**Color categorization in macaques**

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Categorization is a hallmark of high-level cognition, studied extensively with color. Across cultures, color categorization shows universal patterns, suggesting innate mechanisms, and variability, indicative of learning. One popular idea is that all languages show evidence of four basic color categories (red, green, blue, yellow), and variability is achieved by elaboration of these categories (e.g., reddish-yellow=orange). How are colors categorized independent of language? We explored this question by measuring color categorization in macaque monkeys, a primate species with the same retinal color-encoding mechanisms as humans. We used a 4-Alternative-Forced-Choice color-matching task in 3 monkeys over 6 months. They initiated each trial by fixating on a small spot on a monitor. A colored disk (cue) was presented at a parafoveal location. On a subsequent frame, animals were rewarded for distinguishing with an eye movement the matching colored disc from three foils shown. Colors were 64 equally spaced hues, of equal saturation and luminance (CIELUV). Attractor points (“category centers”) were defined as hue angles towards which incorrect choices were biased. Pooled data across all three monkeys show two strong color categories (31±11°, “red”; 207±5°, “blue”), which are evident in all 3 monkeys individually (monkey 1: 46±11°, 206±8°, 76,121 trials; monkey 2: 21±36°, 201±5°, 54,508 trials; monkey 3: 359±21°, 232±87°, 26,038 trials). The pooled data also show an emerging category (113±14°, “yellow”) significant only in one animal. These results suggest that trichromatic primates innately categorize colors into two essential categories (warm vs. cool colors), and that additional color categories reflect differences in color use across species and cultures.

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