Creatures in the Brain

Various concepts may emanate from separate cerebral niches

By BRUCE BOWER

Of the nearly 2,000 brain-damaged people who have been studied by cognitive neuroscientists at the University of Iowa College of Medicine in Iowa City, a handful have exhibited curiously fine-grained gaps in their knowledge about the world. Some of these patients suffer beastly lapses, failing to recognize dogs, horses, and other nonhuman animals. Others display an implement impediment—they have no idea what hammers, saws, or other tools might be used for.

A number of patients are simply at a loss for words. Depending on what part of the brain incurred damage, they cannot recall the names of, for example, familiar people, places, animals, or tools, even though they can still place the individual items in the appropriate category.

The largest studies of these conditions to date, described in the April 11 NATURE, have convinced the Iowa scientists that separate brain systems handle distinct categories of knowledge. Other recent findings support the theory that the brain transforms some information into "pictures in the head" that flicker outside the realm of language (SN: 12/2/95, p. 372).

Knowledge about conceptual categories and about words for items in those categories springs from separate cerebral sources, theorize Iowa's Antonio R. Damasio and his colleagues. When a person looks at a picture of a lion or a screwdriver, for example, certain brain systems enable the viewer to recognize, without pulling up a word, what he or she is seeing. Other neural circuits independently locate words that refer to a four-legged, furry creature with fearsome choppers or a slender metal bar with a flat end and a handle.

"The brain honors a general distinction between systems that handle concepts and those that handle words," Damasio contends. "The brain also honors a distinction between particularly important conceptual categories and the words used to describe them."

Natural selection may have etched into the human brain a heightened sensitivity to conceptual categories—a skill that aided Stone Age survival, Damasio proposes. Familiar faces, places, tools, animals, and foods are some of the categories that probably rest within their own cerebral niches, he maintains.

In one experiment, the Iowa researchers studied 160 adults who had experienced damage to some region of the brain and 150 adults who had not. Each participant viewed a series of slides showing various objects, including 90 animals and 104 tools.

People without brain damage recognized the categorical status of nearly all the animals and tools, even if they could not recall the names of a few of them. However, 14 brain-damaged patients failed to categorize a substantial number of the animals, and another 3 patients encountered severe problems in identifying images as tools.

The scientists then located the site of each patient's brain damage with a technique developed by Iowa's Hanna Damasio. This method generates three-dimensional views of inner anatomy from magnetic resonance imaging (MRI).

Patients whose animal knowledge had deserted them exhibited tissue destruction at the back of the brain, in areas that handle visual associations; the greatest amount of damage appeared in the right hemisphere. In contrast, patients who had lost their mental grasp of tools displayed damage to a region of the brain's left hemisphere. That region helps to incorporate several types of sensory information.

"We're currently exploring the reasons why our brains have specialized knowledge systems of this type," Iowa's Daniel Tranel says. He suggests that the MRI findings may reflect the different ways that people learn to identify objects—usually by seeing animals but by looking at, holding, and using tools.

A second study employed positron emission tomography (PET) to measure blood flow in the brains of nine adults without brain damage as they named pictures of items from three categories—familiar faces, animals, and tools.

Each task boosted blood flow in different parts of the temporal lobe. This chunk of brain tissue may contain groups of neurons that serve as brokers between concepts and the words for them, Antonio Damasio proposes. When we see a lion, for instance, a particular assembly of temporal lobe cells specializing in animals may activate another brain region where the appropriate word for the creature gets reconstructed.

The theory proposed by Damasio's group exhibits a "pleasing elegance," writes neuropsychologist Alfonso Caramazza of Harvard University in an accompanying comment. However, much remains unknown about the organization of word knowledge in the brain, he asserts.

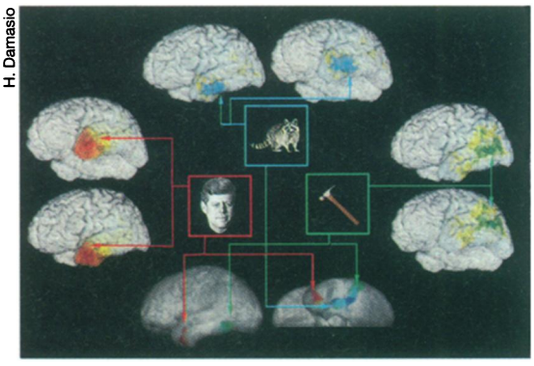
For instance, another PET study has found a slightly different pattern of left-hemisphere activation for animal and tool words (SN: 2/17/96, p. 103).

It is also unclear, Caramazza adds, whether Damasio's theory applies to grammatical categories, such as verbs that require a direct object, and to knowledge of separate abstract concepts, such as justice and ambition.

Whether or not Damasio's theory pans out, he and his colleagues wield the most sophisticated brain-imaging techniques now available, asserts Vilayanur S. Ramachandran, a neuroscientist at the University of California, San Diego.

"These experiments are absolutely lovely and will encourage scientists to think in new directions about how the brain works," says Ramachandran. □

H. Damasio



Brain images of healthy volunteers (bottom center) and brain-damaged patients show regions linked to retrieval of words for individuals (orange), animals (blue), and tools (green).