How to Sniff Wine: Optimal Directional Volatile Transport in Retronasal Olfaction

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Location: 358 Willard Blg.

Coffee and donuts will be provided

Abstract: The ability of humans to distinguish the delicate differences in wines depends partly on retronasal smell, in which wine volatiles entrained into the airway at the back of the oral cavity are transported by exhaled air through the nasal cavity to stimulate the olfactory receptor neurons. Little is known whether wine volatiles are preferentially carried by retronasal flow toward the nasal cavity rather than by orthonasal flow into the lung. To study the differences between retronasal and orthonasal flow, we obtained CT images of the orthonasal airway from a healthy human subject, printed an experimental model using a 3D printer, and analyzed the flow field inside the airway. The results show that, during inhalation, the anatomical structure of the oropharynx creates an air curtain outside a virtual cavity connecting the oropharynx and the back of the mouth, which prevents food volatiles from being transported into the main stream toward the lung. In contrast, during exhalation, the flow preferentially sweeps through this virtual cavity and effectively enhances the entrainment of food volatiles into the main retronasal flow. This asymmetrical transport efficiency is also found to have a nonmonotonic Reynolds number dependence: The asymmetry peaks at a range of an intermediate Reynolds number close to 800, because the air curtain effect during inhalation becomes strongest in this range. This study provides the first experimental evidence, to our knowledge, for adaptations of the geometry of the human oropharynx for efficient transport of food volatiles toward the olfactory receptors in the nasal cavity.

Bio: Dr. Rui Ni is an Assistant Professor in the MNE department at Penn State. He is also partially affiliated with Institute for Natural Gas Research (INGaR). He earned his Ph.D. in the Department of Physics at the Chinese University of Hong Kong in 2011 studying turbulent thermal convection. Then he worked in the Department of Mechanical Engineering and Materials Science at Yale University and in the Department of Physics at Wesleyan University as Postdoctoral Associate. His research interests primarily focus on the development of three-dimensional Lagrangian particle tracking systems and the application of this technique to a variety of problems, including carbon sequestration, oil and gas extractions and advanced thermal management.