Infants show keen ear for speech sounds

Six-month-olds may not utter an articulate word, but a new study indicates they already organize adult vowel sounds into distinct categories and perceive some sounds as better examples of a particular vowel than others. Specific speech sounds apparently serve as "perceptual anchors" from infancy onward, crucially influencing the ability to speak and understand language, say psychologists DiAnne Grieser and Patricia K. Kuhl of the University of Washington in Seattle.

Grieser and Kuhl base their work on the notion that human perception — the operation of senses such as seeing and hearing — sorts diverse incoming stimuli into meaningful categories. Certain stimuli, according to the theory, constitute the best instances, or prototypes, of their particular category. When new stimuli are encountered, the brain assigns them to a perceptual category based on how closely they resemble a category's prototype.

For example, people in a broad array of cultures agree on color prototypes — say, the hue that best represents the color green. These preferences are thought to be inherently defined by the visual system.

Over the past decade, researchers have found that adults group the smallest units of language — consonant and vowel sounds — into acoustic categories and that they perceive some sounds as better examples of a category than others.

Reports also indicate that 6-month-old infants can distinguish between prototypical vowel sounds made by adults and recognize novel variations of the sounds. Grieser and Kuhl, who describe their study in the July Developmental Psychology, examined how infants accomplish this complex feat.

In their first experiment, the researchers conditioned 16 infants to turn their heads toward a loudspeaker when the prototype for one vowel category (the long "e" in the word "peep") changed to another vowel prototype (the short "e" in the word "pep"). Correct responses caused a box on the loudspeaker to light up and reveal a mechanical animal, such as a bear with a drum. A computer synthesizer created the vowel prototypes and 32 acoustic variations of each sound. The new sounds varied in the degree to which they conformed to the prototypes.

Infants heard eight novel sounds from each of the two categories. They recognized the sounds as belonging to the appropriate category, as indicated by head turns, more than 90 percent of time.

In a second experiment, Grieser and Kuhl tested a new group of 32 infants, all 6 months old. Half the group learned to turn their heads in response to the prototype for the long "e" sound; the rest were conditioned to turn their heads in response to a poor representative of the same vowel category. The researchers generated a set of 32 acoustic variations, 16 around the good "e" and 16 around the poor "e." Infants heard all 16 variations of the sound on which they were trained.

Recognition of novel sounds in the same sound category, indicated by lack of head turning, proved significantly greater among those trained on the prototype. This finding offers the first support for the idea that infants organize speech sounds around what adults perceive as good examples of units of speech, the investigators maintain.

It is not known whether vowel "goodness" is inherently defined by the nature of the human hearing system or is the result of considerable experience, even among 6-month-olds, in listening to English sound patterns.

The researchers are now testing U.S. infants on non-English vowel variations to see if training on unfamiliar prototype sounds produces similar effects. If so, they say, speech-sound prototypes may be an inherent characteristic of human hearing. *— B. Bower*

A little thirst can aid plant defenses

Every gardener knows that parched plants become especially vulnerable to insects. The idea that all but well-watered plants are jeopardized "has been the conventional wisdom — probably for a couple hundred years," notes insect ecologist William J. Mattson of the U.S. Forest Service in East Lansing, Mich. But this conventional wisdom fails to recognize that "plants don't respond linearly to stress," he says. Over the past three years, he and others have accumulated data suggesting a new hypothesis: While a lot of water stress is undeniably bad, a little may prove beneficial. Now, researchers at the University of Virginia in Charlottesville have completed what appears to be the first study offering strong confirmatory evidence.

Last year, the Virginia researchers showed that mild water stress made the leaves of white oak saplings less attractive to the oak lace bug. In a far more detailed series of just-completed experiments, Edward F. Connor and Grant McQuate investigated a similar relationship involving soybeans, a leading U.S. crop. Given a choice, Connor told Science News, the larvae of Mexican bean beetles — a major U.S. pest — "definitely preferred" dining on foliage from well-watered plants as opposed to mildly thirsty ones.

Leaves from the mildly thirsty plants contained 11 percent less water and proved a little tougher — and therefore harder to penetrate. But the bugs had a more serious reason to prefer thoroughly watered plants. Larvae forced to feed on mildly water-stressed foliage grew more slowly, entered adulthood smaller and were less hardy than those reared on leaves from well-watered plants. Connor says these findings suggest that stress-induced chemical defenses, called toxicants, in the thirsty plants are at least partly responsible.

In one growth-chamber experiment, Connor fed some larvae leaves harvested from chronically thirsty plants. Only on the night before leaf harvesting were these plants well watered. The last-minute dousing brought leaf water and toughness levels to normal, eliminating the potential physical deterrents. Yet compared with larvae raised on leaves from always-well-watered plants, larvae eating leaves from these generally thirsty plants took about 15 percent longer to mature, gained about 10 percent less weight during high-growth stages and suffered 10 to 15 percent greater mortality. Mortality was twice as high among larvae feeding on intact, mildly thirsty plants in the greenhouse and field.

In spite of the last-minute watering, leaves used for the growth-chamber experiments maintained their stress-induced chemistry. With reduced water, Connor explains, plants tend to break down some of their proteins into free amino acids. Among the mildly thirsty soybeans, he found free-amino-acid levels 36 percent higher on average than in well-watered plants, though some individual amino acids increased sixfold.

Such changes may mean that a water-stressed plant diverts some of its resources from normal growth to the development of other compounds, including waxes, resins and oils, some of which can aid in the plant's defense, Mattson says. For example, ongoing experiments in loblolly pines by Peter L. Lorio Jr. of the U.S. Forest Service in Pineville, La., show that as maturing (30-year-old) trees become thirsty — even mildly thirsty — they step up resin production. While resins normally serve to seal up tree wounds, at high levels they can also thwart bark beetles — the pine's archenemy — from establishing lethal infestations in the tree's outer vascular tissue, or phloem.

In a small study in 1986 and '87, Lorio fostered a bark-beetle infestation on loblollies. He found the trees "greatly resisted a beetle attack" during a slow-growth, dry period but not during a high-growth, well-watered period.

Connor says these observations suggest growers should reconsider watering plants when there's little threat to their growth or yields: "This watering could just increase pest problems." *— J. Raloff*