

Study Shows Limits on Brain's Ability to Perceive Multifeatured Objects

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New research sheds light on how the brain encodes objects with multiple features, a fundamental task for the perceptual system. The study, published in [Psychological Science](#), a journal of the [Association for Psychological Science](#), suggests that we have limited ability to perceive mixed color-shape associations among objects that exist in several locations.

Research suggests that neurons that encode a certain feature — shape or color, for example — fire in synchrony with neurons that encode other features of the same object. Psychological scientists Liat Goldfarb of the University of Haifa and Anne Treisman of Princeton University hypothesized that if this neural-synchrony explanation were true, then synchrony would be impossible in situations in which the same features are paired differently in different objects.

Say, for example, a person sees a string of letters, “XOOX,” and the letters are printed in alternating colors, red and green. Both letter shape and letter color need to be encoded, but the associations between letter shape and letter color are mixed (i.e., the first X is red, while the second X is green), which should make neural synchrony impossible.

“The perceptual system can either know how many Xs there are or how many reds there are, but it cannot know both at the same time,” Goldfarb and Treisman explain.

The researchers investigated their hypothesis in two experiments, in which they presented participants with strings of green and red Xs and Os and asked them to compare the number of Xs with the number of red letters (i.e., more Xs, more reds, or the same).

Participants' responses to unique color-shape associations were significantly faster and more accurate than were their responses to displays with mixed color-shape associations.

The results show that relevant color and shape dimensions could be synchronized when the pairings between color and shape were unique, but not when the pairings were mixed.

These findings demonstrate a new behavioral principle that governs object representation. When shapes are repeated in several locations and have mixed color-shape associations, they are hard to perceive.

This research expands on Anne Treisman's groundbreaking research on feature integration in visual perception, which shows that humans can encode characteristics such as color, form, and orientation, even in the absence of spatial attention.

Treisman is one of 12 scientists who received the National Medal of Science at the White House on February 1, 2013. The National Medal of Science, along with the National Medal of Technology and

Innovation, is the highest honor that the US government grants to scientists, engineers, and inventors.