

# Practical analyses for real-time magnetic resonance (rtMRI) of voice production

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## **Abstract (max 300 words)**

Real-time magnetic resonance imaging (rtMRI) is a technique that provides high contrast videographic data of the vocal tract. These dynamic MRI scans capture 2D T1-weighted mid-sagittal slices that provide a rich description of complex movements inside the mouth and throat. These anatomical structures provide the physiological basis for behaviours such as speech, singing, expressions of emotion, and swallowing, which are otherwise not accessible for external observation. However, while this technology produces images of the dynamic morphological features of the vocal tract, taking quantitative measurements from these images is notoriously difficult. Traditionally, researchers have taken limited measurements of select morphological features, done so on a limited number of images, and in small sample sizes constrained by the extreme laboriousness of these procedures. We introduce a semi-automated processing pipeline that produces outlines of the vocal tract as a means to quantify the dynamic morphology of the vocal tract. Our approach uses simple tissue classification operating within researcher-specified constraints to facilitate feature extraction while retaining the involvement of a human analyst. We demonstrate that this pipeline generalises well to new datasets covering behaviours such as speech, vocal size exaggeration, laughter, and whistling as well as producing reliable outcomes across analysts. This approach provides considerable advantages in the ability to scale analyses to larger datasets relative to traditional analysis strategies. We make this pipeline available for immediate use by the research community, and further suggest that it may contribute to the continued development of fully automated methods based on deep learning algorithms.

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