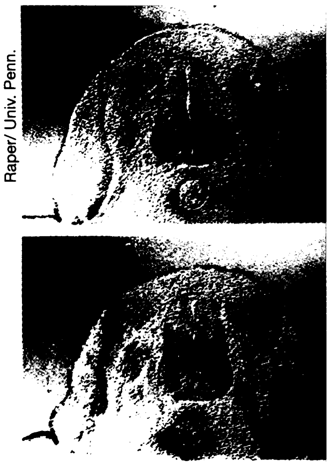
Nerve-guiding molecules that can do it all

For at least a century, neurobiologists have suspected that developing nerve cells are somehow told what connections to make. The extensions, called axons, that sprout from motor neurons and activate toe muscles thread their way from the spinal cord down to the foot, ignoring all other muscles along the way.

"The challenge is to understand how the guidance can be so very accurate," says Marc Tessier-Lavigne of the Howard Hughes Medical Institute at the University of California, San Francisco. Over the past year or so, his research group and several others have been doing just that, identifying molecules that help steer axons in the right direction (SN: 8/27/94, p.135).

Now, they are finding out just how numerous and how versatile these chemical signposts can be. Sometimes, the markers stay stationary; other times, they leave the target and help direct an axon to the correct place. Moreover, molecules that researchers find in worms and grasshoppers have chemical equivalents in mice and chickens, Tessier-Lavigne points out.

His group discovered two such mobile signposts, called netrins, that diffuse from target cells. Some axons sense netrins and grow toward increasing concentrations of these chemicals. But other axons grow away from netrin, he reports this week at the Society for Neuroscience meeting held in Miami. Nor are netrins the only signals with dual effects, he adds.



Raper/ Univ. Penn.

Dark spots in spinal cord and surrounding tissue of a 4-day-old chick embryo show different distributions of collapsin II (top) and collapsin (bottom).

Last year, Jonathan A. Raper of the University of Pennsylvania in Philadelphia found a substance, collapsin, that paralyzes the advancing axon tip. New evidence shows that while collapsin repulses some tips, called growth cones, it attracts others, says Tessier-Lavigne.

In addition, Raper has announced at the meeting the discovery of a second, and most likely a third, kind of collapsin, made by different cells or at different times during the development of the nervous system. Thus, like netrins, collapsin molecules may represent a family of molecules whose unknown number of members have similar structures and functions, Raper notes.

Work by Corey S. Goodman of the University of California, Berkeley, also reported at the meeting, suggests that the guidance molecules his group has found also belong to a larger chemical family. These chemicals may attract or repel an axon, depending on the makeup of the axon's molecular docking sites, Goodman says. His group finds that some axons have docking sites for both connectin and semaphorin II, two such guidance molecules. The former sits on the cell surface, and the latter diffuses through the environment around these cells.

"[The axon] is probably responding to many cues at one time," Raper notes.

Those cues can be very subtle. Raper finds that it takes very little collapsin, for example, to alter an axon's path. "And [the growth cone] is integrating all the information at once," he adds.

The body may have a reason for bombarding the axon with so much information. "To be sure [the axon] won't get misrouted, [the body] has to overspecify the route," suggests Tessier-Lavigne.

Although Goodman found his first semaphorin in insects, other chemical signposts in the semaphorin family now include collapsin, which Raper found first in chicks, and semaphorin III, which exists in humans. *— E. Pennisi*

Brain study finds possible word center

An elaborate network of brain regions handles visual information and enables the eyes to serve as a window to the world. Two locations on this neural pathway, located near the base of the brain, may spark recognition and understanding of written words, according to a new study.

The findings support a theory that the ability to read depends on specific brain structures, assert Anna C. Nobre, a psychologist at the University of Oxford in England, and her colleagues. An opposing view holds that reading derives from more general brain activities, such as those responsible for sorting all sorts of objects into meaningful groups.

"These results suggest that there is a separate stream specialized for word recognition within the [lower] visual pathway," conclude Nobre and her coworkers in the Nov. 17 NATURE. "Damage to the word-recognition stream . . . may help to explain some forms of reading and object-naming deficits in patients with brain lesions."

Nobre's group studied 27 adults, age 18 to 55, undergoing brain examinations prior to possible neurosurgery for uncontrollable epileptic seizures. Minute electrodes implanted inside the skull of each participant picked up electrical activity at points along the bottom surface of the brain.

The researchers recorded patterns of electrical responses in the brain associated with reading five-word sentences that ended with a real word, a made-up word (such as "groad"), or a random string of letters. Another task required participants to identify a particular illustration, such as a face, or a colored pattern, such as a checkerboard, after viewing a series of four other drawings.

Two separate portions of the fusiform gyrus, a fold of tissue that runs lengthwise along the base of each side of the brain, showed distinctive electrical responses to patterns of letters. One region, toward the front of the brain, responded comparably to all types of letter strings but not to illustrations or visual patterns. The second area, near the back of the brain, charged up only during presentations of actual words.

These two sections of the fusiform gyrus take part in a portion of the brain's visual system that specializes in word recognition, Nobre's team theorizes. The first site perceives separate letters in an array and meaningful arrangements of those letters, they propose; the second may form visual meanings of words or help retrieve memories of word meanings based on emotional qualities of a word or its context in a sentence.

This two-step sequence for recognizing common words takes about one-fifth of a second from start to finish.

Electrical activity reflecting this process typically occurred on both the left and right sides of the brain, the scientists note. However, other parts of the visual system on the side more heavily involved in language — usually the left side — probably also facilitate word recognition, they contend.

For instance, a brain-scan investigation has found that reading both real and made-up words boosts blood flow in a visual area on the left side of the brain (SN: 9/1/90, p.134).

"Several studies now indicate that the [same general] part of the visual system is involved in word processing," says Steven E. Petersen, a neuroscientist at the Washington University School of Medicine in St. Louis who directed the brain-scan study. "But experimental procedures and exact locations of this processing differ from one research group to another."

It remains unclear whether brain regions such as those cited by Nobre's team also recognize meaningful groupings of objects outside the realm of reading, Petersen adds. *— B. Bower*