

Disentangling neural mechanisms for perceptual grouping

Junhyung Kim[†] (junhyung_kim@brown.edu)

Drew Linsley[†] (drew_linsley@brown.edu)

Kalpita Thakkar (kalpita_thakkar@brown.edu)

Thomas Serre (thomas_serre@brown.edu)

Carney Institute for Brain Science
Department of Cognitive Linguistic & Psychological Sciences
Brown University

Abstract

Forming perceptual groups and individuating objects in visual scenes is an essential step towards visual intelligence. This ability is thought to arise in the brain from computations implemented by bottom-up, horizontal, and top-down connections between neurons. However, the relative contributions of these connections to perceptual grouping are poorly understood. We address this question by systematically evaluating neural network architectures featuring combinations of these connections on two synthetic visual tasks, which stress low-level “gestalt” vs. high-level object cues for perceptual grouping. We show that increasing the difficulty of either task strains learning for networks that rely solely on bottom-up processing. Horizontal connections resolve this limitation on tasks with gestalt cues by supporting incremental spatial propagation of activities, whereas top-down connections rescue learning on tasks featuring object cues by propagating coarse predictions about the position of the target object. Our findings disassociate the computational roles of bottom-up, horizontal and top-down connectivity, and demonstrate how a model featuring all of these interactions can more flexibly learn to form perceptual groups.

Keywords: Perceptual grouping; recurrent feedback; segmentation; illusions.

Comment to reviewers

This work is currently under submission at NeurIPS. We originally prepared a version of this work for CCN that included figures and methods/results sections. But we received advice from the NeurIPS chair that because CCN submissions have DOIs they violate the NeurIPS dual submission policy. We didn't want to jeopardize our NeurIPS submission, so we have instead submitted this abstract. We hope that the reviewers will still consider this work for a talk despite its brevity.

[†]These authors contributed equally to this work.

