

NOVEMBER 18, 2009, 12:01 AM NY Times

Phys Ed: Why Exercise Makes You Less Anxious

By GRETCHEN REYNOLDS

Joubert/Photo Researchers, Inc A neuron in the brain.

Researchers at Princeton University recently made a remarkable discovery about the brains of rats that exercise. Some of their neurons respond differently to stress than the neurons of slothful rats. Scientists have known for some time that **exercise stimulates the creation of new brain cells** (neurons) but not how, precisely, these neurons might be functionally different from other brain cells.

In the experiment, preliminary results of which were presented last month at the annual meeting of the Society for Neuroscience in Chicago, scientists allowed one group of rats to run. Another set of rodents was not allowed to exercise. Then all of the rats swam in cold water, which they don't like to do. Afterward, the scientists examined the animals' brains. **They found that the stress of the swimming activated neurons in all of the brains.** (The researchers could tell which neurons were activated because the cells expressed specific genes in response to the stress.) But the youngest brain cells in the running rats, the cells that the scientists assumed were created by running, were less likely to express the genes. They generally remained quiet. **The "cells born from running," the researchers concluded, appeared to have been "specifically buffered from exposure to a stressful experience." The rats had created, through running, a brain that seemed biochemically, molecularly, calm.**

For years, both in popular imagination and in scientific circles, it has been a given that exercise enhances mood. But how exercise, a physiological activity, might directly affect mood and anxiety — psychological states — was unclear. Now, thanks in no small part to improved research techniques and a growing understanding of the biochemistry and the genetics of thought itself, scientists are beginning to tease out **how exercise remodels the brain**, making it more resistant to stress. In work undertaken at the University of Colorado, Boulder, for instance, scientists have examined the role of serotonin, a neurotransmitter often considered to be the "happy" brain chemical. That simplistic view of serotonin has been undermined by other researchers, and the University of Colorado work further dilutes the idea. In those experiments, rats taught to feel helpless and anxious, by being exposed to a laboratory stressor, showed increased serotonin activity in their brains. But rats that had run for several weeks before being stressed showed less serotonin activity and were less anxious and helpless despite the stress.

Other researchers have looked at how **exercise alters the activity of dopamine**, another neurotransmitter in the brain, while still others have concentrated on the **antioxidant powers of moderate exercise**. Anxiety in rodents and people has been linked with excessive oxidative stress, which can lead to cell death, including in the brain. **Moderate exercise**, though, appears to dampen the effects of oxidative stress. In an experiment led by researchers at the University of Houston and reported at the Society for Neuroscience meeting, rats whose oxidative-stress levels had been artificially increased with injections of certain chemicals were extremely anxious when faced with unfamiliar terrain during laboratory testing. But rats that had exercised, even if they had received the oxidizing chemical, were relatively nonchalant under stress. When placed in

the unfamiliar space, they didn't run for dark corners and hide, like the unexercised rats. They insouciantly explored.

“It looks more and more like **the positive stress of exercise prepares cells and structures and pathways within the brain so that they're more equipped to handle stress in other forms**,” says Michael Hopkins, a graduate student affiliated with the Neurobiology of Learning and Memory Laboratory at Dartmouth, who has been studying how exercise differently affects thinking and emotion. “It's pretty amazing, really, that you can get this translation from the realm of purely physical stresses to the realm of psychological stressors.”

The stress-reducing changes wrought by exercise on the brain don't happen overnight, however, as virtually every researcher agrees. In the University of Colorado experiments, for instance, rats that ran for only three weeks did not show much reduction in stress-induced anxiety, but those that **ran for at least six weeks** did. “Something happened between three and six weeks,” says Benjamin Greenwood, a research associate in the Department of Integrative Physiology at the University of Colorado, who helped conduct the experiments. Dr. Greenwood added that it was “not clear how that translates” into an exercise prescription for humans. We may require more weeks of working out, or maybe less. And no one has yet studied how intense the exercise needs to be. But the lesson, Dr. Greenwood says, is “don't quit.” Keep running or cycling or swimming. (Animal experiments have focused exclusively on aerobic, endurance-type activities.) You may not feel a magical reduction of stress after your first jog, if you haven't been exercising. But the molecular biochemical changes will begin, Dr. Greenwood says. And eventually, he says, they become “profound.”