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 immunoflorescence 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