

### **Attempts of Visualization of Singing Techniques: MRI Motion Imaging of Diaphragm Activities and Acoustic Features during Singing**

**Introduction and Study Objective:** One of the most significant issues of singing performance and vocal pedagogy is that singers cannot visualize their own systems responsible for singing. When describing their singing techniques, therefore, singers/voice teachers often verbally express their physical awareness. Our recent interviews of professional singers/voice teachers and voice students indicated that they consider the physical awareness of controlling the diaphragm activities played a major role in desirable singing. To visualize the anatomical evidences for this physical awareness of control, MRI motion imaging during singing was utilized as a tool, along with acoustic analyses of the singing voices.

**Methods:** Two sopranos, one professional singer and one voice student, were imaged by MRI during singings of scales and octaves on the vowel /a/. Because of the MRI scanner generated loud noise, singing voices for the acoustic analyses were recorded using the same tasks in an anechoic room just after the MRI experiments. In acoustic analyses, a pitch analysis method designed for accurate and temporally fine measurement and a spectral analysis method applicable to analysis-by-synthesis research paradigm were used.

**Results and Conclusion:** As the professional singer was physically aware of, her MRI images indicated well-controlled diaphragm activities with timely manner and great range of motion appropriate for each task, which were clearly differentiated from those of the voice students. Acoustic data comparisons between the professional singer and the voice student suggested different levels of singing techniques in relation to the diaphragm activities.

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Eri Haneishi, PhD, Professor, Showa University of Music

Reiji Oribe, BA, Graduate Student, Showa University of Music

Hironori Takemoto, PhD, Researcher, Universal Communication Research Institute, National Institute of Information and Communications Technology

Hideki Kawahara, PhD, Professor, Faculty of Systems Engineering, Wakayama University

Kiyoshi Honda, D.M.Sc., Professor, School of Computer Science and Technology, Tianjin University

Takeshi Saitou, PhD, Assistant Professor, Graduate School of Science and Technology, Kanazawa University

Kaori Hagiwara, Associate Professor, Showa University of Music

Hiroko Kishimoto, PhD, Professor, Showa University of Music