Experimental and theoretical study of the influence of mouth mask on the upper airway fluid and aero-acoustic mechanisms: respiration and human speech sound production

Introduction and objectives.

The current covid-19 pandemic introduces a mouth mask in daily life (see Fig. 1). In countries such as France were the population is un-accustomed to wearing a mouth mask, it appears that explicit obligation is needed as it might provoke discomfort. *In this physical study, it is aimed to investigate how a mouth mask affects the fluid flow in the upper airway and associated flow induced phenomena such as the fluid-structure interaction leading to human voice production.* Objective and quantitative evidence to the influence of a mouth mask on the upper airway flow might in term contribute to understanding of the respiratory function, to the mentioned discomfort and even consider when the discomfort becomes problematic. The internship relies on an experimental and modeling aspect as briefly outlined below.

Experimental aspect.

The experimental study relies on mechanical replicas of the upper airways (larynx and vocal tract as illustrated in Fig. 1). The effect of adding a mouth mask as a waveguide termination on the ongoing fluid mechanics, aero-acoustics and acoustics is aimed to be studied experimentally by adding a mouth mask to these existing replicas (Fig. 1) and placing them in an experimental setup allowing to control and measure pertinent physical quantities. It is aimed to quantify in a controlled and repeatable way the effect of a mouth mask on steady and unsteady flow-induced phenomena related to the upper airways.

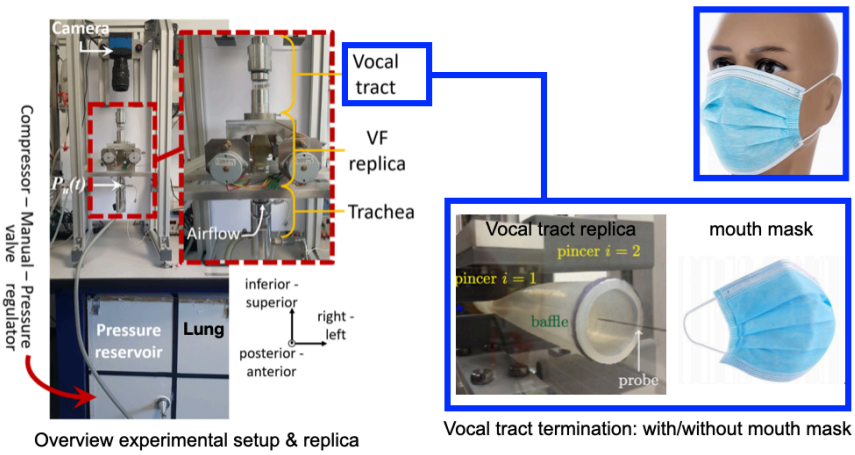

Fig 1: Overview of experimental setup and replica structure [1] and time-varying vocal tract [2] termination without/with mouth mask [3] to be studied.

Modeling aspect.

It is aimed to provide a simple flow model accounting for the influence of a mouth mask on the upper airway flow and to quantify to what extent is explains the measured flow data. Next, it is aimed to see to which extent this flow model explains the measured fluid-structure interaction and acoustic features. Finally, it is aimed to see to which extent it can objectively explain some of the reported discomforts and even indicate if and to which extent a mouth mask might hamper or even prohibit normal upper airway (and respiratory) functioning.

References.

[1] A. Bouvet, 2019. Experimental and theoretical contribution to the analysis and the modeling of the vocal folds vibration. PhD thesis, Univ. Grenoble Alpes, pp.193.

[2] Van Hirtum A., Blandin R., Pelorson X., 2016. A setup to study aero-acoustics for finite length ducts with time-varying shape. Applied Acoustics, 105:83-92.

[3] taken from https://www.respiratorz.com/disposable-masks-100pcs-mouth-mask-3-ply-anti-dust-ffp3-kf94-n95-nonwoven-elastic-earloop-salon-mouth-face-masks-2/

Location and contact.

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Competences required.

Strong interest in research in the fields of mechanics fluid mechanics and aero-acoustics and knowledge in signal processing. Experimental skills are appreciated.