Air flows in mechanical device reveal secrets of speech pathology

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From a baby's first blurted "bowl!'" for the word "ball" to the whispered goodbye of a beloved elder, the capacity for complex vocalizations is one of humankind's most remarkable attributes -- and perhaps one we take for granted most of our lives.

Not so for people who are afflicted with paralysis to their vocal folds and who suffer the social stigma of affected speech. Nor so for engineering professor Michael Plesniak and post-doctoral researcher Byron Erath at the George Washington University (GWU) Biofluid Dynamics Laboratory In Washington, D.C., and their colleague professor Sean Peterson at the University of Waterloo. To them, the ability to vocalize is such a prized ability that they have built a mechanical model of human vocal folds.

Today at the American Physical Society Division of Fluid Dynamics (DFD) meeting in Long Beach, CA, the researchers are reporting their discovery of how asymmetrical airflow impacts normal and diseased vocal fold motion -- observations that may lead to new devices to help those who cannot take for granted their ability to vocalize.

"Potential application of this finding includes assisting otolaryngologists to optimize surgical procedures to correct vocal fold paralysis with an implant that changes the position of the damaged vocal fold," Plesniak says.

Vocal folds, commonly known as vocal cords, are the vibrating structures of the phonatory process that stretch across the larynx, and are driven by air expelled from the lungs. Variability in the physics of sound production from the vocal folds can mark the difference between communication that connects people and enriches their lives and speech so impaired it isolates and estranges.

In the GWU team's most recent investigation, they found that asymmetric flow develops when there is an adverse pressure gradient. Under these conditions, the glottal jet separates from one vocal fold and attaches to the opposing one, disrupting the pressure forces that drive vocal fold motion. This change can have devastating impacts on speech.

"In the past, many investigators have assumed air flow is symmetrical over the vocal folds," explains Erath. "We've discovered that this is not always the case."

While most people's vocal folds tolerate the asymmetry very well, the degree of asymmetry becomes especially important in speech pathologies where tissue stiffness is affected by diseases such as unilateral vocal fold paralysis. In these cases, the asymmetric flow interacts with the damaged vocal fold, causing chaotic irregular vibrations.

Data from the GWU team suggests that devising an implant material with tissue properties that mimic those of the voice apparatus is key to restoring the good vibrations that are the foundation of intelligible speech.

More information: The presentation "The impact of asymmetric flows on pathological speech is on Sunday, November 21, 2010. Abstract: meetings.aps.org/Meeting/DFD10/Event/132273

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