

An Acoustic Study of Segments in Vietnamese Consonant Sequences

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Introduction

- Understanding difficulties faced by Vietnamese learners pronouncing French consonant clusters
- Several strategies of cluster replacement are observed (deformedly pronounced)
- Remaining problem even after several years of practicing
- Phonological differences between Vietnamese and French: Lexical and syllabic structures, segment inventories, restriction in coda position, unreleased plosives, tonal system ...

Plan

- Vietnamese phonology and comparison with French
- Acoustic analysis of segments in Vietnamese consonant sequences
- Results
- Discussions
- Perspectives

Vietnamese phonology

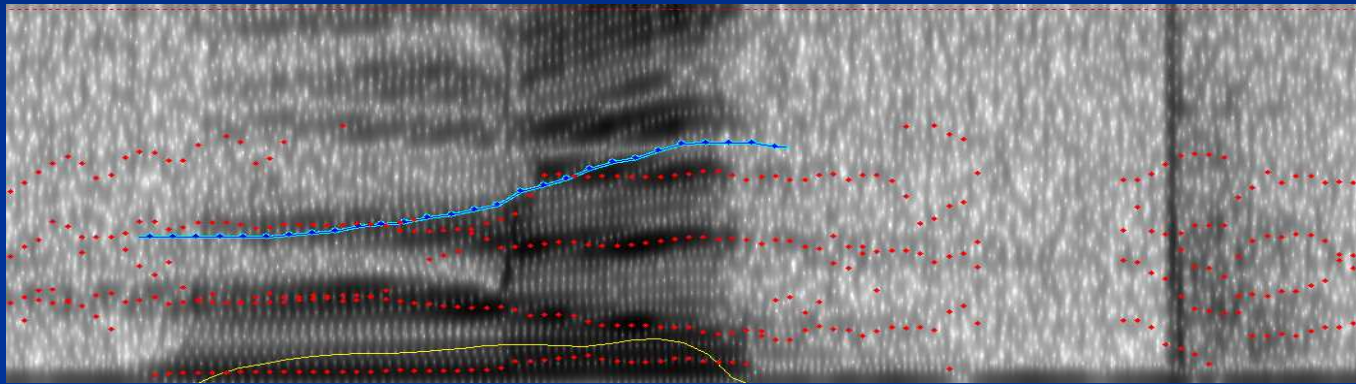
- An isolating language, in which each syllable usually has an independent meaning in isolation, and disyllables can be analyzed as combinations of monosyllables [Doan, 1999]
- A monosyllabic language phonologically, but polysyllabic partially lexically [Michaud, 2004]
- Three main varieties: Northern, Center, Southern
- 22 consonants in onset and only 6 in coda /p t k m n ŋ/.

Among them, /p/ never occurs in onset

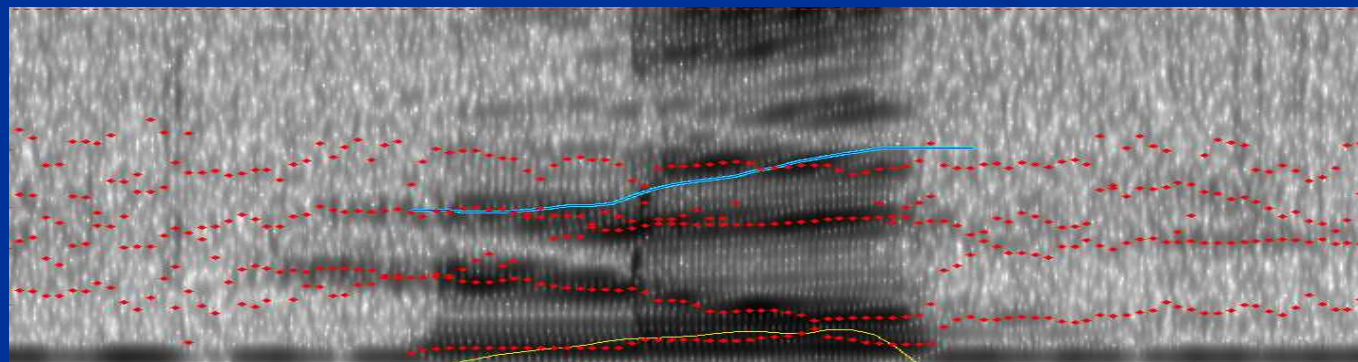
- The 6 final plosives are unreleased whatever the conditions of their realization [Doan, 1999]
- The vocalic nucleus could be a short vowel or a long one or a diphthong
- Lexical tone on each syllable

Characteristic of final consonants

■ “loupe” in French



■ “lúp” in Vietnamese



The most frequent lexical patterns

■ Vietnamese [Tran, 2006]

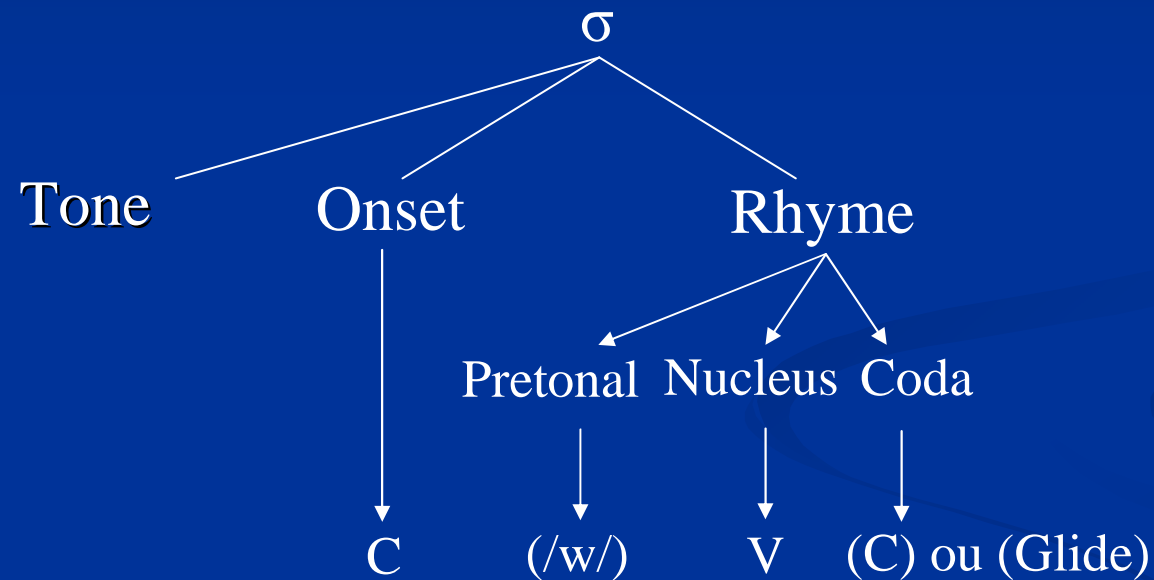
CVC	35 %	CVC.CVC	24,4 %	Others 7,1 %
CV	11 %	CV.CVC	8,1 %	
CCVC	2,6 %	CVC.CV	8,1 %	
		CV.CV	3,7 %	

■ French [Rousset, 2004]

CVC 3,7 %	CV.CVC 6,9 %	CV.CV.CV 6,8 %	CV.CV.CV.CV 2,3 %
	CV.CV 6,6 %	CV.CV.CVC 4,1 %	
	CCV.CV 2,2 %	V.CV.CV 2,5 %	Others 64,9 %

Syllable structures

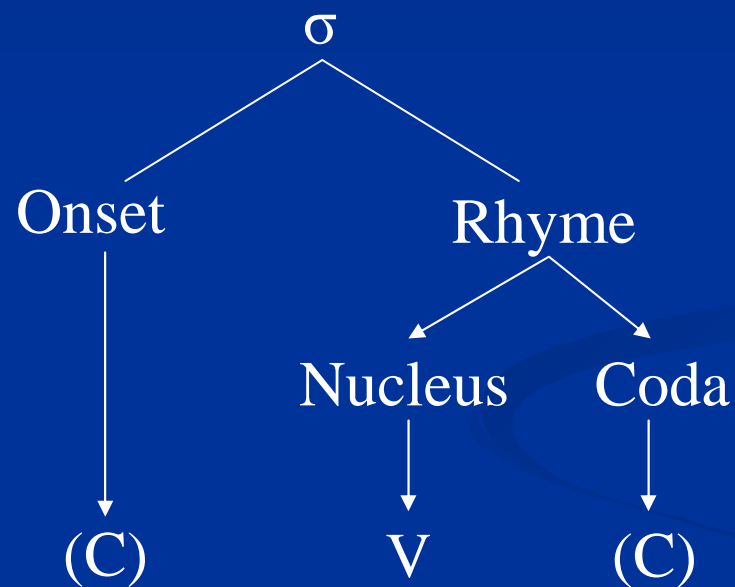
■ Vietnamese



in Vietnamese [Doan, 1999]

Syllable structures

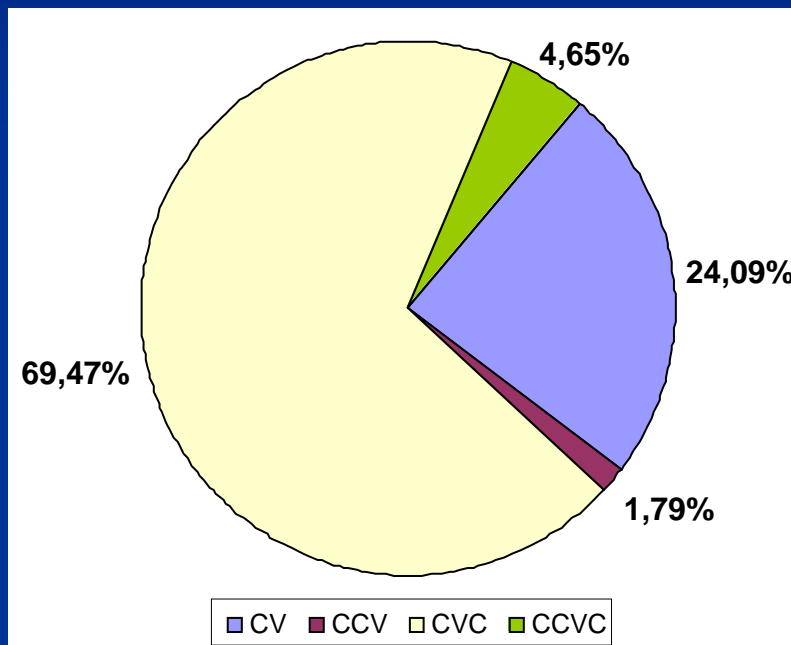
■ French



in French [Rousset, 2004]

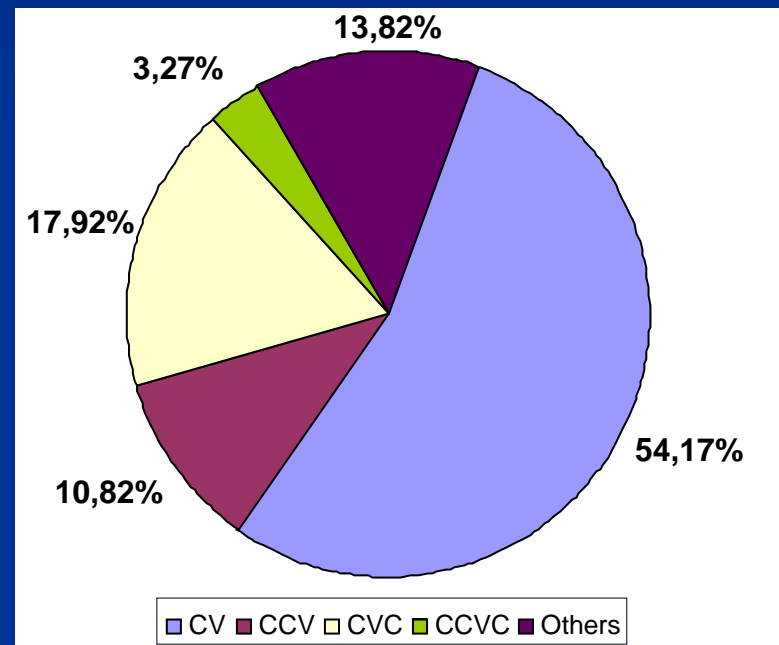
Syllable structures

In Vietnamese
[Tran, 2006]



$C_1(w)V(C_2)$

In French
[Rousset, 2004]



$(C_1)(C_2)(C_3)V(C_4)(C_5)(C_6)(C_7)$



Vietnamese consonant sequences appear only at lexical word boundaries
In the case of lexical compounds $VC.CV$, consonant sequences appear at syllable boundaries

Syllable structures

In Vietnamese

$C_1VC_2 \cdot C_3VC_4$



Consonant sequence

In French

$C_1C_2C_3VC_4C_5C_6C_7$



Consonant cluster

Acoustic study

- Aim: Understanding the realization of Vietnamese consonant sequences
 - By studying and comparing acoustic realizations of Vietnamese plosives and nasals when they are in the final position either of a simple word, or of the first syllable of a lexical compound.
 - Comparing with the acoustic realization of the initial consonant C_1 in \underline{CVC}
- ➡ Questions: Are there acoustic differences due to word structures?
- ➡ If this is true, is C_2 in CVC acoustically different from C_2 in $CVC.CVC$ (C_2 followed by C_3) because of a more important articulatory cohesion at the syllable boundaries of a lexical compound rather than at the word boundaries ?

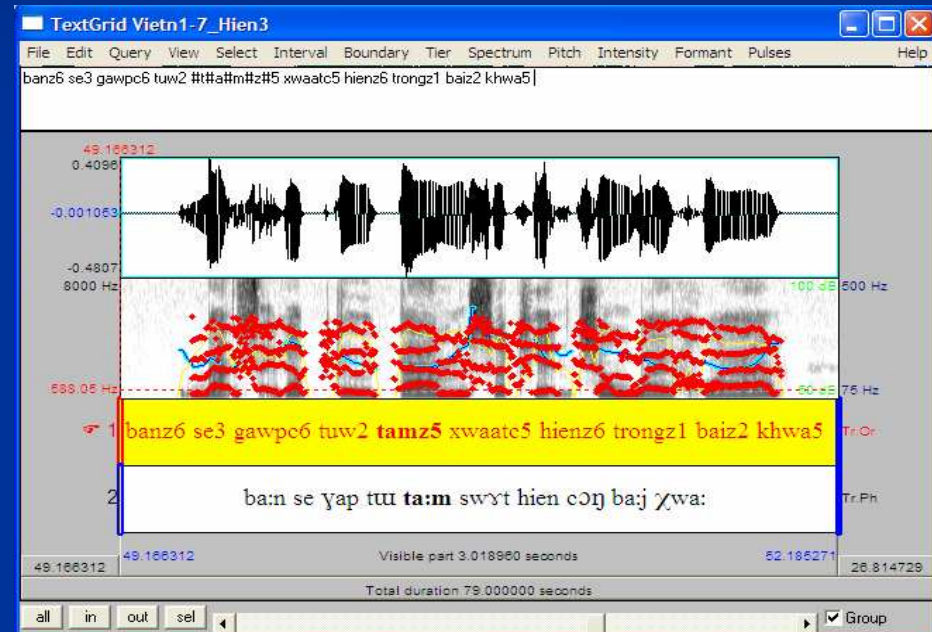
Corpus

- 3 lexical structures: $\{C_1V, C_1VC_2, CVC_2.C_3VC\}$
with $C = /p\ t\ k\ m\ n/$, $V = /a/$, identical lexical tone
- 35 words
- Carrier sentence
- Speaker: Female, 26 years old, Northern variety
- Reading corpus, 4 repetitions in a random order
- Soundproof room, numerical recorder Marantz PMD 670

<i>Spelling sentence</i>	Bạn	sẽ	gặp	từ	« nát »	xuất	hiện	trong	bài	khoá
<i>Translation</i>	<i>You</i>	<i>will</i>	<i>find</i>	<i>the word</i>	« <i>nat</i> »	<i>to appear</i>		<i>in</i>	<i>the text</i>	
<i>Standard phonetic transcription</i>	ban	ʂɛ	ɣăp	tu	nat	swɔ̣t	hien	ʈɔŋ	baj	χwa
<i>Northern phonetic transcription</i>	ban	sɛ	ɣăp	tu	nat	swɔ̣t	hien	cɔŋ	baj	χwa
<i>Tone</i>	6	3	6	2	5	5	6	1	2	5

Methodology (1)

- Data processing: PRAAT
- Phonological and spelling labeling: Praat TextGrid
- Acoustic parameters measured:
 - Duration of the consonant
 - Duration of the vowel /a/ followed or preceded by the consonants C_1 , C_2 , $C_2.C_3$
 - Duration of the occlusion
 - Duration of the VOT
 - Duration and amplitude of the burst
 - F_0 , F_1 , F_2 slopes and Delta Intensity of C_2 in C_1VC_2 and in $C_1VC_2.C_3VC_4$ measured on the last three cycles of the wave before the consonant occlusion



Methodology (2)

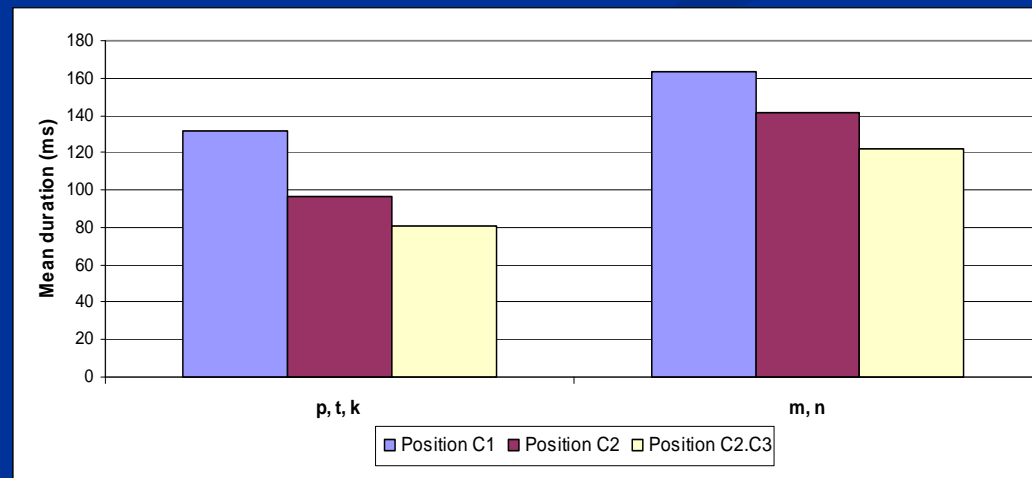
- Statistical analysis: SPSS (Statistical Package for the Social Sciences)
 1. The effect of the position in the syllable (C_1 , C_2 , $C_2.C_3$) on the acoustic parameters of the plosives (total duration, occlusion duration, burst duration, burst intensity)
 2. The effect of the interaction between
 - the position of the consonant C_2 or $C_2.C_3$
 - the place of articulation (labial, coronal, velar)
 - the acoustic parameters of the consonants in final position: evolution of I , F_0 , F_1 , F_2 of the vowel measured right before the closure.

Results (1)

■ Parameter: Position in the word

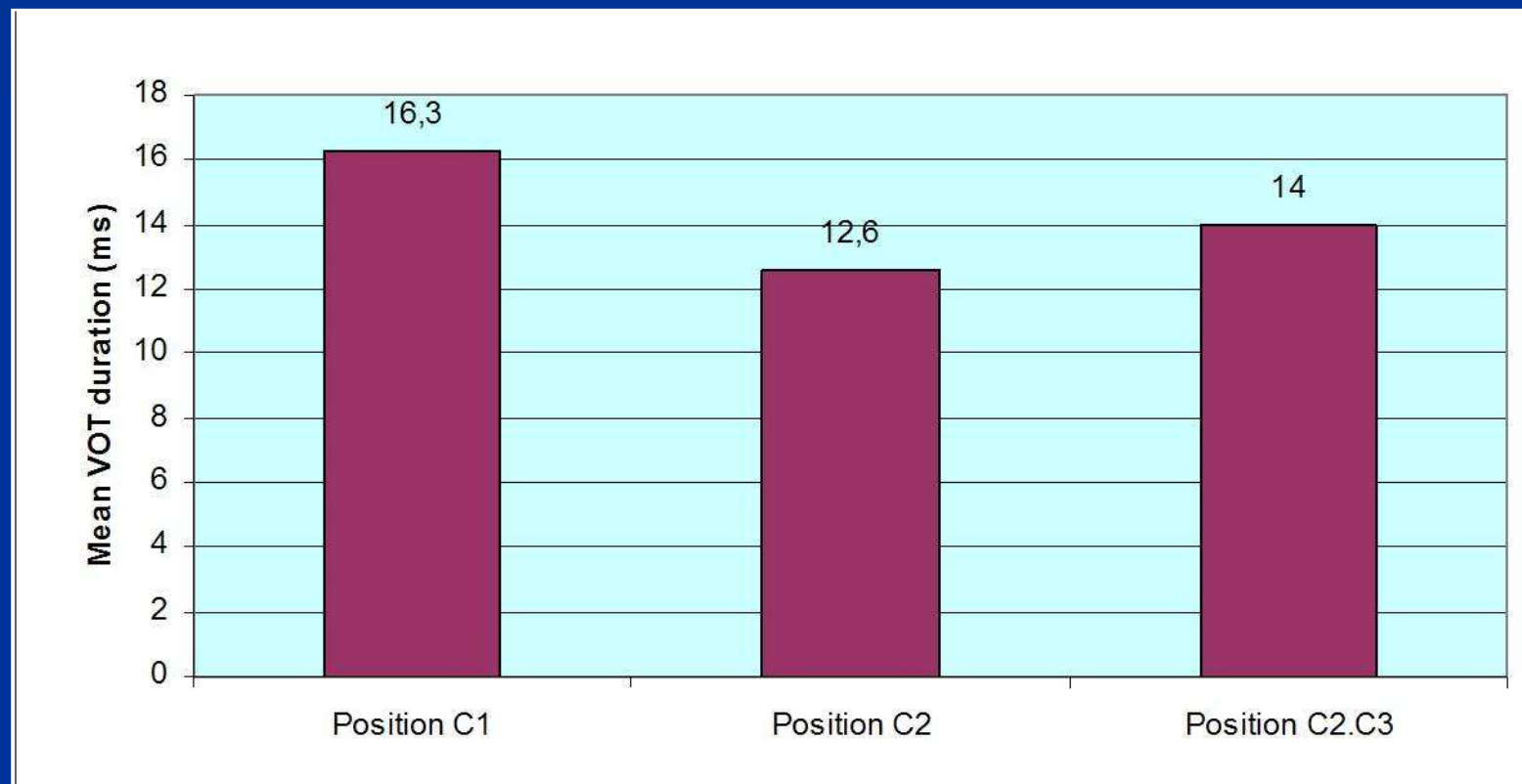
Parameters measured	Plosive duration			Nasal duration			Occlusion duration			Burst duration			Burst intensity		
	C ₁	C ₂	C ₂ .C ₃	C ₁	C ₂	C ₂ .C ₃	C ₁	C ₂	C ₂ .C ₃	C ₁	C ₂	C ₂ .C ₃	C ₁	C ₂	C ₂ .C ₃
C ₁		*	*		*	*		*	*		*	p=0.6		*	*
C ₂			p=0.3			*			p=0.9			*			p=0.5

* : significant difference (p < 0.05)



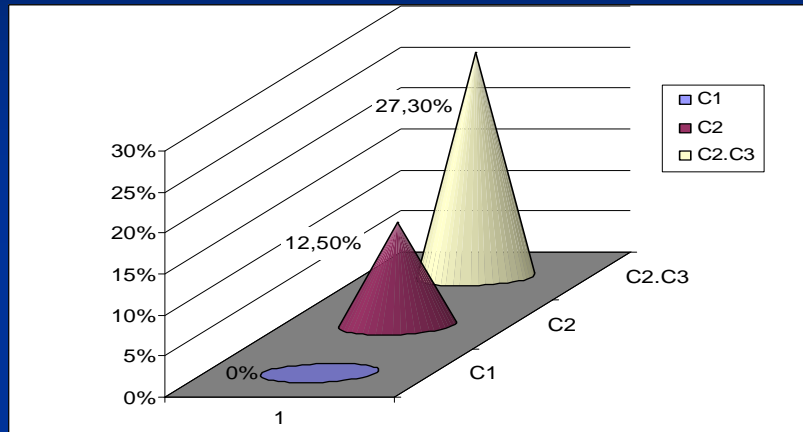
Results (2)

■ Parameter: Duration of VOT

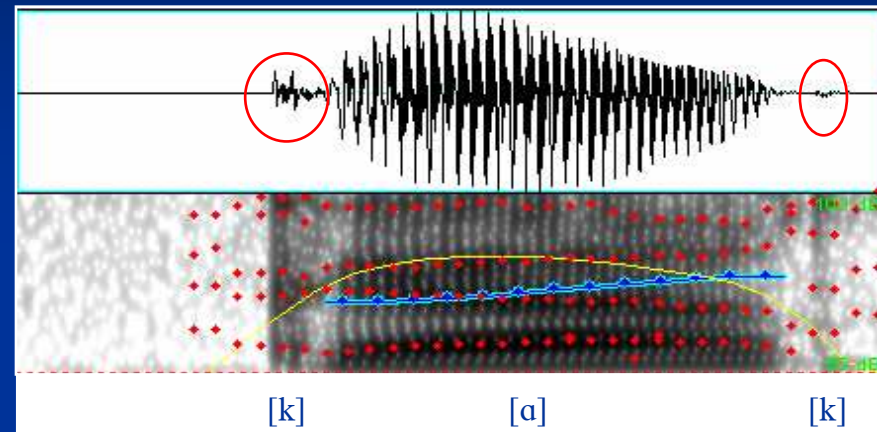


Results (3)

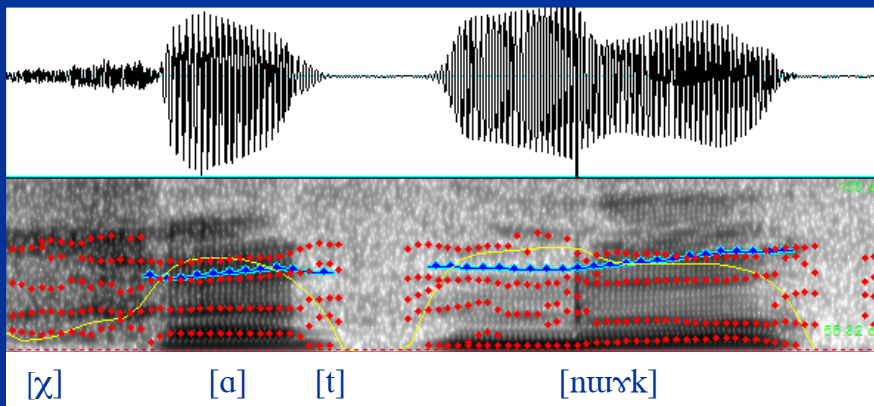
■ Parameter: Plosive bursts



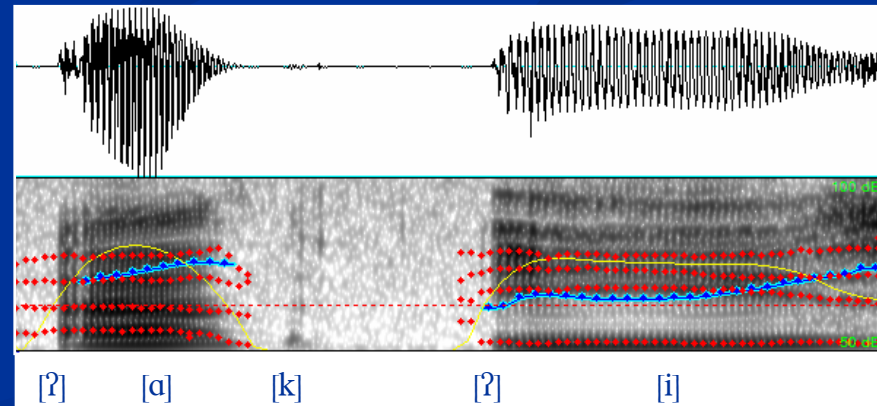
Absence of the plosive bursts according to their positions



Shorter duration of burst in final position



Absence of the burst : no relaxation trace of [t]



The burst of [k] is laryngealized : creaky voice!

Results (4)

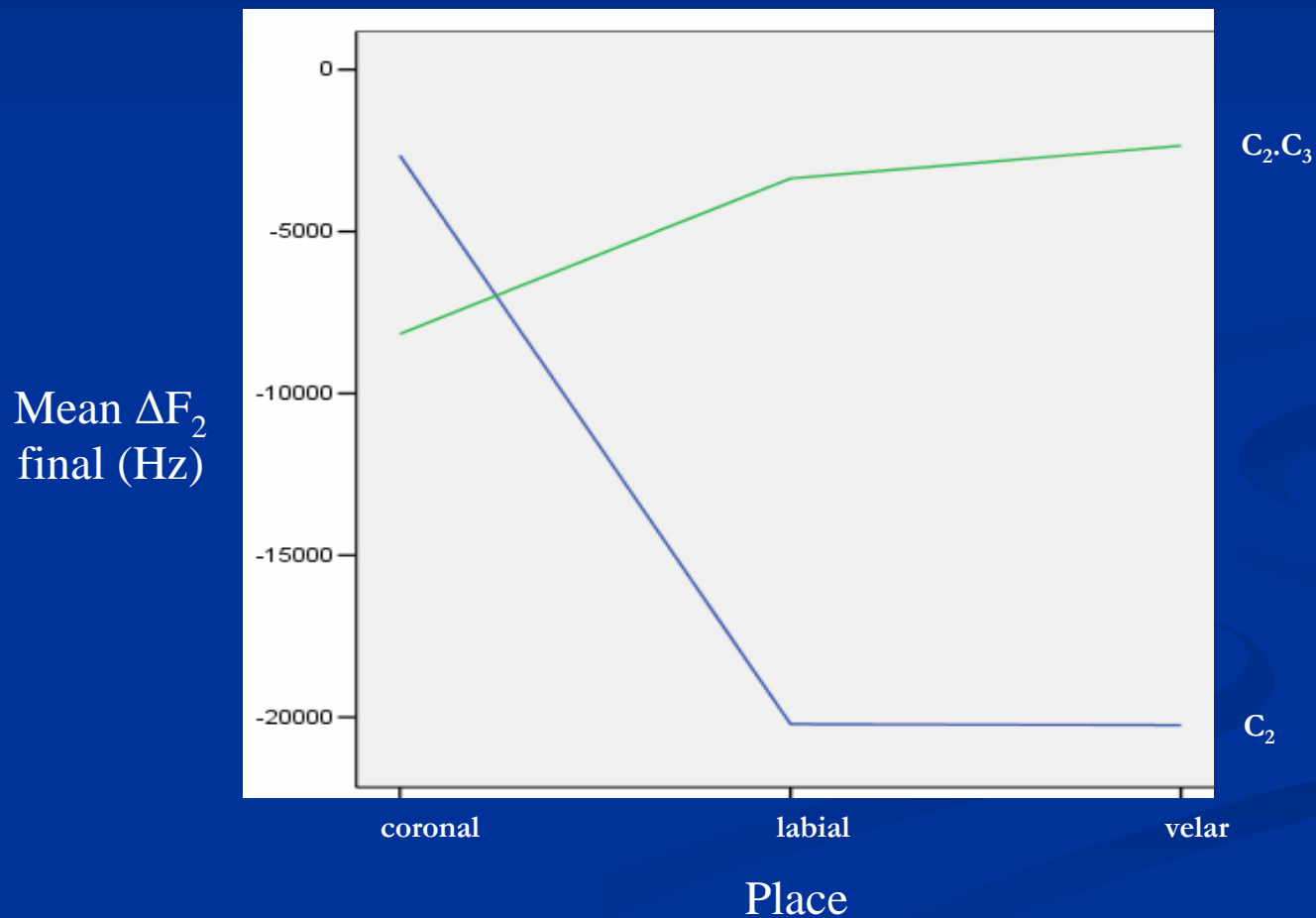
- Parameters: Position, place (slopes) for C_2 and $C_2.C_3$

Parameters measured	Delta Intensity	Delta F_0 final	Delta F_1 final	Delta F_1 final (nasal)	Delta F_2 final (nasal)
Positions	p = 0.96	p = 0.718	p = 0.142	p = 0.703	p = 0.391
Places	*	*	*	p = 0.453	p = 0.531
Interaction (position and place)		p = 0.244	p = 0.912	p = 0.804	p = 0.990

* : significant difference ($p < 0.05$)

Results (5)

- Parameters: ΔF_2 final of plosives in coda C_2 and $C_2.C_3$



Discussion

- Acoustic differences between C_2 in C_1VC_2 and $C_1VC_2.C_3VC_4$
 - Plosives: Burst duration, transitions of I , F_0 , F_1 , F_2
 - Nasals: Consonant duration
- Acoustic differences between C_1 and $\{C_2, C_2.C_3\}$
 - Plosives: Consonant duration, occlusion duration, burst intensity, VOT
 - Nasals: Consonant duration
- C^1 more frequent in final position C_2 followed by C_3 of a lexical compound

Perspectives

- Multi speakers acoustic study
- Accent: Presence or absence in S2 of lexical compounds ?
- Acoustic study of C_3 with regard to C_1 (accentuation ?)
- Perceptive study of sequences VC as final part of monosyllabic lexical and of syllable 1 of lexical compound
- EMMA (Electromagnetic Articulograph) study of $C_2.C_3$ coarticulation compared with coarticulation of consonants at word boundaries
- Comparison with the same phoneme sequences in French pronounced by Vietnamese learners.

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Thanks for your attention !