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How Inactivity Changes the Brain

NOEL HENDRICKSON / GETTY IMAGES

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A number of studies have shown that exercise can remodel the brain by prompting the creation of new brain cells and inducing other changes. Now it appears that inactivity, too, can remodel the brain, according to a notable new report.

The study, which was conducted in rats but likely has implications for people too, the researchers say, found that being sedentary changes the shape of certain neurons in ways that significantly affect not just the brain but the heart as well. The findings may help to explain, in part, why a sedentary lifestyle is so bad for us.

Until about 20 years ago, most scientists believed that the brain's structure was fixed by adulthood, that you couldn't create new brain cells, alter the shape of those that existed or in any other way change your mind physically after adolescence.

But in the years since, neurological studies have established that the brain retains plasticity, or the capacity to be reshaped, throughout our lifetimes. Exercise appears to be particularly adept at remodeling the brain, studies showed.

But little has been known about whether inactivity likewise alters the structure of the brain and, if so, what the consequences might be.

So for a study recently published in *The Journal of Comparative Neurology*, scientists at Wayne State University School of Medicine and other institutions gathered a dozen rats. They settled half of them in cages with running wheels and let the animals run at will. Rats like running, and these animals were soon covering about three miles a day on their wheels.

The other rats were housed in cages without wheels and remained sedentary.

After almost three months of resting or running, the animals were injected with a special dye that colors certain neurons in the brain. In this case, the scientists wanted to mark neurons in the animals' rostral ventrolateral medulla, an obscure portion of the brain that controls breathing and other unconscious activities central to our existence.

The rostral ventrolateral medulla commands the body's sympathetic nervous system, which among other things controls blood pressure on a minute-by-minute basis by altering blood-vessel constriction. Although most of the science related to the rostral ventrolateral medulla has been completed using animals, imaging studies in people suggest that we have the same brain region and it functions similarly.

A well-regulated sympathetic nervous system correctly directs blood vessels to widen or contract as needed and blood to flow, so that you can, say, scurry away from a predator or rise from your office chair without fainting. But an overly responsive sympathetic nervous system is problematic, said Patrick Mueller, an associate professor of physiology at Wayne State University who oversaw the new study. Recent science shows that "overactivity of the sympathetic nervous system contributes to cardiovascular disease," he said, by stimulating blood vessels to constrict too much, too little or too often, leading to high blood pressure and cardiovascular damage.

The sympathetic nervous system will respond erratically and dangerously, scientists theorize, if it is receiving too many and possibly garbled messages from neurons in the rostral ventrolateral medulla.

And, as it turned out, when the scientists looked inside the brains of their rats after the animals had been active or sedentary for about 12 weeks, they found noticeable differences between the two groups in the shape of some of the neurons in that region of the brain.

Using a computerized digitizing program to recreate the inside of the animals' brains, the scientists established that the neurons in the brains of the running rats were still shaped much as they had been at the start of the study and were functioning normally.

But many of the neurons in the brains of the sedentary rats had sprouted far more new tentacle-like arms known as branches. Branches connect healthy neurons into the nervous system. But these neurons now had more branches than normal neurons would have, making them more sensitive to stimuli and apt to zap scattershot messages into the nervous system.

In effect, these neurons had changed in ways that made them likely to overstimulate the sympathetic nervous system, potentially increasing blood pressure and contributing to the development of heart disease.

This finding is important because it adds to our understanding of how, at a cellular level, inactivity increases the risk of heart disease, Dr. Mueller said. But even more intriguing, the results underscore that inactivity can change the structure and functioning of the brain, just as activity does.

Of course, rats are not people, and this is a small, short-term study. But already one takeaway is that not moving has wide-ranging physiological effects. In upcoming presentations, Dr. Mueller said, he plans to show slides of the different rat neurons and, echoing the old anti-drug message, point out that "'this is your brain.' And this is your brain on the couch."

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