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How Exercise Benefits the Brain

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Adam Weiss/Getty Images

Does exercise strengthen your brain while it builds muscle?

To learn more about how exercise affects the brain, scientists in Ireland recently asked a group of sedentary male college students to take part in a memory test followed by strenuous exercise.

First, the young men watched a rapid-fire lineup of photos with the faces and names of strangers. After a break, they tried to recall the names they had just seen as the photos again zipped across a computer screen.

Afterward, half of the students rode a stationary bicycle, at an increasingly strenuous pace, until they were exhausted. The others sat quietly for 30 minutes. Then both groups took the brain-teaser test again.

Notably, the exercised volunteers performed significantly better on the memory test than they had on their first try, while the volunteers who had rested did not improve.

Meanwhile, blood samples taken throughout the experiment offered a biological explanation for the boost in memory among the exercisers. Immediately after the strenuous activity, the cyclists had significantly higher levels of a protein known as brain-derived neurotrophic factor, or BDNF, which is known to promote the health of nerve cells. The men who had sat quietly showed no comparable change in BDNF levels.

For some time, scientists have believed that BDNF helps explain why mental functioning appears to improve with exercise. However, they haven't fully understood which parts of the brain are affected or how those effects influence thinking. The Irish study suggests that the increases in BDNF prompted by exercise may play a particular role in improving memory and recall.

Other new studies have reached similar conclusions, among both people and animals, young and old. In one interesting experiment published last month, Brazilian scientists found that after sedentary elderly rats ran for a mere five minutes or so several days a week for five weeks, a cascade of biochemical processes ignited in the memory center of their brains, culminating in increased production of BDNF molecules there. The old, exercised animals then performed almost as well as much younger rats on rodent memory tests.

Another animal study, this one performed by researchers in the Brain Injury Research Center at the University of California, Los Angeles, and published in September in the journal Neuroscience, showed that if adult rats were allowed to run at will for a week, the memory center of their brains afterward contained more BDNF molecules than in sedentary rats, and teemed with a new population of precursor molecules that presumably would soon develop into fully functioning BDNF molecules.

Perhaps the most inspiring of the recent experiments is one involving aging human pilots. For the experiment, published last month in the journal Translational Psychiatry, scientists at Stanford University School of Medicine asked 144 experienced pilots ages 40 to 65 to operate a cockpit simulator three separate times over the course of two years.

For all of the pilots, performance declined somewhat as the years passed. A similar decline with age is common in all of us.

Many people find it more difficult to perform skilled tasks — driving an automobile, for instance – as they grow older, says Dr. Ahmad Salehi, an associate professor of psychiatry and behavioral sciences at Stanford and lead author of the study.

But in this case, the decline was especially striking among one particular group of men. These aging pilots carried a common genetic variation that is believed to reduce BDNF activity in their brains. The men with a genetic tendency toward lower BDNF levels

seemed to lose their ability to perform complicated tasks at almost double the rate of the men without the variation.

While the pilot experiment wasn't an exercise study, it does raise the question of whether strenuous exercise could slow such declines by raising BDNF levels, thereby salvaging our ability to perform skilled manual tasks well past middle age.

"So many studies have shown that exercise increases levels of BDNF," says Dr. Salehi. While he notes that other growth factors and body chemicals are "upregulated" by exercise, he believes BDNF holds the most promise.

"The one factor that shows the fastest, most consistent and greatest response is BDNF," he says. "It seems to be key to maintaining not just memory but skilled task performance."

Dr. Salehi plans next to examine the exercise histories of the pilots, to see whether those with the gene variant, which is common among people of European or Asian backgrounds, respond differently to workouts.

In people who have the variant and less BDNF activity, "exercise is probably even more important," he says. "But for everyone, the evidence is very, very strong that physical activity will increase BDNF levels and improve cognitive health."