

Brass sounds from the MRI scanner

In April, an unusual sound wafted through the building of the *Biomedizinische NMR Forschungs GmbH*. For several days, the drone of brass instruments regularly punctuated the silence. Occasionally, an isolated note could be heard, sometimes a short sequence. The sounds came from the cellar, or, more precisely, the real-time magnetic resonance imaging (MRI) scanner – the latest development by Jens Frahm's research team. As part of the international *MRI Brass Repository Project*, horn, trumpet and trombone players were playing in an MRI machine – in an unusual position and in a confined space. The scientists involved hope to shed some new light on a job-related disease that has cost many professional brass players their career. The condition known as focal dystonia impairs the controlled tension in their tongue and lips.

This disease is still little-known and has hardly ever been investigated. Why can virtuoso hornists or trombonists that have played for many years suddenly no longer play properly? What is behind this strange condition, which only seems to occur in association with fine motor movements that are highly specialized, trained over years, and constantly repeated? How can this type of condition be prevented or, in the best case, be treated? To date, part of the problem was that researchers did not even know exactly how brass players produce their sound. What happens in the mouth and in the larynx, and which muscle movements occur at which point?

Look into the head of brass players with MRI

These questions can now be answered, for the first time, by the real-time MRI technique developed by Frahm and his team. Thanks to the new technology, which is currently being tested at some top clinical research centers, we can now watch live what is happening within the human body. Physicians can use it, for example, to observe joints in motion or the beating of a heart – and furthermore what is happening in the mouth, for instance, during swallowing or speaking: "With real-time MRI we can now also study the actions of brass players and follow their tongue movements," explains the head of the research project, Peter Iltis, Professor of Kinesiology at Gordon College in Massachusetts (United States). The scientist has an insider's knowledge of the mysterious disease. As a hornist, he had to stop playing after being diagnosed with dystonia in 2002.

He was introduced to the Göttingen team by Eckart Altenmüller, Director of the *Institute for Music Physiology and Musicians' Medicine* at the Hanover University of Music, Drama and Media, and an internationally renowned expert in occupational diseases of musicians. Iltis is happy that he can use the new technology at its birthplace: "This is a great opportunity for cooperation."

The scientists involved in the *MRI Brass Repository Project* are performing a comparative study to investigate both

musicians suffering from focal dystonia, and practicing elite musicians from top orchestras. A normal instrument with valves cannot be brought into the MRI scanner, so the musicians play on a custom-made one. Using a plastic mouthpiece, they blow through a plastic tube, which replaces the valves and which is connected to the non-ferromagnetic metal bell of the instrument. This is placed at the subject's feet when they are lying in the MRI magnet.

In the past year, several French horn players from the *Berlin Philharmonic Orchestra* have already played in the Göttingen real-time MRI scanner, including the famous British hornist Sarah Willis. In the second series of tests this spring, a dozen musicians took part, mostly from the United States.

The chairperson of the *Dystonia Medical Research Foundation*, Glen Estrin, also spent some days at the *Max Planck Campus* in Göttingen to get an impression of the research. As hornist, he was a member of Frank Sinatra's backing band for years and played regularly on Broadway. "It was a fantastic time," he recalls. In 1997, he suddenly noticed that his lips were no longer working properly. "A few months later, I could no longer play at all." It was the end of his career. At that time, dystonia was still virtually unknown as a disease, and it took a long time until a neurologist finally diagnosed it correctly, Estrin recounts. He is one of the founders of the *Dystonia Medical Research Foundation*, which supports research projects such as the *MRI Brass Repository Project*.

Hope to help other musicians

One of the first volunteers in this year's series of investigations was Eric Overholt. Peter Iltis and Jens Frahm explain the procedure and help to get him into the correct position. Eric Overholt, who was once principal hornist in the *Los Angeles Philharmonic*, had to quit the profession three years ago due to focal dystonia. He hopes that by participating in the study he can help to spare other musicians his bitter experience.

From the control room Peter Iltis gives him instructions over the microphone: "*Pianissimo*, please." Overholt plays a short sequence of notes. "That was great," Peter Iltis says. "And now *mezzo-forte*, please." Eric Overholt plays the sequence again, this time a little louder. At the same time, the researchers observe the respective movements of his lips and tongue on the screen. Unlike other real-time MRI recordings,



Douglas Yeo (right), bass trombonist in the *Boston Symphony Orchestra*, takes his position in the MRI scanner.

they have an additional technical challenge to overcome: "We need to record sounds and images simultaneously to fully analyze the results," explains Frahm.

Douglas Yeo, bass trombonist for many years in the *Boston Symphony Orchestra*, is another subject in the study. In the comparative investigation, he is part of the group of top musicians with no impairment. Yeo is also a university professor of trombone and has published numerous technical articles on the bass trombone. For the MRI investigation in Göttingen, he had planned to bring several special instruments made specifically for him by *Yamaha*. "The instruments got lost somewhere, however, on my flight from Phoenix to Frankfurt via Chicago," he reveals. So he is playing on a trombone prepared for the MRI study by the researchers in Göttingen.

Position of the tongue is critical

Douglas Yeo is also steadily working his way through the sequences of notes Peter Iltis plays him. Sometimes he is asked to play with a Wagnerian tone, sometimes with "a very dry *staccato*." "Six counts, and repeat," Iltis instructs. Eckart Altenmüller is currently visiting from Hanover to take part in today's investigations and is attentively following the bass trombonist's playing from the control room. His doc-

toral student Sönke Hellwig has attended the investigations since they started. He is planning to use the results for his thesis on the subject of *Real-time representation of tongue movements in brass players and of wind and brass players with embouchure dystonia*.

One thing is immediately clear to the researchers: The live videos show significant differences in the tongue position of the various brass players while they play. The tongue is an impressively large muscle, and this clearly seems to be the problem. "There are no sensors at the back of our tongue, and that is why brass players cannot exactly control its position," explains Frahm. Using the MRI movies, musicians can now see the position of their tongue and, if needed, correct faulty positioning.

When the MRI procedure is over, Douglas Yeo closely examines the recordings in the control room. He is excited about the moving pictures of the larynx and mouth: "For the first time we can precisely see that tongue movements have a significant impact on how sound is produced. Up to now, we had no idea that this was the case," he marvels. This finding could be of great importance not only in the prevention and treatment of dystonia but also in the future training of musicians.

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