Research explains basics of aerosol formation at the vocal folds

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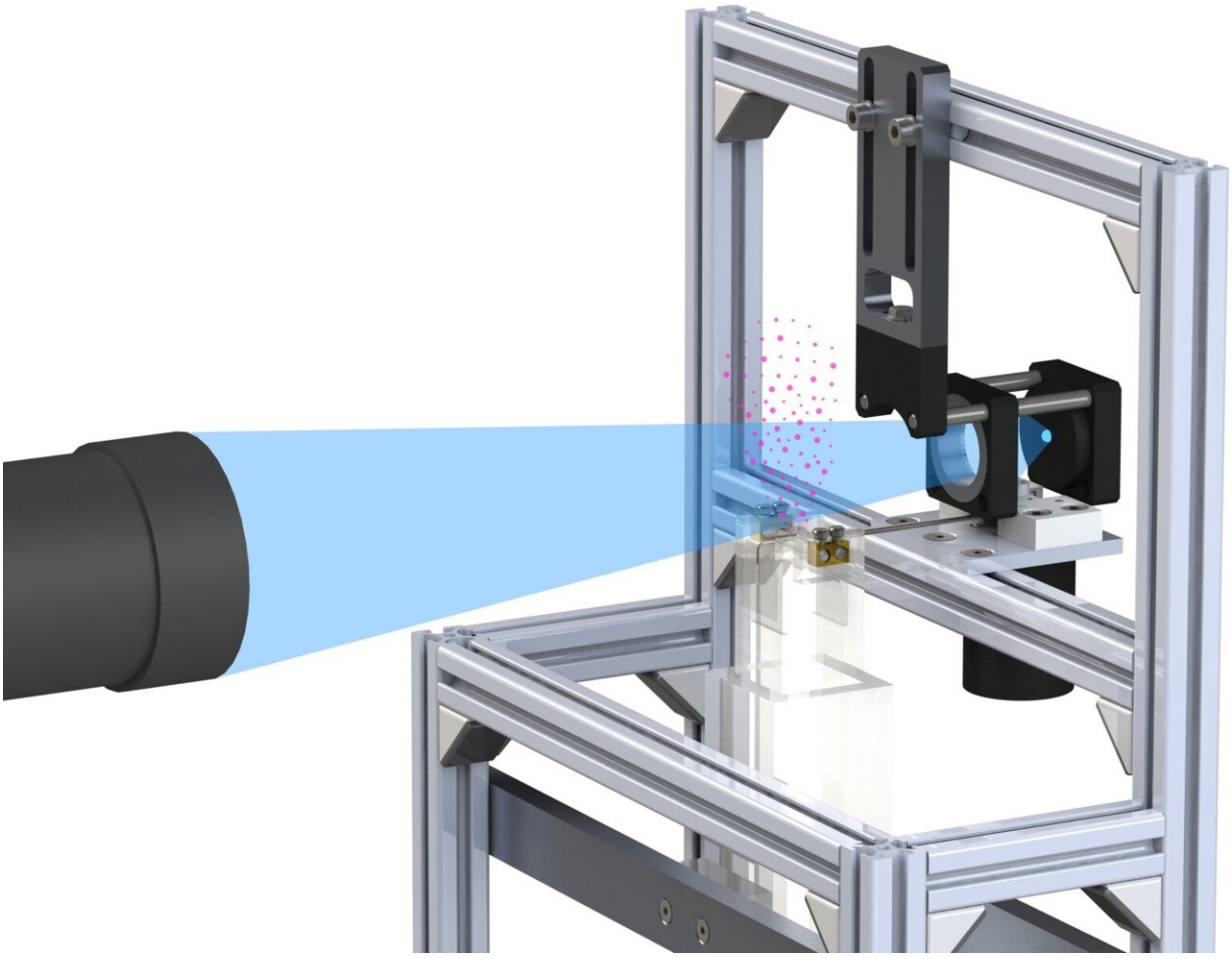

Design and setup of the experiment. Credit: TU Bergakademie Freiberg

Very small exhaled droplets, so-called aerosol particles, play an

important role in the airborne transmission of pathogens such as the coronavirus. Researchers in the field of fluid mechanics used a model to investigate how exactly the small droplets are formed in the larynx when speaking or singing. The team now reports its results in the current issue of *Physics of Fluids*. The findings can now help to develop targeted measures to stop chains of infection.

"Every person spreads not only gases but also aerosolized particles with the exhaled air. The connection between an increased risk of infection and coughing, singing or speaking loudly, suggests that particles are emitted more frequently during these activities," says Prof. Rüdiger Schwarze, an expert in fluid mechanics at TU Bergakademie Freiberg (Germany).

The team has now investigated for the first time how the particles are created in the larynx using a model of the human vocal folds. "For protection, the vocal folds are covered with a thin, gel-like layer of liquid called mucus. When speaking, they are adducted by the laryngeal muscles and induced to oscillate by the exhaled airflow. Depending on oscillation frequency and airflow, different sounds are produced," explains first author Lisa Fritzsche, who developed the model used for the experiments. The model is made of perspex, the artificial vocal folds made of silicone.

To obtain realistic properties of the silicone vocal folds, they were surface-modified at the Freiberg Research Institute for Leather and Plastic Sheeting (FILK Freiberg Institute). The model shows how the mucus forms a liquid film between the oscillating vocal folds. Then the exhaled air inflates the film, creating a bubble. When this bubble bursts, a large number of small droplets are formed, which are transported into the mouth with the airflow and then exhaled as an aerosol.

Detailed measurements using a model experiment

Employing high-resolution cameras and a special optical setup, the researchers were able to measure how different oscillations of the vocal folds affect the size distribution of the aerosol particles.

"If high-pitched tones are produced by fast oscillations, mainly smaller aerosol particles, about the size of a grain of dust, are emitted. Exhaling more air with louder tones, however, increases the proportion of larger aerosol particles that are about the size of a grain of sand," Lisa Fritzsche summarizes.

Basis for targeted measures to break infection chains

The results show which mechanisms are responsible for the formation of the aerosols at the vocal folds and how speech volume and pitch influence the droplet sizes. "What we now need to investigate further are the properties of the mucus and how these relate to the size of the exhaled aerosol particles," says Prof. Rüdiger Schwarze.

If, in the future, the mucus of an infected person could, for example, be specifically influenced by drugs, the risk of infection for contact persons could be reduced. In further studies, the team also wants to investigate the further path of the aerosols in the pharynx in more detail.

More information: L. Fritzsche et al, Toward unraveling the mechanisms of aerosol generation during phonation, *Physics of Fluids* (2022). DOI: 10.1063/5.0124944

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