Variance partitioning reveals consistent representation of object boundary contours in LO across different datasets

Studies have shown that intermediate-level visual areas including Lateral Occipital cortex (LO) represent information about object boundaries. However, because most studies use tightly controlled stimuli (e.g. stimuli with contours and no motion or vice versa), it is unknown how important object boundary contours are relative to other features such as motion and visual categories. To address this issue, we measured fMRI responses while human subjects viewed two sets of movies that varied in many feature dimensions: rendered movies of artificial scenes and cinematic movies. We modeled responses to both sets of movies independently using the same three models: models of motion energy, object boundary contours, and visual categories. In the rendered movies, we used the parameters of the virtual world to label boundary contours, and in the cinematic movie clips, we used a customized version of a recent convolutional neural network (DeepLab v2,) to label contours. We used the encoding models for each type of feature to predict withheld fMRI data, and used variance partitioning to determine whether the various models explained unique or shared variance in each dataset.

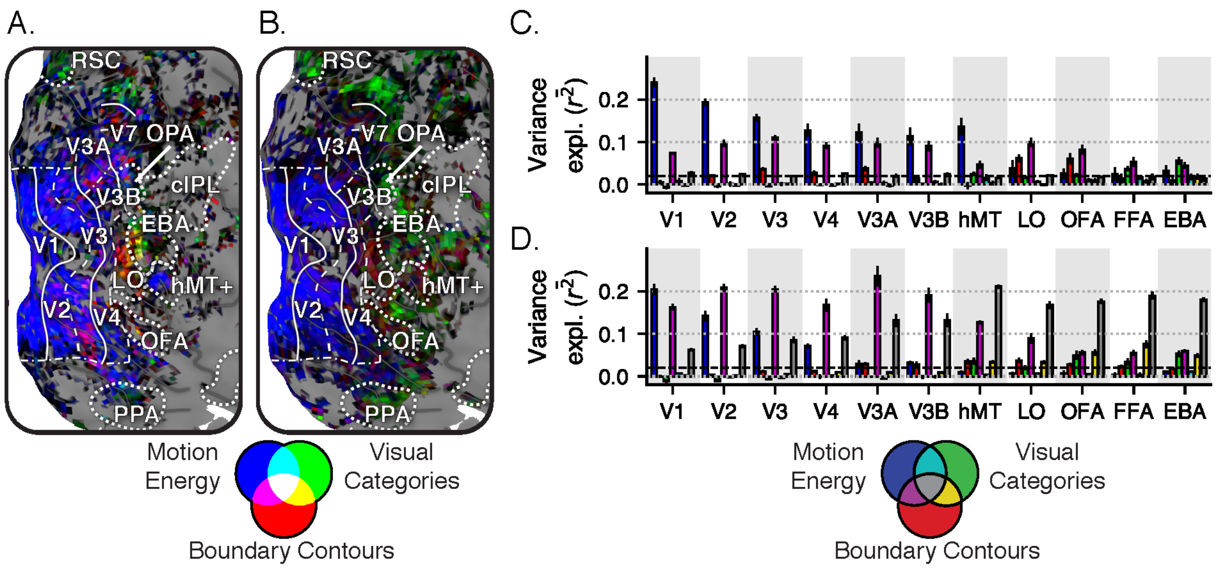

Figure 1: Shared and unique variance predicted by each model. **A.** Unique variance explained by each model in responses to rendered images. Red, green, and blue indicate unique variance explained by the boundary contour, visual category, and motion energy models, respectively. Intermediate colors (e.g. yellow) indicate unique variance explained by multiple models. **B.** Unique variance explained by each model in responses to cinematic movies. Conventions as in (A). **C.** Unique and shared variance by region of interest for rendered movies, averaged across six subjects. Error bars are SEM across subjects. Intermediate colors indicate shared variance between models. **D.** Same as (C), for natural movies.

The pattern of unique variance explained by the three models was qualitatively consistent across both datasets (Figure 1A, B). However, the three models also shared substantially more variance in the cinematic movies (Figure 1C, D), likely due to correlations between model features. For example, much of the motion energy in the cinematic movies was a result of people moving. The shared variance between all three models in the natural movies in particular highlights the need for complex stimulus sets in which features in different models are de-correlated from each other. Nonetheless, the consistent finding of unique variance explained by the boundary contour model in LO in two entirely different datasets provides strong evidence that LO represents boundary contours independent of motion energy or visual categories.