Red is the new orange: Nonlinguistic categorical color perception

Olga F. Lazareva¹

Published online: 25 January 2019
© The Psychonomic Society, Inc. 2019

Summary

Caves et al. (2018) demonstrated categorical perception in zebra finches for the orange-red color category that conveys information about male fitness. This result implies that categorical color perception does not necessarily have linguistic origins, as has been previously believed.

Keywords Categorization · Comparative cognition · Perception · Color perception

We live in a world filled with colors; moreover, colors convey important information that is often critical for our well-being. Red and yellow fruit is ripe and delicious, but the same fruit with brown spots is best to be avoided; bright whites of the eye indicate good health, but reddened or yellowed whites mean that a visit to a doctor is in order. Color spectrum, however, is a continuous rather than categorical dimension, as the physical difference between two shades of orange, 630 nm and 620 nm, is the same as between a 630-nm shade of orange and a 640-nm shade of red. Yet people typically perceive colors as distinct categories, and this phenomenon, termed *categorical perception*, produces a boundary effect: The 620-nm and 630-nm shades classified as “orange” are perceived to be more similar to each other than the 630-nm “orange” shade and the 640-nm “red” shade, despite the constant physical differences between them.

The boundary effect of color categorization is often demonstrated in a visual search task in which participants are asked to locate an odd target among similarly colored distractors. Remarkably, the performance in this task depends on a speaker’s language. For example, Russian speakers who have two basic color terms for “blue” (*goluboi*, or light blue, and *sinii*, or dark blue) quickly find a dark-blue target among light-blue distractors, whereas English speakers find this task much more difficult. Similarly, Korean speakers who have two terms for

“green” (*yeondu*, or yellow-green, and *chorok*, or green) find these two colors to be more dissimilar than do English speakers (reviewed by Davidoff & Fagot, 2010). Although the extent to which language affects color categorization remains a matter of debate, it is generally accepted that linguistic labels have a unique and profound effect on our perception and categorization of colors (e.g., Grandison et al., 2016).

If categorical color perception uniquely depends on language, then one might expect to find no indications of it in nonhuman animals that lack linguistic capacity. On the other hand, it is possible that an extensive experience with colors essential for survival is sufficient to produce a boundary effect indicative of categorical color perception. Caves and coauthors (2018) recently explored this possibility using zebra finches.

Zebra finches (*Taeniopygia guttata*) are small, granivorous, sexually dimorphic birds found in Australia and Indonesia that are often used as a model of song learning. As with many other birds, zebra finches are socially monogamous; thus, a single mating decision affects the reproductive success of an individual across many years. Male zebra finches engage in a courtship display consisting of a distinct song and a dance during which the male repeatedly changes orientation of his entire body (including a beak) toward a female. This courtship display is then used by female zebra finches to select a mate, as both song and dance contain many signals conveying information about mate quality. Color is one of such signals: Male beaks vary in color from orange to red, and the increased redness of the beak indicates an increasingly stronger immune system. Unsurprisingly, given a choice between a male with an orange beak and a male with a red beak, female zebra

✉ Olga F. Lazareva
olga.lazareva@drake.edu

¹ Drake University, Des Moines, IA, USA

finches prefer the latter; but, do they view this distinction categorically?

Caves and coauthors (2018) arranged a version of a visual search task in which they trained zebra finches to flip over circular color discs covering wells with a food reward; the birds had to flip over the discs that contained two colors before approaching discs containing a single color. The colors filling the discs spanned the red-orange boundary, as these colors should represent evolutionarily important categories to female zebra finches due to their role in mating choices.

Once the birds have learned the task, the authors compared birds' accuracy as a function of colors filling bicolored disks. If the distinction between orange and red is categorical, then the birds would be more accurate at detecting and flipping over these disks than the disks filled with two equally discriminable shades of red or shades of orange. Female zebra finches did just that, demonstrating, for the first time, a presence of categorical perception in a nonhuman animal.

Caves and coauthors (2018) were not the first to ask whether categorical color perception may be present in a nonhuman species. However, prior research with baboons (Davidoff & Fagot, 2010) failed to find evidence of categorical perception. Notably, baboons in this earlier study were trained to discriminate colors around blue-purple boundary that, to my knowledge, has no particular evolutionary significance to baboons. It is therefore possible that categorical perception in nonhuman species can be found only for colors associated with mate fitness or similarly important information. Finding such a result will be consistent with recent research in cognitive psychology suggesting that color naming across cultures is associated with a usefulness of a specific color to this culture (Gibson et al., 2017). On the other hand, it is possible that birds, with their exquisite color vision and highly lateralized brain, are the only group that will demonstrate categorical color perception in absence of language.

Indubitably, Caves and coauthors (2018) study opens new and exciting avenues for comparative psychologists to explore, while providing unique insights into evolutionary origins of categorical perception. A long-standing debate in this area contrasts the universalist position stating that color categories are universal and biologically based, with the relativist position maintaining that color categories are arbitrary and driven by the color terms in a speaker's language. Caves and coauthors' findings imply that color categories may be driven by the importance of the color to the survival of the species, suggesting that color categories may not be universal, but neither are they arbitrary. Moreover, language appears not to be critical for an occurrence of such color categories, a result that is certain to generate new theoretical developments in this area.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

References

- Caves, E. M., Green, P. A., Zippel, M. N., Peters, S., Johnsen, S., & Nowicki, S. (2018). Categorical perception of colour signals in a songbird. *Nature*, 560(7718), 365–367. doi:<https://doi.org/10.1038/s41586-018-0377-7>
- Davidoff, J., & Fagot, J. (2010). Cross-species assessment of the linguistic origins of color categories. *Comparative Cognition & Behavior Reviews*, 5, 100–116. doi:10.3819/ccbr.2010.50005
- Gibson, E., Futrell, R., Jara-Ettinger, J., Mahowald, K., Bergen, L., Ratnasingam, S., . . . Conway, B. R. (2017). Color naming across languages reflects color use. *Proceedings of the National Academy of Sciences of the United States of America*, 114(40), 10785–10790. doi:10.1073/pnas.1619666114
- Grandison, A., Sowden, P. T., Drivonikou, V. G., Notman, L. A., Alexander, I., & Davies, I. R. L. (2016). Chromatic perceptual learning but no category effects without linguistic input. *Frontiers in Psychology*, 7, 17. doi:<https://doi.org/10.3389/fpsyg.2016.00731>