

# Is the voicing-dependant duration of obstruents physiological in French?

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The physiological vs. phonological conditioning of voicing-dependant durations of French obstruents was tested by comparing different normal and laryngectomised phonations: modal vs. whispered vs. Tucker vs. oesophageal vs. pseudo-whispered voice. The acoustical duration of voiced vs. voiceless obstruents /b-p t-d k-g f-v s-z j-ʃ/ were statistically compared. For consonants but not vowels, the resistance to laryngectomies argues for an encoding of the voicing-dependant duration at a phonological level.

## Background

### Duration-Voicing covariations

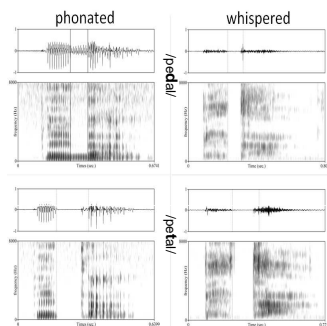
- **Consonant:** [-voice] > [+voice]
- **Pre-C vowel:** [+voice] > [-voice]

### Physiological substratum

- > **C** : aerodynamic constraint on sustained vocal fold vibrations
- > **V** : duration, timing and velocity of articulatory muscular activities

### Linguistic conditioning

- > across many various languages
- > robust to assimilation and whisper
- > effect on perception when duration segmental manipulated
- > large differences: above the physiological threshold?



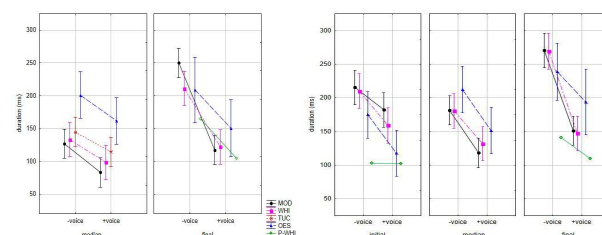
## Results

Effect of Voicing on cross-speaker mean durations (in ms) by phonation conditions in the different lexical positions

### stops

### fricatives

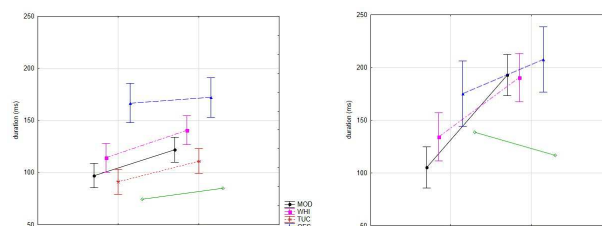
consonants



**C<sub>[+voice]</sub> shorter than C<sub>[-voice]</sub> in all phonations**

- > durational contrast of voicing is **preserved**
- > **robustness** to differences of voice source

pre-C vowels



**longer before C<sub>[+voice]</sub> than C<sub>[-voice]</sub> in laryngeal phonations**

- > OES and P-WHI show less difference or more variability
- > **lower robustness** of non laryngeal voice source

## Hypothesis

**Are the durational differences correlative to the [voicing] feature resistant to laryngeal ablations?**

As function of an increasing distance from the modal-voice mechanism used by healthy subjects, **Δduration**

- reduction > **physiological**
- preservation > **linguistic**

**Phonation conditions** differ by the phonatory **organ and source**

SPEAKER	SPEECH VOICE	LARYNX	SOURCE	
			periodicity	alternance
Healthy (control)	MODal	yes	yes	yes
	WHIsper	yes	no	no
	TUCker	reconstruction	pseudo	yes
Pathological	OESophageal	ablation	pseudo	no
	Pseudo-WHIsper	ablation	no	no

## Material and subjects

**6 contrasts** of voicing : /p t k f s j/ vs. /b d g v z ʃ/

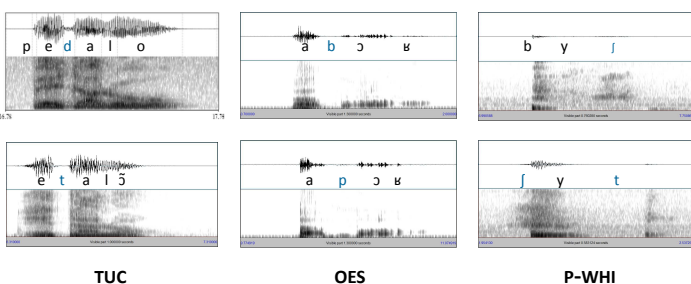
Reading of **isolated lexical words**

(Except P-WHI : embedded words)

1 repetition, several occurrences by C

Exclusions: aberration, error, imprecise segmentation

Speakers	Corpus	N speakers	Consonant	Position	N data
MOD	healthy control (15)	15	fricatives stops	initial, median, final	1444
WHI	tucker (14)	11	fricatives stops	initial, median, final	1218
TUC	oesophagian (6)	14	stops	median	423
OES	pseudo-whisperer (1 exclusion)	6	fricatives stops	initial, median, final	1135
P-WHI		1	fricatives stops	initial, final	95



### Duration ratio

$$= (C_{[-voice]} - C_{[+voice]}) / C_{[-voice]}$$

### Consonants

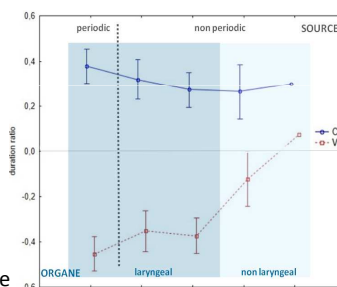
- > gradual reduction with the distance from MO phonation
- > any clear break with phonation changes

**Ratio remains fairly large**

### Vowels

- > slight reduction due to non periodic SOURCE
- > large break due to ORGAN change

**Low resistance to laryngectomies**



## Conclusion

### Duration of obstruents

- only **limited effects** of physiological changes in voice production
- the voicing-dependent contrast overcomes the various physical constraints of the different phonatory mechanisms

### Duration of vowels

- affected by physiological changes in voice source and organ
- the voicing-dependent **contrast is strongly reduced** by a total ablation of the larynx

### Voicing-dependent durations in French: Consonant vs. Vowels

- > **V** would respond to **physiological constraints**
- > **C** would respond to a **phonological conditioning**