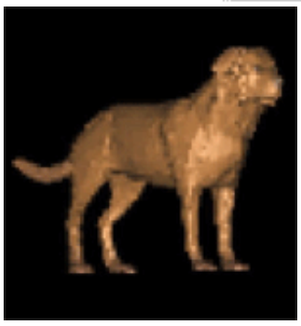

This animation, based on Science illustrations, shows how researchers created morphed images that reflected as close as a 60-40 balance between "catness" and "dogness." The brain activity of monkeys demonstrated that single neurons could store the information required to distinguish between Felix and Fido.

Rewiring the brain

Cat or dog? During quizzes, monkeys show how fast they learn the difference

By Lisa Onaga
SCIENCE

WASHINGTON, Jan. 12 — Somehow, when we look at an object, we know what it is. A red, round object is a fruit called an apple, fresh from the orchard. Or it's a piece of sports equipment, like a kickball on a playground. It seems so straightforward, yet the door opens to more questions when we pause and wonder how the brain distinguishes between similar-looking objects that end up classified into otherwise different groups.

COMPLETE STORY

'We physically rewire our brain so we process our environment.'
— EARL MILLER
Massachusetts Institute of Technology

RESEARCHERS LIKE Earl Miller at the Massachusetts Institute of Technology tease apart the basic processes of how we can automatically associate objects with specific categories. It is this basic level of perception that allows humans to conduct higher-level thinking about meanings, ideas and concepts. Miller is intrigued by how the brain processes information from changing environments and landscapes, which provide new stimuli to the senses that make up "experience."

"Your definition of what things mean is constantly changing," he remarked.

Using monkeys and morphed "cat-dogs," Miller and his research colleagues peered into the operative intricacies of the mind to demonstrate a neural correlation between sensory perception and actual categorization, described in Friday's issue of the journal Science.

JUST ANOTHER MAMMAL?

Wild primates don't usually meet tabby cats and golden retrievers in the jungle — yet, if they did, what would they think? Would all these strangely domesticated four-legged furry friends register as one and the same type of animal? Two eyes, four limbs, some fur — Eureka, a mammal! Or, would monkeys actually tell the difference between slobbering, barking dogs and prowling, meowing cats?

Miller's group trained rhesus monkeys to classify computer-generated images of systematically morphed felines and canines to find out. The researchers inserted thin wires into the monkeys' brains and hooked them up to monitoring devices. Then they recorded the reactions of single nerve cells in the "executive" area of the brain responsible for higher-level thinking, called the prefrontal cortex, as the monkeys responded to rendered graphics of cats and dogs.

Regardless of how morphologically close the images looked, and even after the monkeys were retrained to learn revised criteria for dogness and catness, individual nerve cells responded by reflecting the newly learned categories.

In other words, the brain had rewired itself.

"This laundry list of features that make up what defines a cat or dog becomes internalized due to a unitary representation in a brain," Miller explained. "The bottom line is, our experience changes. We physically rewire our brain so we process our environment. Our experiences with those items have rewired our brains to recognize chairs, doors, and windows. Even though chairs and these objects come in different shapes, we can still recognize a chair is a chair."

PARADIGM REWIRED

Miller's research has attracted the attention of other researchers because it shows the perceptual sophistication of single neurons, as well as their extraordinary plasticity as a result of experience, according to Dr. Charles Gross, a Princeton University neuroscientist.

Gross said this is "the first demonstration that single neurons in the frontal lobes can categorize complex stimuli, and that they can do so under arbitrary dimensions imposed by experience."

"There has been some evidence from past experiments that neurons in the temporal lobe can categorize faces and other stimuli, but Miller's study shows a far more finely tuned categorization for arbitrary stimuli than anyone has shown before," Gross said.

Examining these phenomena interests Miller because of the interplay between the prefrontal cortex, which requests and processes the information used in high-level thinking and organization; and the inferior temporal cortex, which provides long-term storage of cognitive categories.

There is an interplay or collaboration between the

collection of visual information and processing, and the brain is very dynamic, Miller said. “The whole cerebral cortex is rewiring itself.”

The Miller study contributes to the rising amount of research devoted to experiences that can alter the anatomy and physiology of the brain.

“This reflects a general paradigm shift over the last decade that the wiring of the brain and the properties of single neurons are far more plastic than had been believed,” Gross said. “We knew that since we learn and remember, the effects of experience have to be stored in the brain. However, until recently, there was little evidence for anatomical and physiological changes in the adult brain as a result of experience.”

In traditional brain science, people assumed that distinct parts of the brain were hard-wired for specific job functions early in life. For example, certain parts of the brain were slated for sensation, perception, learning and memory. “Now, we realize that mechanisms for sensory processing, perceptual analysis, short-term memory and long-term memory can exist in one brain area and even in a single neuron,” Gross explained.

THE FUTURE OF BRAIN SCIENCE

Miller continues to study the prefrontal cortex, adding to what he already knows about how the brain assigns meaning to the outside world. In addition to figuring out how quickly brains can rewire themselves and accommodate new categories, he wants to find out whether the same neurons represent the same categories in different brains.

From such basic science, medical applications may emerge, Miller noted. Research into the function of the brain’s executive may lead to new treatments for such conditions as schizophrenia, strokes and attention deficit disorder.

For now, though, the most immediate step is to understand the other intricate processes behind categorization, such as neurochemical interactions.

How much is left to learn?

“We know so little that we don’t even know what percentage of the brain workings we understand,” Gross explained. “On the other hand, our knowledge of the brain’s function increases by an order of magnitude every few years. We probably have learned more about the brain in the last 30 years than the previous 300.”

MSNBC COVERAGE

INTERACTIVES Your brain by the numbers: An MSNBC quiz

STORY How the brain turns reality into dreams

STORY This is your future brain on drugs

STORY The brain, the body and the genome

SPECIAL REPORT "Mysteries of the Universe"

SPECIAL REPORT Science news from MSNBC

BBS Discuss scientific curiosities on the Mysteries BBS

LINKS, SITES & MEDIA

MSNBC not responsible for content of Internet links

INTERNET Science Online

MSNBC VIEWERS' TOP 10

Would you recommend this story to other viewers?

not at all 1 - 2 - 3 - 4 - 5 - 6 - 7 highly

BACK TO TOP

Cover | Headlines | News | Business | Sports | Local | Technology | Living & Travel | Health
TV News | Opinions | Weather | Shop@MSNBC | MSN | Comics | Find | About MSNBC | Help | Index
News Tools | Jobs | Write Us | Advertising on MSNBC | Terms, Conditions, and Privacy

MSNBC Find Help NewsTools Write Us