

# WHEN THE BRAIN HAS RE-WIRED ITSELF



by Aage R. Møller, Ph.D.

The brain is "plastic" (changeable) and the connections between the different parts of the brain can change. This is known as neural plasticity — which means that the brain is not "hard wired" like electrical equipment. Pain, muscle spasm, and tinnitus can be the results of changes in the wiring of the brain.

Tinnitus can cause great distress for those who have it as well as for those who treat it. One problem is that conventional tests usually do not show any sign of disease, and the only information that the physician has is the patient's description of his or her trouble. The lack of tests that can help to diagnose the problem and find

out where the problem is located naturally makes treatment difficult. Tinnitus is intuitively associated with the ear and it is therefore often assumed that it is caused by something going wrong with the ear. While it is true that some forms of tinnitus indeed are caused by disorders of the ear, many forms of tinnitus, particularly the more severe forms, are caused by changes in the nervous system. It is the nervous system that makes it possible to hear the sounds that reach our ears.

It has been known for many years that children's brains change as they grow. We now know that the function of the adult brain can also change, and that connections between different parts of the brain can open and close and parts of the brain can become more sensitive or more

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## Tinnitus Spouse Survival *(continued)*

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Second, I sought to combat his inertia by encouraging simple, purposeful tasks that could be achieved within the framework of his shortened attention span. These included short-term community projects as well as household chores. Several times each week I insisted that he join me for a simple outing — a trip to the park or the bookstore — to break his routine and demonstrate that he could "do something."

Third, I found it necessary to set some limits with regard to the discussion of tinnitus. While he was consumed with every facet of it, I still needed to attend to many other aspects of our daily life and it was not always convenient to stop mid-stream to chat or listen — again. Devoting a specific time to talk about tinnitus allowed me to listen without distraction, and it let him know that he had my undivided attention to express the anger, fear, and isolation that he felt.

Over time, I compiled a list of "Tinnitus Spouse Survival Tips" that are based on my not-so-scientific research with a patient population of one. They are, however, the result of my objective observations as a nurse and my subjective experience as a wife. I hope that the reader might find value in them as well.

- ◆ Learn as much about tinnitus as possible.
- ◆ Take notes and ask questions. Become your spouse's medical liaison and advocate.
- ◆ Don't underestimate the value of good psychiatric or psychological intervention for your spouse and for you.
- ◆ Challenge distorted thoughts. Accentuate what is positive, and acknowledge but redirect negative thinking.
- ◆ Get your spouse moving. Exercise, outings, and chores will build a résumé of success that you can use to fight feelings of worthlessness.
- ◆ Decrease as much extraneous stress in your lives as possible. (This may not be the year to make quilts for everyone on your Christmas list.)
- ◆ Be compassionate and commiserate on occasion, but be tough when there is too much whining.
- ◆ Be patient. Successful treatment is probable but this is not strep throat! No 10-day course of Amoxil here.
- ◆ Maintain your social contacts and outside interests. Without any personal outlet you will become less effective in your supportive role.
- ◆ Keep yourself physically and emotionally fit. Your spouse and your family need you and you deserve it! ■

# WHEN THE BRAIN HAS RE-WIRED ITSELF *(continued)*

active. This is mainly caused by changes in the ability of nerve cells to transfer information from one part of the brain to another. Recently, we've learned that the mature brain can grow new nerve cells — something that was regarded as impossible just a few years ago. This new insight has thus revealed that the mature brain is "plastic" and can change the way it functions in ways that are similar to learning. This discovery has changed our view on tinnitus as well as on pain and some forms of muscle spasm.

Normally the ear is connected to parts of the brain that can distinguish different sounds such as speech. After that, the information is sent to other parts of the brain that are involved in understanding the meaning of speech. Music sounds are interpreted by parts of the brain that are involved in enjoyment of sounds. The different parts of the brain must be connected to the ear in the right way in order for our hearing to function normally.

Many people with tinnitus hear sounds as unusually loud or unpleasant or that evoke fear. It is possible that the information is being sent to the wrong part of the brain because the wiring of the brain has changed. One known factor that can cause these changes is a lack of input from the ear, like in silence or when hearing has been damaged.

We normally use only one of the two routes that connect the ear with the parts of the brain that perceive sound. The route we use is called the classical ascending auditory pathway and it leads from the ear to the auditory part of the cerebral cortex where some interpretation of sounds is done. From the cerebral cortex, the information about sounds is sent to brain centers that can extract the meaning of sounds. As the information about sounds travels along this "information highway" it is analyzed in the different clusters of nerve cells (called nuclei) that are located along this pathway.

Tinnitus may be caused by some nerve cells in these nuclei being too sensitive so that they act on their own instead of waiting for sounds to arrive. That could explain some forms of tinnitus. When sounds appear to be stronger than normal (hyperacusis), it may be a result of nerve cells being too active. When sounds are unpleasant or cause fear, it is possible that information is reaching parts of the brain that are not normally involved with sound.

Tinnitus could reach other parts of the brain by way of the other route — the non-classical ascending auditory pathway. Although little is known about this part of the brain, we do know that it processes sounds differently and it connects to completely different parts of the brain than does the classical pathway.

This non-classical pathway connects the ear to parts of the brain that deals with emotions. While the classical pathway only deals with sound, input from other senses mixes with sound in the non-classical pathway. Nerve cells in that part of the brain not only respond to sound but also to touch of the skin, which may affect the way these nerve cells conduct information about sound. We have earlier shown that electrical stimulation of a nerve in the wrist can change the way tinnitus sounds and that was taken as a sign that the non-classical auditory nervous system is involved in some forms of tinnitus. It may be that the opening of this non-classical pathway causes sounds to become unpleasant and sometimes evoke fear. Dr. Richard Salvi's research group in Buffalo, New York, has recently shown evidence that this area in the brain, generally known as the limbic system, is activated by some forms of tinnitus.

The involvement of the non-classical pathway in tinnitus also explains why some people with tinnitus can change their tinnitus by touching their skin or by making muscle contractions or changing their gaze, as has been shown by A.T. Cacace, Ph.D., and co-workers.

It should be possible to reverse the changes in the brain since they are not caused by damage to tissue. But as yet, we do not know exactly how to do that. We do know that silence and strong sounds can cause changes in the connections in the brain. This fact should make us avoid these conditions as much as possible. People with tinnitus should avoid silence, too, even if sound is unpleasant.

This new understanding of how the auditory nervous system works and how connections between different parts of the brain can change has helped us understand tinnitus better. Such progress naturally improves our possibilities to treat and prevent tinnitus. ■

*Dr. Møller is a researcher at the University of Texas at Dallas, Callier Center for Communication Disorders.*