The temporal dynamics of hierarchical object relationships

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Exploring the factors that guide human attention in real-world environments is a fundamental challenge in cognitive neuroscience. Prior behavioral research suggests that within complex scenes, objects form meaningful subunits which can be referred to as *phrases*. Each of these phrases comprises an *anchor object,* typically a prominent object that imparts diagnostic information about nearby *local objects* that cluster around it. In this study, we aim to unravel the neural basis of the hierarchical structure of object relationships within scenes and explore its temporal dynamics. Employing electroencephalography (EEG), we presented participants with anchor and local objects that belonged to four different phrases within kitchen and bathroom scenes. Our central hypothesis posited that neural activation patterns of objects belonging to the same (1) phrase and (2) scene would exhibit greater similarity to each other than objects derived from disparate phrases or scenes. Moreover, we hypothesized that the proposed hierarchical structure unfolds over time. We applied representational similarity analysis (RSA), predicting neural representational dissimilarity matrices (RDMs) from RDMs that correspond to the assumed hierarchical object-to-object relationships. Our results show that this predictor RDM successfully predicts the representational dissimilarity of viewed objects. Examining predictors individually, we observe that scene, phrase, and object category all significantly predict neural activation patterns. Notably, object category emerges the earliest and accounts for most variance. In sum, our results offer valuable insights into how real-world object relationships might give structure to the neural processing of objects within scenes, shedding light on the intricate dynamics of visual scene processing.

Keywords: scene-object relationship, object representations, scene grammar, scene hierarchies, representational similarity analysis, electroencephalography