

Forging new pathways in the brain



Neuroplasticity helps the brain recover lost function.

by Cynthia L. Kryder

Phil See strums his guitar as he sings a song he composed recently. See, a Seattle-based musician diagnosed with relapsing-remitting multiple sclerosis in 2002, acknowledges that his ability to perform music was limited for a while. “After my diagnosis, I developed muscle weakness and incoordination that made playing any instrument difficult,” See explains. “But that didn’t stop me. I was determined to keep playing no matter what.” See’s determination, and his brain’s neuroplasticity, made his musical recovery possible.

“Neuroplasticity refers to the brain’s ability to adapt to new experiences and reorganize itself by forming new neural connections,” says Dr. Lauren Krupp, professor of neurology and director of the Multiple Sclerosis Comprehensive Care Center at New York University’s Langone Medical Center.



Phil See, a Seattle-based musician, retrained himself to play guitar after his MS diagnosis.

Photo courtesy of Phil See

Every day, See completed a series of exercises designed to increase strength and improve coordination in his fingers and hands. Gradually, as his brain formed new connections, he relearned how to play a musical chord, then scales and finally an entire song. “It took about six months to get back to music,” he says. “I actually think I play better now than before my diagnosis.”

Rewire the circuits

Scientists once believed that the human brain could not change substantially after young adulthood. But that notion was debunked by scores of discoveries showing that the brain is a dynamic rather than static organ. The adult brain is capable of forming new cells, and undamaged neurons in the brain can sprout new nerve endings to link with other cells. Today we know that the brain continues to reorganize itself throughout life by establishing new connections. This phenomenon enables the brain to compensate for function lost to illness or injury, and rewire its activity in response to new experiences or changes in the environment.

To perform specific functions, neurons in different areas of the brain form complex networks of interactions, known as functional networks. “Following damage to a specific part of the brain, remaining parts within the same functional network can learn how to take over the functions that were lost,” says Dr. Netta Levin, senior neurologist and head of the functional magnetic resonance imaging unit at Hadassah Hebrew University Medical Center in Jerusalem. “In essence, the brain recruits other uninjured regions within the same network to compensate for dysfunction caused by injury.”

Some regions of the brain are more “plastic” than others, Dr. Levin says. Areas that receive and integrate information from many different senses, such as those involved in higher-level cognitive functions like memory, judgment and decision-making, have greater plasticity than

those regions that receive and interpret input from only one main source, such as the area devoted to eyesight, the primary visual cortex.



How do you create new neural pathways? Engage in cognitively demanding situations, suggests Dr. Lauren Krupp. Photo courtesy of Dr. Lauren Krupp

Neuroplasticity in MS

In MS, neuroplasticity is likely responsible for masking some visible symptoms of MS, especially early on. Evidence shows that following an MS relapse in which there is a loss of myelin (the protective covering that surrounds nerve fibers), nerve fibers can recover some function by reorganizing their electrical properties. In addition, functional recovery from symptoms involves a reduction of inflammation, some repair of myelin within areas of damage (lesions), and adaptive networking of the brain to restore lost function.

Functional magnetic resonance imaging (fMRI) is a tool researchers use to peer into the brain to determine which regions become activated when individuals perform specific motor or cognitive tasks. Studies using fMRI have found that because of neuroplasticity, the brains of people with MS are organized in different ways than the brains of people who do not have the disease. For example, people in the early stages of MS activate more regions during a given task than do people without the disease; this suggests that neuroplasticity may be involved very early in the disease process, and that this extra activation is one way the brain compensates to allow the person with MS to maintain motor and cognitive function for a period of time.

Nevertheless, the brain's ability to adjust for accumulating damage in MS varies from person

to person and among the different disease types. Moreover, neuroplasticity has its limits. The brain becomes less plastic with age and duration of disease.

Building connections

Making new neural connections depends on an individual's experience and environment. "We can enhance neuroplasticity through exercise, balanced nutrition, avoidance of toxic agents such as excessive alcohol or tobacco, and by engaging in cognitively demanding and novel situations," Dr. Krupp says.



Some regions of the brain are more "plastic" than others, such as those involved in higher-level cognitive functions, says Dr. Netta Levin. Photo courtesy of Dr. Netta Levin

An activity as simple as exercising with a video game may create new neural pathways and improve motor skills. In one study, people with MS used a Nintendo Wii balance board and video games five times a week for 30-minute exercise sessions for 12 weeks. At the end of the study, not only did many of them have better balance, they also showed increased connectivity in several regions of the brain, as detected by fMRI. This finding implies that repetitive physical training enhances neuroplasticity, and that neuroplasticity is responsible for improved function.

There's also recent evidence from the lab suggesting that learning new motor tasks—anything that requires learning to move in a new way, such as a new dance step—actually builds new myelin.

It's not just physical training that imparts benefits, however. "A cognitively stimulating environment can boost reorganization in the brain and may improve performance," Dr. Levin says.

Indeed, fMRI studies show that interventions aimed at recovery—for example, treatments designed to improve attention, memory, information processing, executive functions and higher-level language processes—actually increase brain activity and stimulate neuroplasticity. More importantly, people who engage in these activities improve their cognitive performance. To boost your brain, take a class, learn to play a musical instrument or engage in new hobbies.

There is much more to learn about neuroplasticity and the mechanisms by which the brain compensates for the inflammation and nerve degeneration seen in MS. Future research is attempting to identify the most effective training strategies to stimulate neuroplasticity and improve functioning. Dr. Krupp is investigating the potential of a plasticity-based adaptive computerized program to treat learning, memory and problem-solving difficulties in adults with MS. "The results of this research will help guide us in the design of future studies," says Dr. Krupp, and could help develop new strategies to enhance cognitive function.

See is a good example of how stimulation and repetitive practice can help to establish new brain connections. Today he motivates other musicians faced with neurologic challenges and spreads the word about neuroplasticity. His advice to others with MS is simple: "Don't give up your passions. Neuroplasticity works. I'm living proof."

Cynthia L. Kryder is a freelance medical writer in Phoenixville, Pennsylvania.

A song by Phil See will be featured in an upcoming book called [Stories of Music: Volume 2](#), coming out this fall.

Download the **Momentum** tablet app and listen to Phil See's song about neuroplasticity.