PHYS ED

Lobes of Steel

Horacio Salinas

Consider this before skipping yet another workout: exercise could make your brain stronger and faster, too.

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The Morris water maze is the rodent equivalent of an I.Q. test: mice are placed in a tank filled with water dyed an opaque color. Beneath a small area of the surface is a platform, which the mice can't see. Despite what you've heard about rodents and sinking ships, mice hate water; those that blunder upon the platform climb onto it immediately. Scientists have long agreed that a mouse's spatial memory can be inferred by how quickly the animal finds its way in subsequent dunkings. A "smart" mouse remembers the platform and swims right to it.

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In the late 1990s, one group of mice at the Salk Institute for Biological Studies, near San Diego, blew away the

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others in the Morris maze. The difference between the smart mice and those that floundered? Exercise. The brainy mice had running wheels in their cages, and the others didn't.

Scientists have suspected for decades that exercise, particularly regular aerobic exercise, can affect the brain. But they could only speculate as to how. Now an expanding body of research shows that exercise can improve the performance of the brain by boosting memory and cognitive processing speed. Exercise can, in fact, create a stronger, faster brain.

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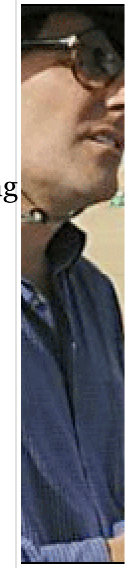

This theory emerged from those mouse studies at the Salk Institute. After conducting maze tests, the neuroscientist Fred H. Gage and his colleagues examined brain samples from the mice. Conventional wisdom had long held that animal (and human) brains weren't malleable: after a brief window early in life, the brain could no longer grow or renew itself. The supply of neurons — the brain cells that enable us to think — was believed to be fixed almost from birth. As the cells died through aging, mental function declined. The damage couldn't be staved off or repaired.

Gage's mice proved otherwise. Before being euthanized, the animals had been injected with a chemical compound that incorporates itself into actively dividing cells. During autopsy, those cells could be identified by using a dye. Gage and his team presumed they wouldn't find such cells in the mice's brain tissue, but to their astonishment, they did. Up until the point of death, the mice were creating fresh neurons. Their brains were regenerating themselves.

INSIDE

All of the mice showed this vivid proof of what's known as "neurogenesis," or the creation of new neurons. But the brains of the athletic mice in particular showed many more. These mice, the ones that scampered on running wheels, were producing two to three times as many new neurons as the mice that didn't exercise.

But did neurogenesis also happen in the human brain? To find out, Gage and his colleagues had obtained brain tissue from deceased cancer patients who had donated their bodies to research. While still living, these people were injected with the same type of compound used on Gage's mice. (Pathologists were hoping to learn more about how quickly the patients' tumor cells were growing.) When Gage dyed their brain samples, he again saw new neurons. Like the mice, the humans showed evidence of neurogenesis.

Gage's discovery hit the world of neurological research like a thunderclap. Since then, scientists have been finding more evidence that the human brain is not only capable of renewing itself but that exercise speeds the process.

"We've always known that our brains control our behavior," Gage says, "but not that our behavior could control and change the structure of our brains."

The human brain is extremely difficult to study, especially when a person is still alive. Without euthanizing their subjects, the closest that researchers can get to seeing what goes on in there is through a functional M.R.I. machine, which measures the size and shape of the brain and, unlike a standard M.R.I. machine, tracks blood flow and electrical activity.

This spring, neuroscientists at Columbia University in New York City published a study in which a group of men and women, ranging in age from 21 to 45, began working out for one hour four times a week. After 12 weeks, the test subjects, predictably, became more fit. Their VO2 max, the standard measure of how much oxygen a person takes in while exercising, rose significantly.

But something else happened as a result of all those workouts: blood flowed at a much higher volume to a part of the brain responsible for neurogenesis. Functional M.R.I.'s showed that a portion of each person's hippocampus received almost twice the blood volume as it did before. Scientists suspect that the blood pumping into that part of the brain was helping to produce fresh neurons.

The hippocampus plays a large role in how mammals create and process memories; it also plays a role in cognition. If your hippocampus is damaged, you most likely have trouble learning facts and forming new memories. Age plays a factor, too. As you get older, your brain gets smaller, and one of the areas most prone to this shrinkage is the hippocampus. (This can start depressingly early, in your 30's.) Many neurologists believe that the loss of neurons in the hippocampus may be a primary cause of the cognitive decay associated with aging. A number of studies have shown that people with Alzheimer's and other forms of dementia tend to have smaller-than-normal hippocampi.

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