Signs of the FUTURE

GOOD HALF-BRAINS

Calling someone a half-brain is not scientifically much of an insult. People can lose large sections of one brain hemisphere and as long as the other remains intact they often keep their intelligence. Since 1954 this mysterious self-sufficiency of the brain's halves has been probed deeply by a team of neuropsychologists under Dr. R. W. Sperry at the California Institute of Technology. Their findings, published this month, confirm the fact that each half of the brain, though normally controlling only one side—the opposite side—of the body, can in a pinch take over both sides.

Further, Sperry's team has discovered that after severing the connections between the right and left hemispheres of a cat's or monkey's brain,

SPLIT-BRAIN CAT

they can then educate the two halves separately. They put the split-brain animal in a test rig where it can get a food reward by learning to paw a pedal in response to the sight of zeros first, then crosses. In learning to choose zeros the animal is allowed to use only the eye controlled by one side of its split brain. In learning to choose crosses, it can use only the opposite eye. Thus half the brain learns to choose zeros over crosses, the other half learns to choose crosses over zeros.

Surprisingly little "internal conflict" results when the animal is free to use both eyes and is confronted with both crosses and zeros. One of its half-brains simply takes over while the second half rests, and the animal makes no effort to hit the pedals with both paws at once.

D-2

D-3

Monkeys Do 2 Things at Once

Pasadena, Calif. (AP) — Biologists at the California Institute of Technology have taught monkeys to do two things at the same time. An animal's left hand literally doesn't know what its right hand is doing.

It's done by cutting the brain in half, in effect giving a monkey two brains.

Each brain operates independently of the other. In their two-by-four-foot training boxes at Caltech, the monkeys perform even contradictory tasks simultaneously.

Dr. Roger W. Speery, professor of psychobiology who developed the surgical technique of severing the brain lobes, explained in an interview how the box works.

The monkey can see out only through a pair of peep holes. His left eye and left brain are taught that if he presses a lever marked with a circle he gets a peanut. If he presses a lever marked with a triangle he gets nothing.

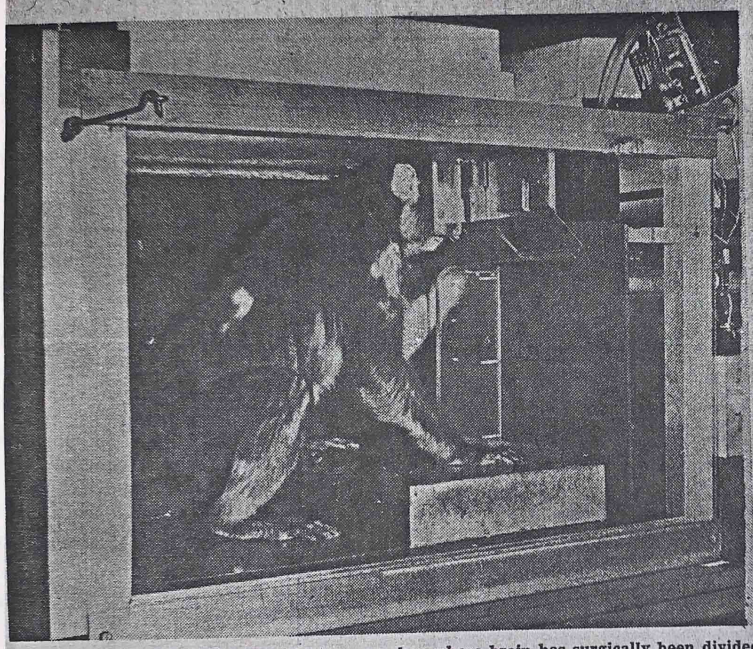
At the same time, his right eye and right brain are taught just the opposite.

The study so far, Sperry says, suggests that memory, thinking and consciousness may be split and that two distinct personalities may be developed in a double-brain monkey.

What happens when the monkey is given a choice—is there any conflict between the two brains?

Not so far, says Sperry, perhaps because a correct choice by either brain has always been rewarded with a peanut. But later, he says, he may want to see what happens if one brain gets more peanuts than the other.

Brain splitting would not help humans perform two complicated tasks at the same time, Sperry says, because the human brain is much more complex than a monkey's.



MONKEY WITH TWO BRAINS—Boris, a monkey whose brain has surgically been divided in two, works in an experimental box at Pasadena, Calif., where scientists have trained Boris and other monkeys to do two opposite tasks at the same time. Half of Boris' brain gets him food by selecting orange instead of blue markers, while the other brain half also gets him food by rejecting orange in favor of blue. The study suggests, scientists say, that the two distinct personalities might be developed in such a monkey (AP Wirephoto)

PERSONALITIES

D-4

CONGRATULATIONS to our June graduates! Bill Baughan, Mt. San Antonio College; David Nalbach, John Muir High; Dan Biles, South Pasadena High; Barbara Browder, Arcadia High.
(If we have omitted anyone, please let us know.)

DOUBLE CONGRATULATIONS to Beth Pickering, who graduated from Westridge in June and won a Cornell National Scholarship, one of 35 students among 3000 or more candidates to receive this award which is made on the basis of scholarship, leadership, character and personality.

AT THE REQUEST of Bee Jordan, we give "credit where it is due" to her three assistants on the Flower Committee for our anniversary evenings: Mrs. Emma Cushman, who made the arrangements, from her garden flowers, for the Historical Evening; Mrs. Lloyd Hill and Mrs. Willard Smith, for the intriguing "then and now" table decorations at the Banquet.

HOSPITALIZED FOR EYE SURGERY are Dr. Willa Cameron (Huntington Hospital) and Mr. Reginald Gregory (St. Luke's Hospital); convalescing at home after a hospital stay is Mrs. Loyall McLaughlin. Our best wishes for a speedy recovery!

RETIRING FROM ACTIVE NURSING is Miss Mary Hathway, whom we hope to see more often now that her stint on the night shift is over - sixteen years at Huntington Hospital was her pre-retirement stretch. Mary has already tasted her freedom, visiting in Redwood City and stopping off at Lake Tahoe.

WE LEARN ABOUT OUR FRIENDS from the public prints! Club news recently disclosed that: Miss Edith Mallory was feted at a meeting of Lord Tennyson Chapter, Daughters of the British Empire, on her 92nd birthday; Miss Anna Laura Folbrecht, retiring as Press Chairman of the Browning Society, was aptly termed "a treasure" and a "model of efficiency"; Mrs. Alton Amdahl is Conservation Chairman of the Temple City Junior Women's Club; Mrs. A. J. Horn is the new president of Pasadena Chapter, Women's Int'l League for Peace and Freedom.

REVIEWED IN THE Christian Century of June 21 is a book entitled "Essays in American Historiography: Papers in Honor of Allan Nevins". This distinguished historian is now "one of ours", as is his charming wife.

IF YOU READ "LIFE MAGAZINE" you saw the mention of Dr. Roger Sperry's experiments in dividing the brain of a monkey. Dr. Sperry is professor of psychobiology at Caltech.

WE EXTEND THE SYMPATHY of all their friends at Throop to Mrs. Hugh Hollembeak and to Bob Hartley, both of whom have recently lost their mothers by death.

IT IS WITH SPECIAL PLEASURE that we welcome the two latest members to join our church - Paul and Ilse Knust Graichen! We are also happy to be able to report that Paul has found employment, after weary weeks of searching, and can now settle down to enjoy a full life in his adopted country.

TRIBUNE SCIENCE HIGHLIGHTS

Are 2 Brains Better Than 1? If So— Would 2 Half Brains Do Just as Well?

If two heads really are better than one, then wouldn't it be more cosmetic to arrange two brains inside one head?

At California Institute of Technology in Pasadena this is being arranged — for monkeys — with some intriguing results that can lead only to further investigations along similar lines.

CalTech's psychobiology group, in a number of experiments with both cats and monkeys, has been exploring the frequently suspected (but never solidly proved) possibility that half a brain may be as good as a whole brain for many tasks. If this is true, the normal equipment of two half brains per individual conceivably could be organized to function as two brains. Or, more reasonably, the technique could help further pinpoint the areas of the brain responsible for extremely specific functions.

As described by Roger W. Sperry, Ph.D., Professor of Psychobiology, the procedure entails surgical severing of the cross-connections — commissures — that link the two brain hemispheres. Of particular importance is the biggest single fiber tract in the brain, the corpus callosum, which has been studied for the past seven years or so by several different groups in this country.

Functions Unimpaired

It already had been confirmed that complete section of the corpus callosum produced surprisingly little disturbance of ordinary behavior, Dr. Sperry said. Even when more extensive brain midline cuts were made, almost all the sensory inflow, motor outflow, and other brainstem relations remained relatively intact. The major effect usually was a partial loss of vision.

The latest work has been to study these "split-brain" animals more carefully, under special training and testing conditions in which inflow of sensory information to the divided hemispheres can be controlled.

The first definite finding was that each hemisphere has its "independent mental sphere or cognitive system," Dr. Sperry said. The effect was as if each half were unaware of what was experienced in the other half, "as if neither has any direct memory of anything that has gone on in the other subsequent to the midline surgery." A virtual case, as it turned out, of the right hand's not knowing what the left hand was doing.

Intact Callosum Important

In surgically sectioned cats this resulted in an animal unable to perform with one eye the visual pattern discriminations learned with the other eye. Other experiments showed that it was the cutting of the corpus callosum that made the division. If only the optical chiasm were cut and the callosum left intact, then discriminations learned with one eye were readily passed to the other eye.

The upshot of these experiments, Dr. Sperry said, was that "the corpus callosum is shown to be instrumental in laying down a second set of memory traces, or engrams, in the contralateral hemisphere —a mirror image duplicate or weak carbon copy of the engram (depending on the dominance of the hemisphere) on the directly trained side."

Next the CalTech group evaluated sensory discriminations and found that "the same kind of functional independence prevails in the separated hemispheres with respect to somesthetic learning and memory involving touch and pressure on the surface of the forepaw." In testing this with primates the experimenters set up a "monkey automat" in which the animal feeds itself by manipulating two levers distinctively marked with different geometric figures or different colors.

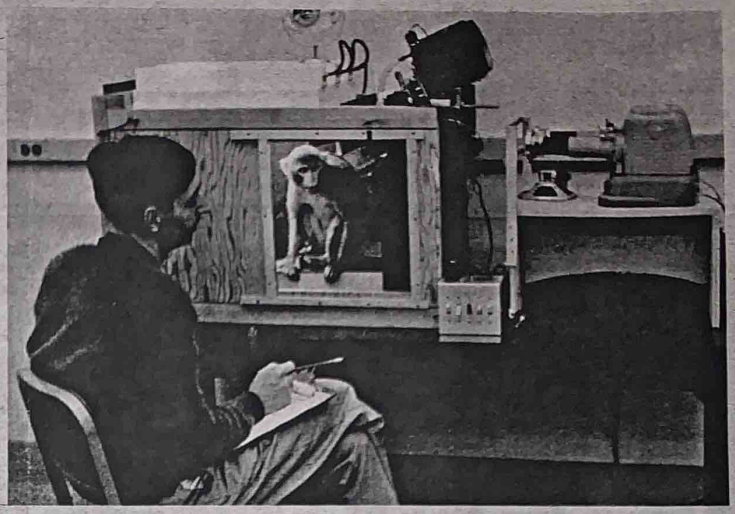
One at a Time

Up to this point the investigators had been working with one side of the brain at a time. For all they knew, the mental attention might have to be concentrated alternately by the animal. But such was not the case. Another experiment showed a monkey could learn two contradictory patterns at one time — "not only concurrently but really simultaneously."

The crucial part of this experiment was in the animal's expression of the split-level learning when it was asked to do something with it—such as get food.

The monkey displayed some hesitancy, Dr. Sperry said, but not extreme conflict. First one hemisphere took over and the monkey worked smoothly. Later the other hemisphere assumed command and the monkey accomplished the same goal but was moved to do so by a completely different stimulus.

The secret of this merged "twin-brain" activity seems to lie in the fact that only the higher centers are divided, a circumstance that presents little problem so long as there is unity in the lower, more primitive centers of the brain.



Experiments are determining if each half of a simian brain can function as well as a whole brain. Dr. Colwyn Trevarthen, above, designed apparatus with Dr. Sperry.

D-1

Cats' Brains Aid Science

The cat was an ordinary looking cat, black and white and furry on the outside. But its brain had been altered by Dr. Roger W. Sperry and his colleagues at the California Institute of Technology.

Sperry had cut the cat's brain in half down the middle of the left and right side. But the cat went on being a cat, mostly. It mewed and scratched, lapped milk and did things cats usually do. It didn't seem to be different at all.

But the cat was different, and only the subtlest kind of experiment brought out the difference, a differnce which has profound lessons for the scientist who is studying the operation of that complex box of living matter—the brain.

Let's burrow into that cat brain and see what happened in Sperry's laboratory.

Normally two large bundles of nerves carry electric impulses, from each eye to opposite sides of the brain: left eye to right brain; right eye to left brain.

By cutting the optic bundles where they cross, Dr. Ronald Myers was able to get each eye connected to the same side of the brain: right eye to right brain; left to left.

He then placed a mask over one of the eyes and taught the cat (by rewarding it with food or punishing it with a slight electric shock or some similar traning procedure) to distinguish between various sizes and shapes of things with the one eye.

Now he took the mask off the other eye and transferred it. Could the cat make the same discrimination with the untrained eye? The answer was yes. The training was used by the other eye, even though it had not been exposed to the lessons.

A further bit of surgery. In another cat he cut the connecting fibers between the two halves of the brain right down the middle, after having connected the two eyes to the same sides of the brain as before.

PAW TRAINING

He trained one eye. Does the cat transfer the training to the other eye? This time the answer was no. The fibers between the two halves of the brain—called the corpus callosum — seem to be the tract over which impulses carry from one-half of the brain to the other.

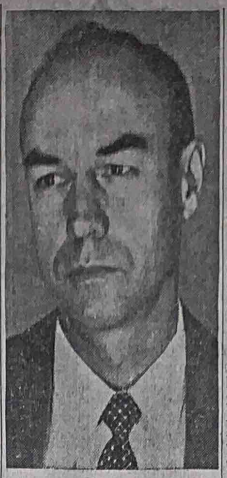
Sperry and Dr. John Stamm applied this principle to paw training and found that with the corpus callosum intact the training was transferred. If you cut the corpus callosum the transfer was nil.

Actually this work indicates that one might be able to get along with half a brain, just as well as with a whole one. In fact, nature seems to protect you against losing half your brain by spreading the memory of things you do equally through both sides of your head via the corpus callosum, but the location of specific memory traces is as inaccessible to science now as the top of Mt. Everest was 20 years ago.

But there is a more subtle point in this research. The ability of each half of the brain to learn after the corpus callosum has been cut seems to be equal.

This indicates that the ability to learn is an inborn character, resulting from the organization of nerve networks. If this were not so, it would be possible to change learning ability of each half of the brain by training, and this cannot be done now. However, some of the more subtle learning abilities may be controlled by training.

More evidence concerning the inborn character of learning comes from the frog, another of Sperry's experimental creatures. In these animals the eye nerve tracts were cut as in the cat, and allowed to regrow to the same, rather than to the opposite, sides of the brain. In the cat there are connections from both eyes to both sides of the brain, so that cutting the tracts merely connects the same eye to the same side of the brain.



Caltech's Sperry.

However, in the frog, the nerve tracts have to regrow.

Again the frog was tested—this time with house flies. If the frog saw a house fly with its left eye, it flicked its tongue at the fly as if the frog had seen it normally with the right eye. No amount of training could correct this error.

This means that the basic nerve connections of the frog tell its brain what is is seeing, regardless of training and experience, a finding, Sperry pointed out, which is contrary to what had been believed for many years. It had been thought that you were trained to see things and very little of this ability had anything to do with inborn nerve connections, except in the most gross way.

But even more interesting was the fact that, if the fly were far to the left, the frog would behave as though it were far to the right. If the fly were close to the mid-line of vision, the frog would see the fly close to the mid-line too, but on the wrong side.

WRONG EYE

This indicates that the regrowing nerve connections grow precisely to the spot in the eye—the wrong eye—that they would have connected to in the correct eye.

The explanation is that each nerve cell apparently has an inborn chemical property which matches those of the particular spot in the back of the eye and a particular spot in the brain. The two halves of the brain, then, are chemically similar except that left and right are reversed, and seem to be a chemical map of the back of the eye.

Sperry and his group are performing many other surgical experiments to uncover the mysterious function of brain organization. For example, in the cats with the corpus callosum cut, they have cut away in one-half the brain all but that part which has to do with vision — the visual cortex. Vision in one eye was destroyed.