ArtSpeech

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RESPIRATION IN SPEECH: CONTROL, GLOBAL AND LOCAL EFFECTS

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BACKGROUND

- Breathing is essential to man's ability to speak. The respiratory bellows provide the power to the vocal apparatus.
- Expiration in speech often continues until lung volume decreases below functional residual capacity.
- Speakers appear to achieve a compromise between ventilatory and speech demands on flow rates. How?

OBJECTIVES

- How is the relative constancy of P_s achieved despite the continual change of relaxation forces?
- How to account for the relation between P_s and fundamental frequency (F_0) in intonation and stress patterns?

METHOD

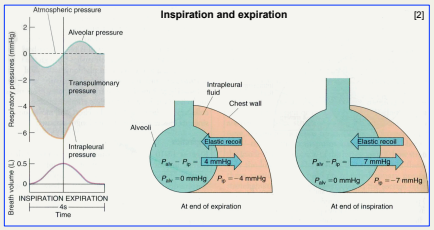
- Simultaneous recording of intraoral (P_o), subglottal pressures (P_s) and oral airflow.
- P_s by direct tracheal puncture under the cricoid cartilage.
- P_o with a tube inserted through the behind the velum.
- Oral airflow measured with a flexible rubber mouthpiece.
- All parameters, including the speech signal, synchronized with a *Physiologia* workstation [1]
- 2 subjects pronounced a set of English sentences with varying intonation and stress patterns.

References

[1] Teston, B. & Galindo, B. (1990). Physiologia : un logiciel d'analyse des paramètres physiologiques de la parole. T*ravaux Interdisciplinaires du Laboratoire Parole et Langage d'Aix-en-Provence (TIPA)*, 13 :197–217.
[2] Vander et al. (1998). *Physiology - The Mechanisms of Body Function*. Mac Graw Hill.
[3] Bouhuys, A. (1977). *The physiology of breathing: a textbook for medical students*. New-York. Grune & Stratton.
[4] Demolin, D., Hassid, S., Ponchard, C., Yu, S. and Trouville, R. (2019). *Speech aerodynamics database*. Laboratoire de phonétique et de phonologie, CNRS-MR 7018, Sorbonne Nouvelle, Paris 3, ILPGA.

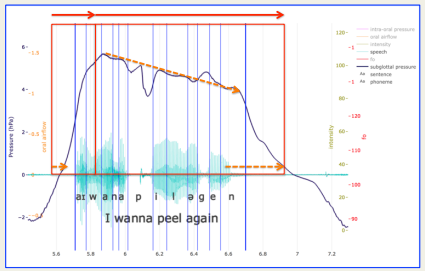
CONTROL

During speech an extra 6-10 hPa must be sustained above atmospheric pressure to provide the energy to speak. This is in addition to the ventilatory demands. Respiration functions as a dissipative system. How is it controlled in speech? By which neuromuscular mechanisms?

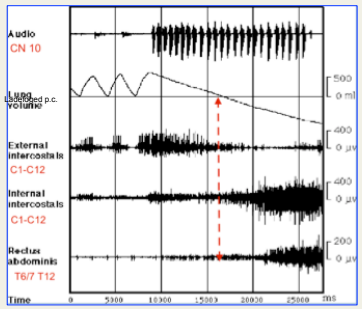


Inspiration & expiration in speech

More energy is introduced in the system for speech.



P_s is sustained by the expiratory muscles after the recoil of the lungs tissues.



The external and internal intercostals muscles are the most important to regulate P_s. Not the diaphragm [3] What is role of the cervical and cranial nerves?

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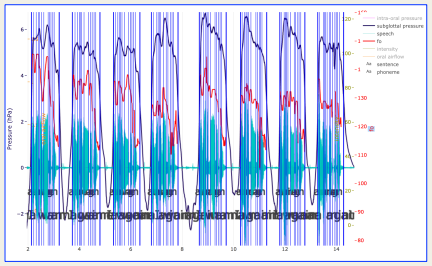
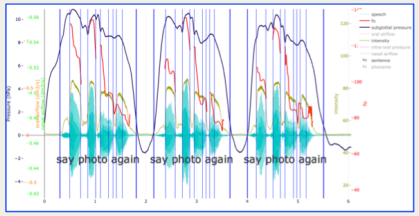
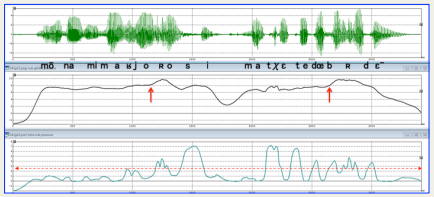
GLOBAL EFFECTS



ΔP_s = loss due the system's compliance + effects of changes in R_g and R_o. ΔP_s = 2 hPa. Short inspiratory air takes between sentences, larger between groups of sentences.

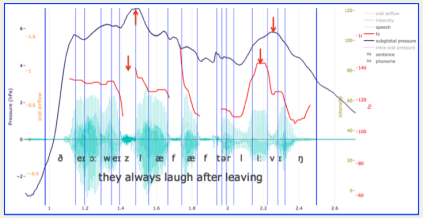


Effects of R_g on P_s



Uvular trills P_s + 2 hPa

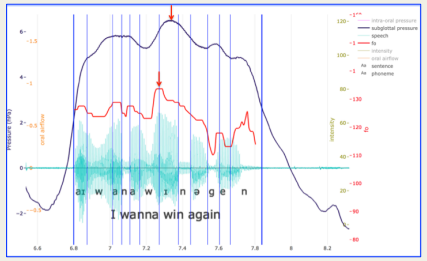
Effects of stress on P_s and F_0



When a F_0 peak preceedes the P_s peak in a stressed syllable, *Rg* triggers the rise of P_s

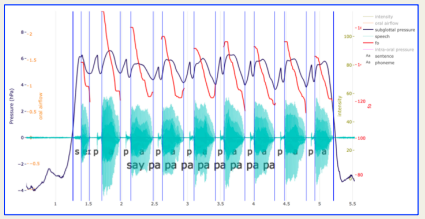
LOCAL EFFECTS

Effects of R_g on vowels and voiced consonants; R_o on voiceless consonants and trills and R_g + R_o on voiced fricatives. Lexical and emphatic stress have a 1 to 2 hPa elevation of P_s.

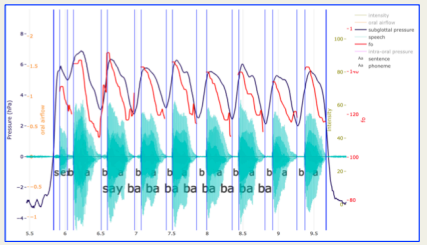


R_g can quickly be adjusted and make F_0 rise before P_s. In this cas the thee P_s elevation is due to a higher R_g.

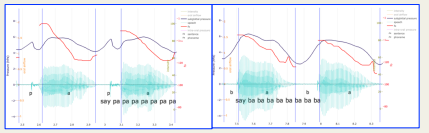
Effects of glottal settings on P_s and F_0



Gradual decrease of F_0 peaks and not of P_s



P_s and F_0 in phase



CONCLUSION: Respiration in speech affects P_s and F_0 in complex ways. It is regulated by the cervical and cranial nerves.