Grown-Up Monkey Brains Get Growing

During adulthood, according to traditional views of primate brain development, neurons check out, but they don't check in. In the densely connected mass of mature brain tissue, cells die and leave behind no fresh replacements.

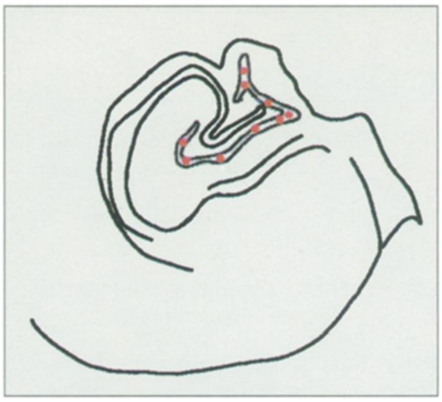
Overturning tradition, researchers have for the first time documented the creation of new neurons in the adult primate brain—in an area linked with learning and memory. What's more, a single, highly stressful event can interfere with the production of neurons in monkeys for at least 3 weeks, reports a research group headed by neuroscientist Elizabeth Gould of Princeton University.

"In the classical scientific view of the adult brain, our findings seem ridiculous," Gould says. "But the production of new neurons during adulthood and its inhibition by stressful experience may be common to many species, including humans."

Previous research conducted separately by Gould's team and a group in La Jolla, Calif., documented neural generation throughout adulthood in the hippocampus and adjacent regions of the inner brain of rats and tree shrews. This so-called hippocampal formation helps to regulate memory formation and the learning of information.

In the new research, described in the March 16 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, Gould and her colleagues injected into the brains of six adult male marmoset monkeys a substance that marks neurons in early phases of development. Either 2 hours or 3 weeks later, the researchers added another chemical marker to slices of the animals' brain tissue to tag fully developed neurons previously identified in their formative stages.

Gould/PNAS



Red dots represent parts of the adult monkey dentate gyrus in which brain cell precursors matured over 3 weeks. The blue dot marks areas in which precursors did not mature.

Over 3 weeks, sizable neural production occurred in a part of the hippocampal formation called the dentate gyrus, Gould holds.

The scientists also transferred four adult monkeys individually to the cage of another adult monkey for 1 hour, a stressful situation in which aggressive displays by the resident animal elicited submissive behavior from the intruder. The four stressed monkeys subsequently produced fewer new dentate gyrus neurons than the nonstressed monkeys.

This finding adds to prior indications from several animal species, including humans (SN: 6/3/95, p. 340), that stress and trauma trigger the release of hormones that can damage the hippocampal formation.

"The discovery that new cells are made in the adult primate dentate gyrus is novel and very exciting," says neuroscientist William T. Greenough of the University of Illinois at Urbana-Champaign.

Further investigations are needed to examine whether the fresh neurons are incorporated into the web of preexisting cellular connections, and, if so, how they function, Greenough says.

Gould suspects that dentate gyrus cells generated during adulthood rapidly form neuronal connections and become involved in learning and memory.

She and her coworkers have also reported that neurons are generated in the adult rat brain in a section of the outer layer, or cortex, that processes smells. This raises the possibility, also open to future research, that parts of the primate cortex produce new cells during adulthood, Gould notes. —*B. Bower*

Cage provides key to water droplet

Just how tiny is the smallest drop of water? Computer simulations show that a three-dimensional cluster of six water molecules, connected by eight hydrogen bonds, begins to assume the properties of the bulk liquid. In this way, a water hexamer is the smallest drop of water possible, says David C. Clary of University College London.

Starting with just two molecules, Clary and his colleagues systematically modeled water clusters of increasing size to determine their geometries. Groups of up to five molecules join together in a ring, but arrays of six can also take on cagelike or prism structures, he says. In the cage hexamers, the distances between molecules and the distribution of charges are similar to those of liquid water. Clary presented the results of his group's calculations this week at a meeting of the American Physical Society in Los Angeles.

The findings complement other research that examines the elusive behavior of water and ice, for example how molecules interact during melting or freezing. "The basic theory that we've been developing will ultimately be needed to explain those very subtle properties," says Clary.

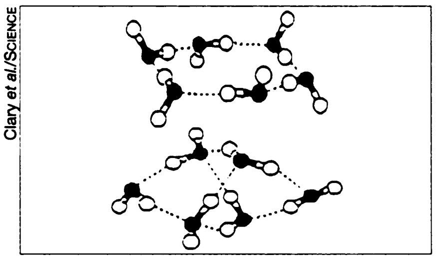
Clary has also modeled how organic molecules such as benzene associate with water. Although benzene is not soluble, "understanding how benzene interacts with one water molecule—then two and three and four" can illustrate the process of dissolution.

The simulations match experimental results. Richard J. Saykally of the University of California, Berkeley and his colleagues study water clusters with infrared spectroscopy, which reveals the strength of the hydrogen bonds between water molecules.

First, they spray water into very fine droplets, a process that "produces water clusters cooled to temperatures very near absolute zero," Saykally says. Then, they excite the droplets with an infrared laser and record the spectrum of absorbed light frequencies. Analysis of this spectrum reveals the size and shape of the clusters. Saykally and his coworkers see evidence of the six-molecule water clusters in the ring, cage, and prism configurations.

One of the goals of these studies is to "quantify the force field of water—the forces that hold liquid water together," Saykally says. The Berkeley group has completed the force field analysis for a two-molecule water cluster, and extending the model to larger ones should be "very easy," he remarks. —*C. Wu*

Clary et al./SCIENCE



Clusters of six water molecules can assume several shapes, including a ring (top) and a three-dimensional cage (bottom).