Brain images reveal key language areas

When a person looks at a string of letters, a specific area at the back of the brain quickly determines whether those letters meet learned criteria for a word, report researchers who have conducted a new brain-imaging study. If the string of letters passes muster, it then rapidly activates a section of the left frontal lobe, they say, suggesting that this brain region helps assign meaning to words. The two-part evaluation process apparently occurs without conscious awareness.

These findings, described in the Aug. 31 SCIENCE, support the recent psychological theory that some aspects of vocabulary and semantic processing automatically commence without conscious effort whenever a word is read.

Neurologist Steven E. Petersen of Washington University in St. Louis and his colleagues mapped blood-flow changes in the brain with positron emission tomography (PET). Increased blood flow in a particular area reflects greater activity there. The scientists injected minute amounts of a radioactively labeled oxygen compound into eight healthy, right-handed adults with good reading skills. This tracer remains active in the body for only a few minutes, allowing for a rapid series of PET scans. The scans record gamma rays emitted as the radioactive isotopes decay; a computer then generates color-coded images of blood flow.

The team scanned participants looking at four lists, each presenting a different type of stimulus: common nouns; "pseudowords" that followed English spelling rules (such as FLOOP); consonant letter strings (such as JVJFC); and strings of curved and straight lines not corresponding to any alphabetical letters. Each list consisted of 256 words or stimuli. One stimulus per second appeared on a computer screen, remaining visible for 150 milliseconds.

To pinpoint brain activity specific to each task, computer software compared individual PET scans taken while participants concentrated on a blank screen with scans taken during each of the four trials.

Petersen's team found that only the real words and pseudowords activated the left medial extrastriate visual cortex, located in the rear brain near regions that handle visual information. Right-handers process most basic language tasks in the left brain. The left-brain area detected by the scans appears to distinguish between letter strings that do or do not conform to learned spelling rules, and it does so just as visual processing gets underway, the researchers assert.

To identify brain activity prompted by general visual features, the team used PET scans showing volunteers' responses to nonalphabetical symbols. When compared with scans taken during other tasks, these revealed an important difference between brain activity sparked by real words and by pseudowords: Only real words elevated blood flow in the left frontal lobe. In a previous PET study, Petersen and his associates charted increased blood flow in the same brain region among people who read a list of 40 nouns and verbally reported a use for each item (SN: 4/30/88, p.281).

The left frontal lobe area must handle some yet-unspecified, automatic aspect of assigning meaning to individual words, they propose. — *B. Bower*

Growth-hormone levels plummet in space

The earthly theater of evolution has undergone countless scene changes since life first emerged, but gravity has never been absent.

Only in the past three decades of space flight have organisms spent prolonged periods beyond gravity's powerful grasp. And biological business does not go on as usual in the microgravity setting. Astronauts and test animals have returned to Earth with atrophied muscles, embrittled bones, depressed immune systems and other bodily changes.

Some of these problems may result from a decreased ability to secrete functioning growth hormone, suggests biochemist Wesley C. Hymer of Pennsylvania State University in State College. The pituitary-produced hormone serves many roles, including regulating growth and metabolism.

In 1983, Hymer and Richard Grindeland of NASA's Ames Research Center in Mountain View, Calif., sent cultured rat pituitary cells into space aboard Space Lab 3. Two years later, they orbited five live rats aboard a space shuttle. In 1987 and 1989, they placed equal numbers of rats aboard Soviet Cosmos Biosatellite missions.

Hymer, who also heads one of NASA's 16 Centers for the Commercial Development of Space, presented the pooled results of these experiments this week at a meeting of the American Chemical Society in Washington, D.C.

Space-flown pituitary cells, tested soon after their return, produce as little as half as much active growth hormone as their Earth-bound counterparts, Hymer reports. Biochemical tests show that microgravity leads to smaller aggregates of growth-hormone molecules, possibly explaining the hormone's reduced ability to induce bone growth in physiological tests. A graduate student in his lab also discovered that standard immunofloresecence probes misleadingly indicate high hormone levels in the space-flown cells despite the hormone's relative inactivity.

The rat findings may not bode well for long-duration space visits by humans, Hymer says. Still, he notes, no one has demonstrated a link between the decline of active growth hormone in test cells and the loss of muscle and bone strength in astronauts. But if that link exists, studies like his might point toward drug strategies to compensate for space-induced hormone deficits, he says.

Moreover, diseases such as osteoporosis may involve similar growth-hormone-mediated processes under normal gravity conditions, Hymer speculates. If so, he says, space-flown rats and cell cultures could provide a model for drug companies seeking to test new treatments for earthly patients. — *I. Amato*

Electron holography on a crystal canvas

Surface scientists expend a great deal of effort pinpointing the locations of atoms on or near a material's surface — a task they would find easier and more revealing if they could obtain three-dimensional images with enough resolution to depict the atoms' precise locations. That capability now seems within reach.

For the first time, a team of researchers has reconstructed a surface's three-dimensional crystal structure from the pattern generated by electrons emitted from surface atoms. The results prove that a diffraction pattern produced by such electrons can be interpreted as a hologram — the electron-generated equivalent of the visible-light holograms so often used today as security features on credit cards.

"Experimentalists have been seeing these [diffraction] patterns for years. They had just never thought of interpreting them as holograms," says physicist Dilano K. Saldin of the University of Wisconsin-Milwaukee. He and his colleagues describe their reconstruction technique in the Aug. 20 PHYSICAL REVIEW LETTERS.

When an atom near the surface emits an electron, that electron may come directly to the surface or it may bounce off a neighboring atom before emerging. Because electrons also behave like waves, electrons traveling along paths of different lengths would overlap at the detector, producing a distinctive interference pattern. The intensity of that diffraction pattern would vary from place to place, depending on the angle at which the electrons leave the surface.

Saldin's group developed a computer-based technique for analyzing such intensity patterns to extract information about the crystal's atomic arrangement

and to reconstruct its three-dimensional structure. The researchers say their technique is powerful enough to handle diffraction data produced by a variety of methods currently used by scientists to probe the nature of surfaces, including photoelectron and Auger spectroscopy.

"We can do the reconstruction in a few minutes on a personal computer," Saldin says.

The resulting image shows the relative positions of a typical atom and its nearest neighbors. Because individual atoms yield only one electron, the hologram and its subsequent reconstruction represent averages over all electron-emitting atoms and their nearest neighbors. Thus, the new technique works best when all the electron-emitting atoms sit in roughly the same surroundings, as they would in a near-perfect crystal.

Surface scientists have several methods for punching electrons out of specific types of surface atoms. Each method produces a distinctive electron diffraction pattern amenable to holographic reconstruction. In many cases, researchers can focus on one element, which allows them to work out how its particular atoms are arranged.

Saldin and his colleagues have successfully tested their reconstruction scheme on diffraction patterns created by electrons scattering from copper surfaces. — *I. Peterson*

Herbicide curbs human parasite's spread

In the search for new drugs against human parasitic diseases, a popular weed killer has emerged as a promising candidate.

Farmers in the United States and abroad use an herbicide called trifluralin to eliminate grasses and some broadleaf weeds in fields of soybean, cotton, safflower and other crops. But new research on human and mouse cells shows that the herbicide also stops the parasite *Leishmania mexicana* dead in its tracks while leaving the mammalian cells unharmed. This suggests that some close chemical cousin of trifluralin may eventually prove therapeutic for many of the world's 10 to 20 million people infected with leishmania protozoans. These single-celled organisms, common in many developing countries, cause skin ulcers and potentially fatal organ damage.

The odd discovery had its beginnings in work performed two years ago. Dunne Fong and his colleagues at Rutgers University in Piscataway, N.J., determined the exact sequence of amino acids that form a leishmania protein called beta-tubulin, a key component of tiny fibers called microtubules. Microtubules provide cells with structural support and are critical to cell division.

Although leishmania parasites belong in the animal kingdom, Fong's team found that the amino acid sequence of leishmania beta-tubulin has more in common with plant tubulin sequences than with animal ones. Reasoning that chemicals toxic to plant tubulin might, if specific enough, interfere with leishmania cells without bothering human tubulin, Fong and Marion Man-Ying Chan began searching for such a compound.

The Rutgers researchers tested several herbicides whose *modus operandi* is to interfere with plant beta-tubulin. They report in the Aug. 24 SCIENCE that trifluralin binds to *L. mexicana* beta-tubulin but not to mammalian beta-tubulin. Even at extremely low concentrations, the herbicide interferes with the parasite's replication, cutting infectious spread by half in cultured human and mouse cells, they say. Yet at 20 times this dose, it still leaves the mammalian cells unscathed.

Fong and Chan don't propose spraying the herbicide on infected people. For one thing, they note, the compound breaks down very quickly in sunlight — an advantage for an agricultural chemical not meant to build up in the environment, but a drawback for a drug applied to skin. Instead, they suggest that scientists might design a closely related compound with anti-leishmania activity and superior pharmacological traits. Moreover, they say, "there may be other potentially useful . . . agents [against these and other parasites] among the commercially available herbicides."

Health officials estimate that parasitic diseases such as leishmaniasis, malaria, amoebiasis and toxoplasmosis affect more than one-quarter of the world's population, or well in excess of 1 billion people. For many of these diseases — including leishmaniasis, transmitted by a biting sandfly — current drug treatments remain unsatisfactory at best. — *R. Weiss*

Magellan radio loss remains mysterious

Venus-orbiting Magellan — its wayward radio link now restored for the second time — has forced NASA to devise new measures to restore communications should the spacecraft go silent again.

Mission engineers at the Jet Propulsion Laboratory in Pasadena, Calif., have written emergency commands to send to Magellan if the signal problem recurs. They plan to send the new instructions slowly, at 40 bits a second, to the craft's low-gain antenna, which has a wider field of view than the other antennas. Officials admit they don't know and may never determine precisely what silenced Magellan on either occasion (SN: 8/25/90, p.117).

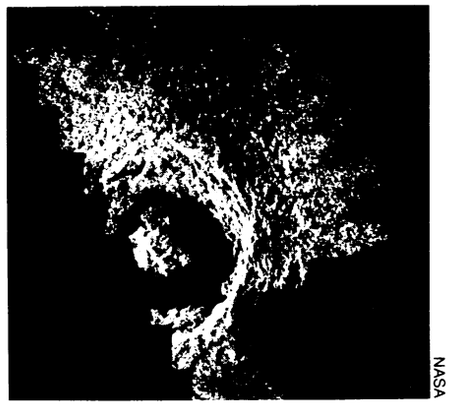
Magellan lost contact with Earth for nearly 15 hours on Aug. 16 and for 17 hours on Aug. 21. Both signal interruptions apparently occurred when the craft unaccountably entered a "safe mode." Magellan's attitude-control-system computer is programmed with several such modes to help protect the craft against malfunctions that arise without warning.

Officials hope the new commands will rapidly correct any future communications losses. "I want a safing action that the spacecraft takes to establish quick communications to Earth," says project manager Anthony Spear. "My heart can't stand this 17 hours' loss of signal."

Magellan science manager Thomas W. Thompson says engineers succeeded on Aug. 24 in getting the craft to send 1,200 bits of information per second, not just the 40 bits per second to which it dropped during its recovery from the first signal loss. The data speed-up was only a test, however, because transmissions sometimes prove less reliable at the faster rate, Thompson says.

Project officials have formed a special team of about 12 experts from inside and outside NASA to study the communications failures. Spear says the group is analyzing several possible causes, including an electric spark; a cosmic ray striking and altering a computer chip; and computer memory failures during the jettisoning of the rocket motor that put Magellan into its Venus orbit.

With the communications mystery still unsolved, Thompson says Magellan will not begin its full radar-mapping of Venus before late September. The long-term mapping had been scheduled to start on Sept. 1. — *J. Eberhart*



NASA

Magellan test image indicates that Golubkina, a crater about 34 kilometers in diameter, resulted from a meteorite striking Venus. The image reveals Golubkina's terraced inner walls, a central peak and radar-bright features that appear younger than the surrounding plain.