Data-driven clustering of neural responses to a large set of natural images

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Question

How can we characterize the space of the brain's visual representations?

➔ Employ data-driven k-means clustering to identify qualitative properties of images that give rise to characteristic clusters of activation patterns.

Methodology

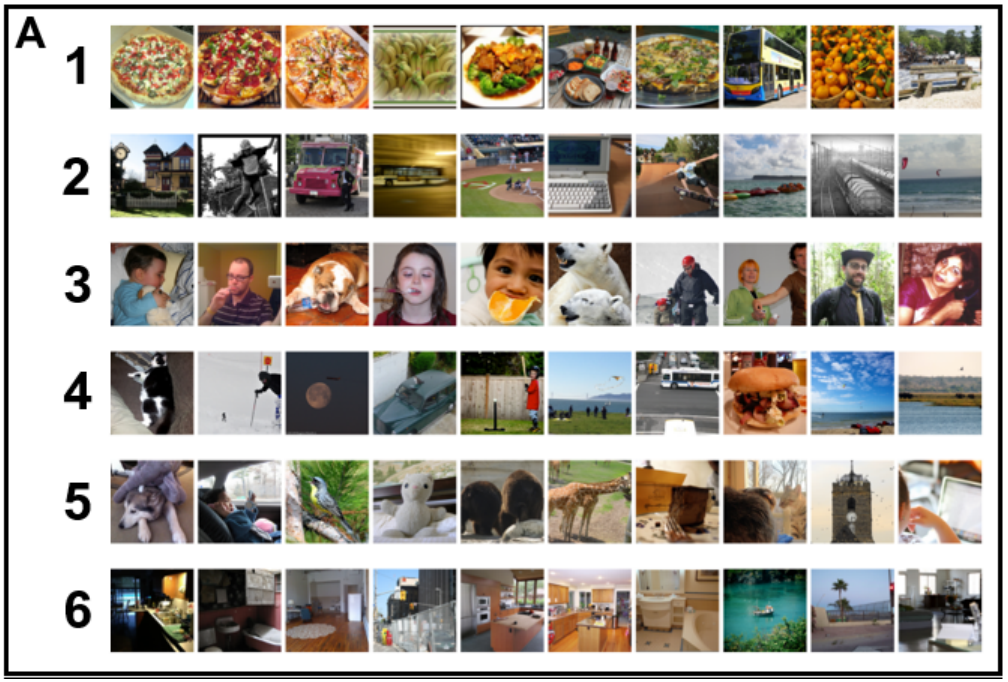
-Natural Scenes Dataset (Allen *et al*., 2021)

-7T whole-brain, high-resolution fMRI of eight healthy subjects, collected over a year's time (30-40 sessions, 60 mins each)

-Subjects were shown 9,000-10,000 images from the COCO dataset

-After parcellation, data consisted of 22,500-30,000 neural response vectors of dimension 23-28

-K-means clustering (k=6) with correlation distance to identify groups of similar brain responses across individuals and images



Findings

Looking at the top 10 and 100 images closest to each centroid, we can ascertain markedly distinct themes amongst the clusters.

We consistently find that the clusters divide into images of 1) food/high frequency patterns, 2) bodies/outdoor scenes, 3) faces, 4) sky/landscapes, 5) animals, and 6) downward-facing/indoor scenes.

We confirm these observations quantitatively by counting the labels of the images (e.g. there are around 50 times more instances of broccoli in the first cluster, etc.) and moreover provide visualizations of these counts in the form of wordclouds.

We verify the clusters' consistency by computing correlations between centroids for various values of k and across subjects, finding in nearly all cases strong correlations (greater than .8).