BIOLOGY

Julie Ann Miller reports from the meeting in Atlanta of the Society for Neuroscience

Lessons in bird songs

Recent data on birds indicate "how woefully inadequate simple reflexological interpretations are for understanding the complexities of their behavior," says Peter Marler of Rockefeller University.

Marler believes a song bird's heredity launches its learning along a certain trajectory, but the birds mix that innate tendency with more flexible imitation, modification and invention. He and Susan Peters have studied song sparrows and swamp sparrows, birds that live together in nature and that have similar but distinct songs. The song sparrow sings a pattern of four or five syllables, whereas the less common swamp sparrow warbles a simple trill of repeated two- to four-note syllables.

The scientists find that while learning their correct song, birds do not passively mimic everything they hear. The investigators played to young birds tape recordings of synthetic songs, made up of rearranged syllables from each species. They found that the swamp sparrow, when it began to sing a few months after hearing the tapes, had restructured the synthetic songs into its characteristic trill. It composed songs only from the swamp sparrow syllables it had heard. Apparently the swamp sparrow has a greater intrinsic interest in sounds of its own species. Data on cardiac response show a more dramatic reaction of swamp sparrows to songs of their own species than to songs of the neighboring song sparrows (or of never-encountered canaries).

Similarly, song sparrows constructed songs of their characteristic pattern from synthetic songs, Marler reports. They melded syllables of different training songs, reiterated syllables and added invented materials to produce a typical song. The song sparrows, however, were less particular than swamp sparrows about the origin of the syllables used. But, Marler points out, in nature the song sparrows must hear but don't imitate songs of swamp sparrows.

Endorphin: Hibernation signal?

Beta-endorphin, a natural peptide molecule that produces effects similar to those of opium, has been implicated in a variety of physiological and behavioral activities (SN: 11/25/78, p. 375). Now David L. Margules of Temple University has a theory that he believes ties together the many observations. "I suggest that beta-endorphin stimulates a widespread, integrated series of adaptive reactions throughout the body, preparing it for an impending food shortage," Margules says. Those reactions would precede animal hibernation and, erroneously triggered, could instigate the urgent overeating of human obesity.

According to Margules's theory, beta-endorphin creates a "pre-famine" hunger, which encourages both overeating and efficient storage of excess calories in fat tissues. Among beta-endorphin's actions that could prepare the body for famine are a lowering of the respiration rate, heart output, thyroid hormone activity, body temperature and response to pain, as well as conservation of water and efficient extraction of nutrients by inducing the kidneys to concentrate urine.

Margules points out that these changes, and the resultant lethargy, mimic animal hibernation. He and co-workers have found that injecting an antagonist of beta-endorphin into hibernating hamsters dramatically increases heart and respiratory rates, induces shivering and rudely awakens the animals. The antagonist, naloxone, has no effect on chilled but nonhibernating animals.

Margules predicts that another natural system will be discovered to counteract beta-endorphin's activities. He and collaborators have found a peptide in the pituitary and thyroid glands of obese rats that is the first potential component of such a system.

Paths through the blood-brain barrier

"We have changed from saying that the brain only talks to itself, to saying it listens intimately to the rest of the body," Floyd E. Bloom of the Salk Institute told reporters. Two findings suggest that the brain is not as isolated from body chemistry by the "blood-brain barrier" as it was once though to be.

A rich network of arteries, capillaries and veins — discovered by using vascular casts and scanning electron microscopy — seems to connect the pituitary gland to the brain, reports Richard M. Bergland of Beth Israel Hospital in Boston. "Some of the arrows from the brain to the rest of the body should be repointed," Bergland says. "We believe that the anatomy is arranged so that some of the hormones from the master gland, the pituitary, go north instead of south." The brain produces hormones itself, but Bergland suggests that under special conditions it obtains greater quantities from the pituitary gland.

The brain may also be monitoring levels of hormones circulating in the blood. Bloom says, "Some elements of the brain aren't on the brain side of the 'blood-brain barrier.'" He bases his statement on observations made in several laboratories (SN: 11/25/79, p. 364) and recently replicated and extended by his own research team. Brain peptides injected just under the skin of a rat can influence its memory. The peptides were detected in the blood for about 20 minutes after the injection, but they were never detectable in the brain. The behavioral effect, however, lasted for hours. "It might be a 'hit and run' peptide that changes something in the brain," Bloom says.

Chemical anatomy of the brain

A special system of nerve cells related by their chemistry has been mapped in the brain. All the cells in that system produce a family of peptide molecules, including the morphine-like beta-endorphin and the hormone adrenocorticotropin (ACTH). "These peptides appear to be only produced in cell bodies in the hypothalamus and then transported to other sites possibly to influence memory and pain," says Earl A. Zimmerman of Columbia University. Animals lacking those cells are unusually sensitive to pain, he reports.

The system was discovered through the use of fluorescent tags on antibodies, which can locate specific chemicals in slices of brain tissue. The family of peptides was found, in the several mammalian species examined, in nerve cell bodies in a brain area called the arcuate nucleus of the hypothalamus and also in those cells' far-flung branches that course into other areas of the hypothalamus and into other regions of the brain. One other system of nerve cells containing peptides (oxytocin and vasopressin) has been known to project from an area of the hypothalamus to a variety of brain regions. That system sends fibers to many of the same areas as does the ACTH system.

In the brain, as well as in the anterior lobe of the pituitary gland, the peptides ACTH and beta-lipotropin (beta-LPH — from which beta-endorphin is derived) are formed from a larger precursor molecule called 31 K (SN: 11/17/79, p. 342). The newly identified brain cells contain ACTH, beta-LPH, a precursor containing ACTH and beta-LPH, beta-endorphin and another peptide derived from ACTH. Removal of the pituitary gland does not affect the distribution of those peptides in the brain, but destruction of the arcuate nucleus of the hypothalamus in newborn rats eliminates all the cell bodies and branches in the brain containing those peptides. The scientists do not yet know whether different nerve cells in each system or even various branches of the same nerve cells contain different products of the precursor. "The regulation of peptide formation in different parts of the neuron may have profound effects on nervous communication," Zimmerman says.