

Bigger Brains, Better Genes

Believe it or not, those are among the benefits of exercising more and eating healthier.

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*"Go pump some neurons! Expand your craniums!"
—Robin Williams, in "Mrs. Doubtfire"*

You don't need to read this column to know that exercise is good for you. You probably already know that regular, moderate exercise is one of the best things you can do for your health and well-being. What you may not know is that new research is showing that exercise beneficially affects your genes, helps reverse the aging process at a cellular level, gives you more energy, makes you smarter, and may even help you grow so many new brain cells (a process called neurogenesis) that your brain actually gets bigger.

Really.

So does improving your nutrition. A diet high in sugar and saturated fat diminishes neurogenesis, whereas other foods increase it, including chocolate (in moderate amounts), tea and blackberries, which contain a substance called epicatechin that improves memory. Small amounts of alcohol increase neurogenesis, whereas larger amounts decrease it. Chronic emotional stress decreases neurogenesis, but stress management techniques increase it. Drugs such as nicotine, opiates and cocaine decrease neurogenesis, whereas a study published in the *Journal of Clinical Investigation* in 1995 showed that cannabinoids (found in marijuana) increase it, at least in rats. (Uh, what were we just talking about?)

Use It or Lose It

Until about nine years ago it was thought that you were born with a certain number of neurons, and they tended to decrease in number as you got older. The best you could hope to do was to slow the rate at which you lost brain cells.

Fortunately, it's not true. Researchers at the Salk Institute for Biological Studies and at Columbia University showed that older adults continue to generate new neurons at virtually any age. Earlier this year these researchers found that in addition to growing new neurons, exercise doubled blood flow to the brain. A study published last year by researchers at the University of Illinois reported that just walking for three hours per week for only three months caused so many new neurons to grow that it actually increased the size of people's brains.

Best of all, the region of the brain that grew the most was the hippocampus, the part most involved with memory and cognition. After only three months, those who exercised had brain volumes typical of people who were three years younger! Also, the new neurons tend to find their way to well-established existing connections and replace ones that are damaged or nonfunctioning. Those who showed the most improvement in fitness also showed the greatest enhancement in memory. The authors concluded, "These results suggest that cardiovascular fitness is associated with the sparing of brain tissue in aging humans. Furthermore, these results suggest a strong biological basis for the role of aerobic fitness in maintaining and enhancing central nervous system health and cognitive functioning in older adults."

Regular, moderate exercise (along with healthier eating and stress management techniques) also reduces inflammation throughout your body, including in your brain, and reduces the incidence of tiny strokes that can impair your ability to think clearly. Exercise also helps boost your sense of well-being. Levels of beneficial neurotransmitters such as dopamine, serotonin and norepinephrine are higher in those who exercise—the same ones elevated by many antidepressants. These, in turn, may help reduce depression, elevate mood and help you focus better.

Exercise Makes You More Intelligent

Other studies have shown that older adults who exercise regularly have better memory, are better at going from one mental task to another, and can focus and concentrate better than those who are sedentary. In other words, exercise makes older people more intelligent.

Exercise makes younger people smarter too. Kids who exercise have fewer problems with attention-deficit disorder and learn faster. Studies have shown that physical education in schools improves academic performance as well as physical fitness. For example, a study by the California Department of Education of 322,000 seventh-grade students found that the most fit scored in the 66th percentile on their SATs, whereas the least fit scored in the 28th percentile. Studies at the University of Illinois also found that those who were more fit had better standardized test scores.

Exercising Your Genes

Your genes are not your fate. The choices you make each day in your diet and lifestyle have a direct influence on how your genetic predisposition is expressed—for better and for worse. You're only as old as your genes, but how your genes are expressed may be modified by exercise, diet and lifestyle choices much more than had previously been believed—and more quickly. For example, Finnish scientists reported in a study published in July that increased moderate to vigorous physical activity modified two genes involved in type 2 diabetes and reduced the risk of developing the disease, independent of changes in weight or diet.

Another recent study compared mitochondria in muscle biopsies of older and younger men and women. Your mitochondria are the "energy generators" of your body's cells. One of the reasons many people feel less energetic as they get older is that their mitochondria work less efficiently with age. The investigators found that in those who were mostly sedentary, mitochondrial function declined markedly with age and was affected by more than 300 genes. Then the investigators put these older men and women through a six-month exercise program that involved strength training for one hour only two days per week using the types of weight machines found in most gyms. Resistance exercise for each session consisted of three sets of 10 repetitions for each of: leg press, chest press, leg extension, leg flexion, shoulder press, lat pull-down, seated row, calf raise, abdominal crunch and back extension, and 10 repetitions for arm flexion and arm extension.

After only six months, the subjects' strength improved by 50 percent, and they reported feeling much more energetic. Many of the 300 genes that had declined with age began to now act more like those in younger people. In fact, the investigators found that exercise affected age-associated gene expression

more than in younger people, meaning that exercise is especially beneficial as people get older.

These high-tech studies illustrate what a powerful difference low-tech interventions such as changes in exercise, nutrition and stress management techniques can play in our lives. People often believe that advances in medicine have to be a new drug, a new laser or a surgical intervention to be powerful—something really high-tech and expensive. They often have a hard time believing that the simple choices that we make in our lives each day—how much we exercise, what we eat and how we respond to stress—may make such a powerful difference in our health, our well-being, and even in our brains. But they often do.

How to remember to exercise in a way that's sustainable? Do what you enjoy, make it fun and do it regularly. If you grow new neurons, then you won't forget!

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