PSYCHOLOGY

Understanding Memory

Scientists are beginning to understand the physical basis of memory, that function of the brain underlying learning, thought, personality, even consciousness itself.

By PATRICIA McBROOM

➤ MEMORY is losing its mystery. Scientists are studying it from every possible angle. Yet like personality, it has not been located, duplicated or even very well defined.

Over the past decade, memory, learning and, by implication, thought processes themselves have become subjects for the neuroanatomist. The far-reaching implications of this "brave new science of the mind," as one scientist called it, are comparable to anything man has ever done in science, whether it be breaking his own genetic code or splitting the atom.

The physical traces of memory are lost in billions of nerve cells and a string of little-understood chemicals. Nevertheless, without understanding exactly what or where memory is, scientists have already discovered a crude method of altering it with drugs.

Most publicized of all these chemicals is the memory-enhancing drug, magnesium pemoline, tradenamed Cylert by researchers who found it at Abbott Laboratories in North Chicago. Magnesium pemoline, as a stimulant, has been on the European market for several years, its users apparently unaware they were getting more than a temporary pick-up.

When Abbott scientist N. Plotnikoff tested the drug on rats, he discovered improved learning capacity—up to five times the learning rate of untreated rats. And the learning was permanent.

Pills Tried on Humans

Now the memory pill is being tried on humans. Preliminary results will not be in for some time, said Dr. Ewen Cameron, of the Veterans Administration Hospital in Albany, N.Y., but hope is high that the chemical will do for elderly people what it did for rats in Dr. Plotnikoff's laboratory.

Indications are that Cylert will work. It appears to improve the production of a chemical found in the brain as well as in all living cells—ribonucleic acid or RNA. The work was done by biochemists Alvin J. Glasky of Abbott and Lionel N. Simon of the Illinois State Pediatric Institute.

When Dr. Cameron injected RNA directly into humans, he found that it had a distinctly beneficial effect on memory. Unfortunately, it also caused nausea in the test patients.

If Cyclert does not work, it will leave some dashed expectations in its wake. By now the RNA chemical is so surrounded by excited debate, that it has been raised almost to the status of a master chemical. In fact, RNA has been called the "memory molecule."

Besides RNA's seeming ability to enhance learning by improving memory, the opposite action appears to take place if its work is blocked. A number of chemicals have been found that can inhibit RNA operation in one way or another. The chemical puromycin, for example, when injected into experimental animals (goldfish and rats), prevents the establishment of permanent memory.

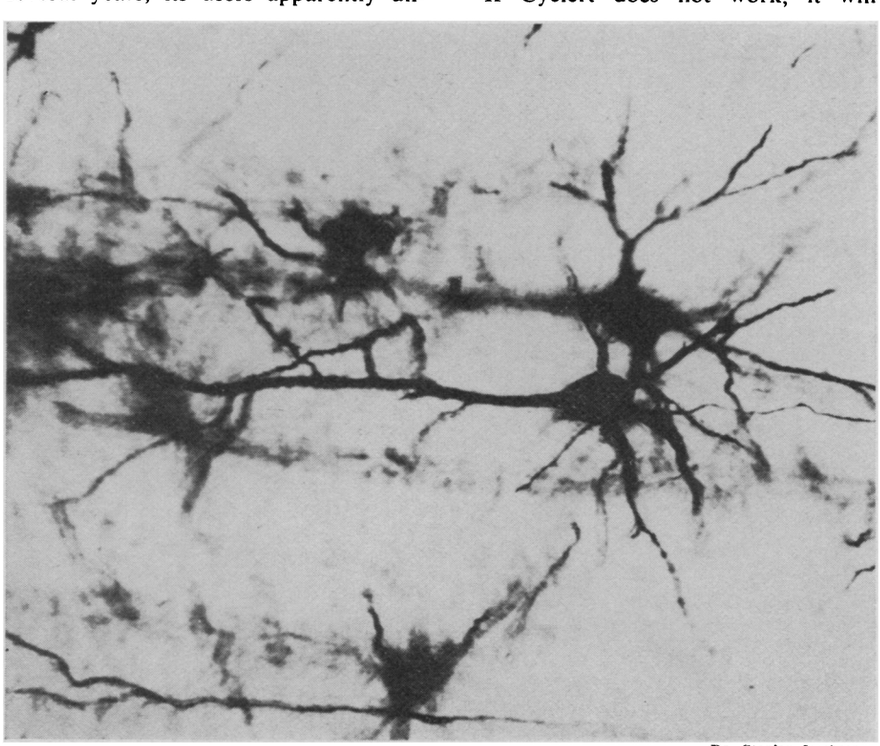
Puromycin is an antibiotic which blocks protein synthesis, the opposite action from that of RNA.

This implies a connection between memory and RNA production, and scientists believe there is one. But here the accord ends, and one of the more heated controversies of the day begins.

One theory is that RNA carries memories in coded form, possibly similar to the way in which DNA carries genetic information. If this is true, it follows that memory can be transferred from one animal to another by transplanting RNA.

A handful of scientists have attempted this learning transfer using rodents and worms and have proclaimed their experiments a success. Usually the learning involves an elementary response like going to a cup of food upon the sound of a bell.

At this point the imagination begins to boggle. Visions arise of apes in business suits, bottled RNA from men of genius, textbooks in capsule.



Dr. Stanley Jacobson

BRAIN NEURONS—Nerve cells from the sensory cortex of an albino rat have here been stained and magnified 500 times. The unique properties of the neuron are evident in its small nucleus and branching dendrites. A human cortical neuron might have as many as 50 dendrites.

Knowledge Is Vague

Clamping down on the speculation, critics of these transfer experiments point out that knowledge of memory processes is far too vague to single out any one chemical as the explanation of memory.

"To talk of RNA as a memory molecule is sheer nonsense," said Dr. David Krech, psychologist at the University of California at Los Angeles. "The physical basis of memory is a large series of interacting biological parts," he said. "We are still on the biological level, not the molecular level."

Dr. Wesley Dingman, an authority on cells with the National Cancer Institute in Bethesda, Md., described some of those interacting parts:

A man's brain contains some 10 billion neurons—a tenth of the total cells contained in the cranium. The others are believed to be supportive cells, carrying blood and nutrition to the neurons. Neurons have some peculiar properties, besides a strange appearance.

First, all evidence indicates they do not regenerate as do skin cells, for

instance, and once the full complement of neurons is reached, no more are created. This is true whether the nerve cell is located in the brain or somewhere in a muscle of the peripheral nervous system, said Dr. Dingman.

Second, the neuron resembles no other cell in the body. It has a microscopic nucleus, and many branching fibers or nerve endings called dendrites. Under a microscope neurons in the brain resemble interlaced but unattached root systems.

One neuron in the human cortex may have 50 branches and be in a position to influence 4,000 other neurons. Because of this the neuron is uniquely suited for communication with other cells.

Explanation in Dendrites

Since these neurons are the most likely candidates for the thinking processes but do not reproduce, how are new memories established in cells, if they are? An explanation may lie in the dendrites.

It is now well established that peripheral dendrites, some of which extend for several inches down the length of an arm or leg, will grow back after they have been severed, mangled or otherwise damaged. Logically then, neurons in the brain also can send out new branches, though this has never been observed. Man would require far more subtle instruments than he now possesses to find such new dendritic growth among 10 billion neurons.

There is, however, some provocative new evidence linking dendritic complexity to intelligence. Rats raised in enriched environments and in company with other rats were found more adept at learning tricks than their brothers and sisters raised in complete isolation. When Dr. Krech and his co-workers at UCLA examined and compared the brains, they found a striking difference in dendritic growth—with deprived rats on the short end of the stick.

Somehow, dendrites, RNA and memory drugs all fit into the same picture. Chemistry and cellular growth are inextricably joined in one grand operation, designed by nature and only now being tentatively plumbed by man.

Protein Synthesis

Cells are built from proteins. Ribonucleic acid is a chemical that works to synthesize proteins. RNA performs this function for cells whether they be in the liver or the toenail. Dendrites of the cortical neurons may also require protein synthesis for their growth and maintenance. Possibly by increasing the amount of RNA in the brain, one can also speed up the manufacture of protein and, as a result, feed the production of dendrites. Many biologists believe this would explain the mysterious memory-enhancing qualities of RNA and the new "smart" drug.

Such an explanation of memory formation fits with what is known about learning. During the so-called "formative years" of a child's life, learning is exceedingly rapid. Not surprisingly, these years between birth and age seven or eight are also the time of greatest dendritic growth. Thereafter, an individual's ability to learn decreases steadily, for the rest of his life.

If memory drugs can do nothing but return to elderly people the learning capacity of their younger years, they will be of inestimable value to man.

Aid to Retarded

Besides the aged, retarded children are also likely to get the memory pill during its experimental phase. If most retarded children are slow because their brain cells did not develop a normal degree of complexity, as pediatricians now believe, the drug may offer a slight bit of hope.

Despite the promise of these new chemicals, however, the warning signals are up in all directions.

Drugs are all right in their place, but they pose dangers both psychological and physical, in the opinion of many scientists. Dr. Krech tagged this the "Pill Century." There are pills for contraception, pills for mood, pills for temperament, now pills for memory, he said. "Who is going to control the memory pills?" Will they be controlled by Government with all the dangers implicit there?

The use of drugs to control minds is an ancient technique. Colonialists used alcohol to subdue peoples under their rule. "Now with the increased subtlety of chemicals, is it all right," he asked, "to do the same thing?"

Include Public

Dr. Krech recommended that scientists worry out loud about the problem and bring the public into their confidence.

Dr. Jose M. R. Delgado, a professor at the Yale University School of Medicine, well known for his work in controlling the behavior of monkeys by electrical stimulation of various sections of their brains, expressed a similar concern.

"There is a real risk in psychopharmacology," he said. Electrical control of behavior, which can be done, is not particularly dangerous. It is not practical to imbed electrodes in the brains of masses of people, he pointed out, but drugs can be administered without their knowledge.

The tremendous advances made in brain research over the past few years hold potential for great human improvements, Dr. Delgado said. But the benefits are most likely to be secured in traditional, if more expensive and tedious, ways.

Knowing the physiology of the mind would, for instance, reveal how moral codes are structured in the brain. Teachers could use this knowledge to educate more sociable and less cruel human beings.

"If we are able to locate the mechanics of happiness, we can show people where to find it and how to avoid illness and neurosis," Dr. Delgado said.

Indeed, scientists have already provided society with a method of raising its general level of mental health.

Dr. Krech's work with rats starved of psychological and sensory stimulation has direct application to the deprivation many children endure. If rats develop less able brains, fewer dendrites, under such conditions, why not humans?

"On the basis of this experiment alone," he stated, "any society that isn't willing to invest billions in Head Start (the Federal Government program for pre-school culturally deprived children) or better is guilty of criminal neglect."

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Nature Note

Red Water Mite

➤ IN ANY woodland pool this spring or early summer one might see a bright red creature, no bigger than a pinhead, half swimming, half crawling on the bottom.

This is the water mite, *Hydryphantes ruber,* seeking a place to lay its eggs. Some may be brown or almost black, although most are red.

Mites, as well as ticks, chiggers and their relatives, are members of the order Acarina, which includes some of man's most irritating pests. Many mites, however, help man by destroying insect pests. As they crawl around on plants, in the soil or in shallow pools, the tiny creatures feed on eggs of aphids and attack nematode worms in the soil. The water mite attacks large beetles and grasshoppers, attaching itself securely under the insect's wings or legs. The immature mite is a parasite preying on insects, at a time when it has only six legs and looks much like an insect itself. As an adult it grows its full quota of eight legs.

There are grain mites, chicken mites, rat mites and many other kinds of mites that feed on various living things. The mite that directly affects most people is the irritating chigger, member of the genus *Trombicula.* This unpleasant creature lies in wait on grass or other plant stalks until an animal or human comes along and brushes close to the grass. Then it moves onto the new host, bites through the skin and discharges a drop of digestive agent which opens a tubular path into the lymph glands and provides the mite with a meal. Within one to seven days, it has eaten enough, drops off and completes its development on the ground.

If it is a female, it eventually mates and lays a batch of eggs from which new generations of young chiggers climb up grass stalks and wait for an animal or human to pass.

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