Brain growth: Sex differences

There is ample evidence that males and females differ, not only in the more obvious reproductive activities, but in such nonreproductive behaviors as emotionality, aggression, play and food preferences. Brain maturation also proceeds at a different tempo in males and females and appears to affect learning ability, Patricia S. Goldman and her team at the National Institute of Mental Health report in the Nov. 8 SCIENCE.

Goldman and her neuropsychology colleagues first studied 17 monkeys of both sexes. They removed part of the brain cortex—the orbital prefrontal area—in eight of the monkeys. The other nine monkeys served as controls. When all the animals were two-and-a-half months old, they were tested for their "object reversal" abilities. That is, they were trained to discriminate between two objects differing in color, size and shape. After the animals reached criterion (two successive 30-trial sessions with 90 percent correct in each session), the reward contingencies were reversed so that the previously positive object became negative. Each monkey's score for this task was the total number of errors to criterion made over six reversals. The male monkeys that had been operated on showed impaired learning compared to the males that had not been operated on. But the females that received operations learned as well as did the males and females that had not.

Goldman and her team then conducted a second study on 33 monkeys that had had part of their cortexes removed in infancy, but were tested at 12 months of age for "delayed response" abilities. In the delayed-response task, the monkeys were trained to observe the experimenter conceal a bait in the left or right of two food wells located on a test board in front of the animal. The position of the baited well on successive trials was governed by a modified random order. On any given trial, the monkeys were allowed to select the baited food well only after an opaque screen had been interposed between them and the test board for up to five seconds. Again results were sex-dependent: males that had been operated on did not learn as well as did males that had not been operated on. However females that had been operated on showed learning ability comparable to that of males and females that had not been.

All the monkeys tested at 12 months of age for delayed response abilities were subsequently tested around 15 and 18 months of age for object reversal abilities and still another learning task—"delayed alternation." During this task the monkeys were required to alternate between the left and right food wells on successive trials separated by five-second intervals. The monkeys' scores for each of these tasks were the number of trials required to achieve a performance criterion of 90 percent correct responses in 100 consecutive trials.

At 15 months of age, more than half the females that had been operated on began to show learning deficits as severe as those displayed by the males that had been operated on. By 18 months of age, they definitely did so. And at both 15 and 18 months, male and female controls learned as well as before. These results suggest that, up to about one year of age, damage to the brain cortex impaired learning in the males, but not in the females. But at later ages, 15 to 18 months and beyond, the brain damage impaired learning in both sexes to the same degree. The variety of conditions under which learning was tested indicate that neither the age of the animals at surgery, nor the particular test given, nor interaction between tests were critical factors in the results. Rather, what was crucial was the sex of the animal and the age at testing.

"In spite of the similar performance of unoperated groups," the investigators conclude, "the finding that lesion-induced deficits can be detected at earlier ages in males than in females may be regarded as evidence that the functions of the orbital cortex develop earlier in males than in females." □

Skin cancer: Self-prevention by cells

Affluence, leisure time and southern latitudes have contributed to Americans' love of the sun. Migration patterns show a steady flow of cold northerners and crowded easterners toward the sunny Southeast, Southwest and Far West. Unfortunately, Americans pay for their sun worship with 300,000 cases of skin cancer per year. Although physicians can treat successfully about 98 percent of the annual cases, scientists still do not understand all of the factors that interact with sunlight to cause skin cancer, do not know who is prone to contract it or exactly how the cancers begin at the molecular level.

One group studying these problems has pushed back the darkness considerably this year with three major studies on the effects of light on the human white blood cell. Biochemist Betsy M. Sutherland of the University of California at Irvine earlier this year reported finding a photoreactivating enzyme in the human leukocyte. Such enzymes had been isolated from all other groups of animals and are credited with repairing the damage that can be caused to the DNA when ultraviolet light strikes the cell. (This damage, it is thought, may lead to the formation of cancerous lesions if not repaired by the cell.) The enzyme is called *photo*reactivating because it is nudged into action by the presence of visible light. Biochemists had suspected the photoreactivating enzyme to be present in human cells, but Sutherland and her students were the first to find and report it.

Sutherland, Paul Runge and John C. Sutherland now report in the Nov. 5 BIOCHEMISTRY the second step in their important work. They were able to show that, at least in the test tube, the human photoreactivating enzyme actually is activated by visible light and does repair damage done to DNA by ultraviolet light. When DNA is struck by highly energetic ultraviolet light, pyrimidine base pairs (cytosine, thymine and uracil) can "get stuck" to each other as well as to the backbone of the DNA helix, and form what are called dimers. These pyrimidine dimers will code for mutations unless split up by photoreactivating enzymes into properly functioning monomers.

A third piece of research by the Sutherland team will appear in the January PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES. Sutherland told SCIENCE NEWS that they have now been able to detect the enzymes' activity *in vivo*, that is, within living human cells. The group also will report that persons who suffer from a rare skin disease called xeroderma pigmentosum have from none to only half the normal level of the photoreactivating enzyme. Patients with this disease lack the ability to repair damage done by ultraviolet light and produce dozens, even hundreds of cancerous lesions before dying at a young age. In addition to the photoreactivating system, some human and animal cells also have an enzyme system that excises damaged portions of DNA and replaces them with functioning sequences. Both systems appear to be lacking or reduced in the individual with xeroderma pigmentosum.

Sutherland says if the team can prove that damage to the DNA is repaired with photoreactivating enzymes and the cell no longer suffers the deleterious effects, then "this will provide evidence that the pyrimidine dimer is the agent responsible for the adverse biological effects." This in turn, "will allow us to test for the involvement of dimers in malignant