

THE INTERNATIONAL MRI HORN REPOSITORY PROJECT (IMHRP)

Project History and Previous Results

The International MRI-Horn Repository Project (IMHRP) began in 2013 utilizing real-time magnetic resonance imaging (RT-MRI) to study tongue and throat movement strategies of elite horn players and players who suffer from career-threatening movement disorders, with emphasis on embouchure dystonia (EmD).

RT-MRI enables a systematic study of the structural movements within the mouth and throat of brass performers. Prior to the IMHRP, Schumacher, et al. [1] were the first to apply RT-MRI in their study using trumpet players in 2013. Over the past 2.5 years, the IMHRP has extended the application to horn players, and has provided advancements that include dynamic, quantitative measurements [2], the fastest acquisition rates yet published (100 frames/sec) [3], and the first comparative studies of elite horn players and horn players with the movement disorder, embouchure dystonia (EmD) [4, 5]. These comparative studies provide vital insight into the nature of EmD by elucidating the inefficient and aberrant movement strategies used by EmD patients in comparison to elite performers.

To date, the IMHRP has acquired RT-MRI films on 12 elite horn players, six EmD horn players, and 12 college/conservatory level horn players. Current research from this project has provided the following results:

1. Publications in the following:
 - a. Iltis PW, Schoonderwaldt E, Zhang S, Frahm J, Altenmüller E. Real-time MRI comparisons of brass players: A methodological pilot study. *Hum Mov Sci.* 2015;42:132-45
 - b. Iltis PW, Frahm J, Voit D, Joseph AA, Schoonderwaldt E, Altenmüller E. High-speed real-time magnetic resonance imaging of fast tongue movements in elite horn players. *Quantitative imaging in medicine and surgery.* 2015;5(3):374-81. doi: 10.3978/j.issn.2223-4292.2015.03.02.
 - c. Iltis PW, Frahm J, Voit D, Joseph A, Schoonderwaldt E, Altenmüller E. Divergent oral cavity motor strategies between healthy elite and dystonic horn players. *J Clin Mov Disord.* 2015;2:15. doi:10.1186/s40734-015-0027-2.
 - d. Iltis PW, Frahm J, Voit D, Joseph A, Burke R, Altenmüller E. Inefficiencies in motor strategies of horn players with embouchure dystonia. *Medical Problems of Performing Artists.* 2016;31(2):69-77.
 - e. Iltis PW, Gillespie SL, Frahm J, Voit D, Joseph A, Altenmüller E. The role of the glottis in horn playing: A pilot study. *Medical Problems of Performing Artists.* 2016, (in review)

- f. Douglass, N., Iltis PW, Frahm J, Voit D, Joseph A, Altenmüller E. Real-time MRI biofeedback in oromyofacial disorder therapy: A case study (manuscript in preparation)
2. Presentations at international symposia dealing both with horn pedagogy and medical problems of performing artists
 - a. Iltis PW, Epstein E. Healthy Horn Playing: Injury Prevention Through Pedagogy Informed by Science. International Horn Symposium, Los Angeles, CA, August 2015.
 - b. Iltis PW, Epstein E. MRI Horn, The Inside Story: Pedagogy Informed by Science. International Horn Symposium, Ithaca, NY, June 2016.
 - c. Iltis PW, Burke R. The Use of Real-time Magnetic Resonance Imaging in Performing Arts Research: Application to Brass Performance and Movement Disorders. Performing Arts Medicine Association International Symposium, Weill Cornell Medical Center, New York-Presbyterian, NY, NY, July 2016
3. The development of simultaneous imaging in 2 and 3 imaging planes (essentially providing 2-3 different concurrent views of motor activity in the mouth and throat during any given performance task).
4. The development of real-time visual feedback allowing subjects to view and modify movement strategies while they perform inside the MRI scanner (see 1.f. above)
5. A YouTube website (MRI Horn Videos: Pedagogy Informed by Science (https://www.youtube.com/channel/UCqy7OihCf5sb5_xV7OhCRig)) featuring a developing series of short videos that present IMHRP findings that are of particular importance to brass pedagogy. To date, these include:
 - a. Episode 1: Introduction to the RT-MRI Horn Project <https://www.youtube.com/watch?v=LTMe38uOaT8>
 - b. Episode 2: The Role of the Tongue and Jaw in Pitch <https://www.youtube.com/watch?v=7Cz5HoQ1fCI>
6. An internationally-televised episode with Deutsch Welle Television, on the program, Sarah's Music: Music and Science (April, 2015), hosted by Sarah Willis, the world-renowned horn player from the Berlin Philharmonic Orchestra.

Proposed Scope of Research

The International MRI-Horn Repository Project (IMHRP) began in 2013 utilizing real-time magnetic resonance imaging (RT-MRI) to study tongue and throat movement strategies of elite horn players as well as strategies of those who suffer from movement disorders such as embouchure dystonia (EmD). The IMHRP is providing leading-edge research for those affected by EmD. By creating an expanded database from additional elite players, further insights may be gained which will help scientists, doctors and musicians further understand debilitating, career-ending movement disorders. Additionally, the RT-MRI movies produced by the IMHRP provide a valuable source for expanding the understanding of brass pedagogy [6-8].

Two significant testing sessions of IMHRP located at the Max Planck Institute in Göttingen are planned for the next calendar year (January 2017-January 2018). During each 10-day session, 12 elite horn players from significant European and American orchestras will be recruited for scanning. Our projected outcomes for this testing are the following:

1. Increase the number of elite performers from Europe and the United States who will participate in the IMHRP to provide a broader sampling. Specific exercises are designed to test a broad range of skills required to play the horn, and have been vetted by a committee of elite performers and horn pedagogues. The resulting films will be carefully annotated to provide important interpretive information that can be easily understood by students and teachers alike, explaining in plain terms the principles underlying common movement schemes that are employed by these elite artists.
2. Provide controlled-access publication of these annotated films on the web for approved use by musicians, academics, and the medical community.
3. Publish in related scholarly outlets that support this type of research.

Future aspirations for IMHRP include expanding its scope of study to include other brass wind instruments (trumpet, trombone, tuba).

The IMHRP has secured the commitment of Dr. Jens Frahm, Director of Biomedical NMR Research in Göttingen, to collaborate in this ongoing research project. Dr. Frahm's laboratory has led the way in RT-MRI research, particularly with respect to high-speed acquisition rates that retain high spatial resolution. Further, to our knowledge, his is also the only lab to have accomplished simultaneous multi-plane acquisition using RT-MRI, and the first to provide simultaneous visual feedback to subjects in the scanner. The IMHRP provides Dr. Frahm with an outlet for vital practical application of his data acquisition techniques, and the collaboration thus far has been extraordinary. The generosity of the Max Planck Institute for Biophysical Chemistry in allowing this project to have completely cost-free access to Dr. Frahm, his research team, and his MRI scanner for this important work is most extraordinary.

The need for extended study in this area is readily apparent, and again, this MRI film repository will provide a vital reference base with which to make comparisons in future studies.

Project Timeline

Two significant testing sessions at the Max Planck Institute in Göttingen are planned for the next calendar year (January 2017-January 2018). During each 10-day session, 12 elite horn players from significant European and American Orchestras will be recruited for scanning.

IMHRP's tentative schedule is as follows:

Oct. 2016 – Jan. 2017:	Recruitment of 12 musicians (Cohort A)
Apr. 2017:	Session One: Data Collection (Cohort A)
May, 2017 – Sept. 2017:	Analysis of Cohort A data, and recruitment of 12 additional musicians (Cohort B)
Oct. 2017:	Session Two: Data collection (Cohort B)
Nov. 2017 – Jan. 2018:	Data analysis and report compilation

Project Budget: See attached spreadsheet

Principal Investigators

The principal investigator for this project Dr. Peter W. Iltis holds a Ph.D. in exercise physiology from the University of Kansas, and is professor of kinesiology at Gordon College in Wenham, MA. In addition to his responsibilities in the Department of Kinesiology, Dr. Iltis also taught horn for 15 years at Gordon, and was a professional free-lance horn player. His horn playing career ended in 2002 when he was diagnosed with embouchure dystonia (EmD). The intersection of being a horn player, an EmD patient, and a scientist has made his involvement in research on EmD a natural fit. Dr. Iltis served for four years as the medical and scientific issuing editor for the *Journal of the International Horn Society* (The Horn Call). This, along with his interest and research in music physiology, led to an invitation in 2014 to serve as a research associate at the Institute for Music Physiology and Musician's Medicine in Hannover, Germany, directed by Dr. Eckart Altenmüller. There, Dr. Iltis was given responsibility to lead the nascent RT-MRI brass research project in collaboration with the Max Planck Institute for Biophysical Chemistry.

Collaborators are Dr. Jens Frahm, director of Biomedical NMR Research at the Max Planck Institute for Biophysical Chemistry, and Dr. Eckart Altenmüller, director of the Institute for Music Physiology and Musician's Medicine, Hannover, Germany.

Research Location

The IMHRP is jointly-hosted at the Max Planck Institute for Biophysical Chemistry in Göttingen, Germany, the Institute for Music Physiology and Musician's Medicine in Hannover, Germany, and at Gordon College in Wenham, Massachusetts, U.S.A.

References

1. Schumacher M, Schmoor C, Plog A, Schwarzwald R, Taschner C, Echternach M et al. Motor functions in trumpet playing-a real-time MRI analysis. *Neuroradiology*. 2013;55(9):1171-81. doi: 10.1007/s00234-013-1218-x.
2. Iltis PW, Schoonderwaldt E, Zhang S, Frahm J, Altenmüller E. Real-time MRI comparisons of brass players: A methodological pilot study. *Hum Mov Sci*. 2015;42:132-45. doi:10.1016/j.humov.2015.04.013.
3. Iltis PW, Frahm J, Voit D, Joseph AA, Schoonderwaldt E, Altenmüller E. High-speed real-time magnetic resonance imaging of fast tongue movements in elite horn players. *Quant Imaging Med Surg*. 2015;5(3):374-81. doi:10.3978/j.issn.2223-4292.2015.03.02.
4. Iltis P, Frahm J, Voit D, Joseph A, Burke R, Altenmüller E. Inefficiencies in motor strategies of hornplayers with embouchure dystonia. *Medical Problems of Performing Artists*. 2016;31(2): 69-77.
5. Iltis PW, Frahm J, Voit D, Joseph A, Schoonderwaldt E, Altenmüller E. Divergent oral cavity motor strategies between healthy elite and dystonic horn players. *J Clin Mov Disord*. 2015;2:15. doi:10.1186/s40734-015-0027-2.
6. Iltis P, Epstein E. RT-MRI Technology: Implications for Brass Pedagogy. *International Horn Symposium*; August, 2015; Los Angeles, CA2015.
7. Iltis P, Epstein E. RT-MRI: Pedagogy Informed by Science. *International Horn Symposium*; June, 2016; Ithaca, NY2016.
8. Iltis P, Epstein E. MRI Videos: Pedagogy Informed by Science. 2016. https://www.youtube.com/channel/UCqy7OihCf5sb5_xV7OhCRig. 2016.