

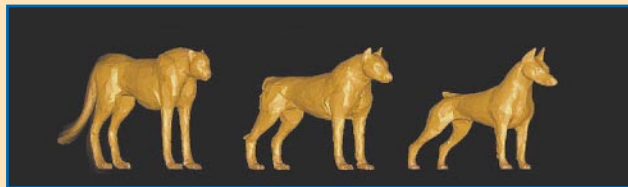
Cats, dogs and categories

Any child can tell a cat from a dog. But the difference has to be learned, and describing it is far from simple. Cats include cheetahs, lions and tabbies; dogs include Siberian huskies and dachshunds. How do we make the jump from recognizing a particular set of features to establishing a more general concept or category that will help us extrapolate to new situations?

Writing in last week's *Science* (291, 312–315; 2001), David J. Freedman and colleagues describe how they have explored this question by training monkeys to distinguish between 'catness' and 'dogness'. The authors used computer graphics to create blended images from a set of three dog and three cat images. An example of a cheetah, a Doberman and, in between, a blend of the two is

shown on the right. They then taught the monkeys to indicate, by releasing a lever, whether a sample image was of the same type as a test cat or a test dog. Monkeys, it turns out, are good at learning this distinction: even when the image was 60% cat and 40% dog, the monkeys reliably reported that it was like a cat. Furthermore, monkeys were not simply memorizing specific blends of cats and dogs as belonging to one category, because new blends were tested during the experiment.

To find out how these categories are represented in the brain, the authors recorded neural activity in the lateral prefrontal cortex — an area of the frontal lobes previously implicated in guiding complex behaviours — while the monkeys performed the task. Surprisingly, they found category



information represented at the level of single neurons. That is, regardless of whether the image was 60%, 80% or 100% dog, individual neurons responded in a similar way; but they responded differently for 60%, 80% or 100% cat.

Obviously, these category representations were the result of training — neurons in a monkey's lateral prefrontal cortex probably don't care about 'dogness' under normal circumstances. Indeed, the authors

went on to train one of their monkeys on a new, more abstract categorization of the same images, and showed that neurons no longer distinguished cats and dogs as they did previously, but now coded for the new categories. How these representations come to be formed rapidly and reversibly in this part of the brain is not going to be easy to answer. But it is clearly closely related to how we learn to categorize our world into meaningful concepts.

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