visual processing is linked to VTC_ant, which seems to encode fine-grained visual cues that enable it to distinguish between objects based on appearance and animacy. At p = 0.0167, the classification accuracy for VTC_post was likewise noteworthy. This suggests that, like VTC_ant, VTC_post is also capable of generalizing neural patterns from similar items to the equivalent animals. VTC_post can process and discern fine-grained visual information since it is involved in visual object recognition.

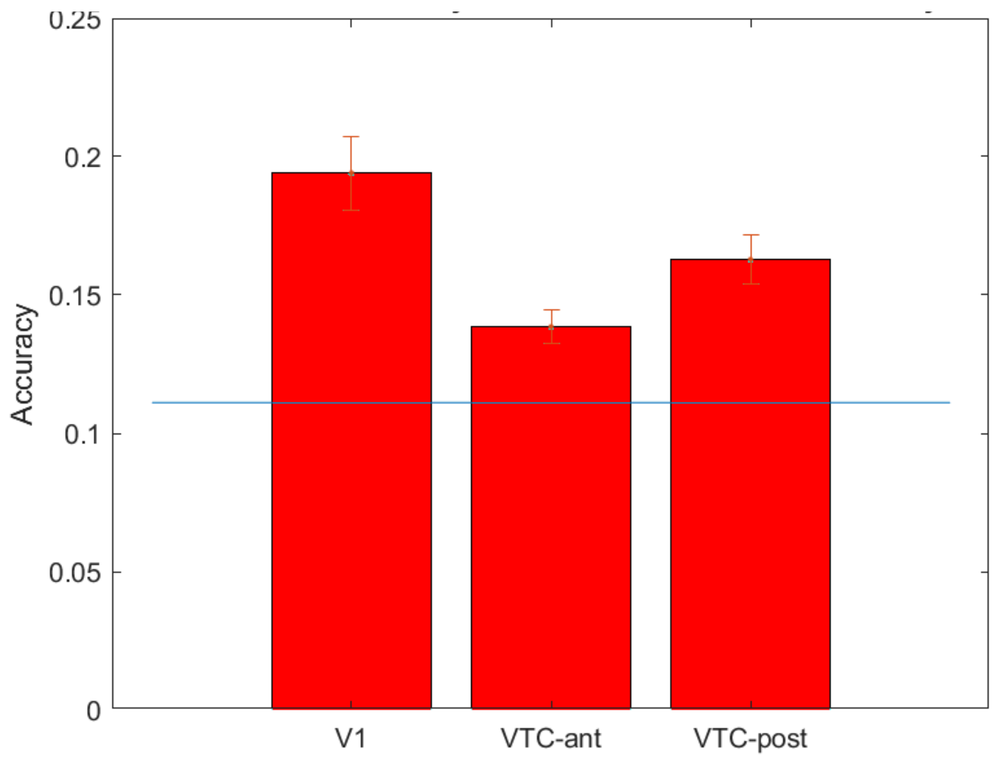

Figure-3: One vs One classification(OvO) for trained on lookalike objects and tested on inanimate objects

ROI	Significant or not	P-value	Alpha level
V1	1	0.00003	0.001
VTC_ant	1	0.00035	0.001
VTC_post	1	0.000067	0.001

Figure-2: Significance Test for trained on lookalike objects and tested on inanimate objects

The classification accuracy for V1 was statistically significant at a high level (p = 0.00003). This significant finding suggests that V1 has the ability to apply brain patterns learned from like items to their comparable inanimate objects. The outcome implies that V1 is responsible for processing fundamental visual characteristics that are adequate for identifying non-living things. The classification accuracy for VTC_ant was statistically significant with a p-value of 0.00035. This suggests that VTC_ant successfully applies neural patterns from similar things to their respective non-living counterparts. This indicates that VTC_ant incorporates both visual characteristics and individual attributes in its cognitive processing. The classification accuracy for VTC_post was highly significant (p = 0.000067). The study demonstrates that VTC_post is capable of extrapolating neural patterns from similar things to their respective inanimate objects, emphasizing its significance in precise object recognition.