

# OTELO

• + Modeling phonetic variation to help : °  
° disambiguation in connected speech

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DIG seminar – Télécom Paris



# My background

2006-2009  
**Bachelor (equivalence) in Literature and German studies**  
Lycée Fénelon, Paris  
Classe Préparatoire aux Grandes Écoles (CPGE) littéraire (hypokhâgne, khâgne), german, english, latin

2009-2010  
**Master 1 in Linguistics**  
Université Paris IV (Sorbonne)  
Master thesis in general linguistics : *La relation syntaxe-sémantique dans le cas des adverbes : Exemples français, allemand, anglais*  
Supervisor: SAMIR BAJRIĆ (UFR de langue française)

2010-2011  
**Master 2 in Linguistics**  
Université Paris IV (Sorbonne) and Ruprecht-Karls-Universität Heidelberg (Germany)  
Master thesis in traductology: *L'adjectif substantivé neutre en allemand et sa transposition en français. Etude sur corpus: Le Monde d'hier de S. Zweig*  
Supervisor: MARTINE DALMAS (UFR d'allemand)

2013-2018  
**PhD in Linguistics**  
Université Paris 8 Vincennes-Saint-Denis – École doctorale Cognition, Langage, Interaction (CLI, ED 224) ; CNRS : Laboratoire Structures Formelles du Langage (SFL, UMR 7023) ; Équipes Langues, Grammaire, Modélisation (LaGram) et Langage, Cognition, Acquisition (LCA)  
PhD thesis in phonology: *La détente syllabique et ses implications phonologiques*  
Supervisors: JOAQUIM BRANDÃO DE CARVALHO & SOPHIE WAUQUIER  
Defended Dec. 5<sup>th</sup> 2018.

⇒ Multilingual approach

⇒ Corpus studies

⇒ Semantics, syntax

⇒ Experimental approach

⇒ Phonology-phonetics

# Phonetic variation

- Inherent fine-grained phonetic variation in every oral interaction
- DigiCosme:
  - Voicing alternation in 5 Romance languages [1, 2, 3, 4, 5]
    - /ptk/ pronounced [bdg]  
Ex. Fr. *jupe* 'skirt' pronounced *ju[b]*.
    - /bdg/ pronounced [ptk]  
Ex. Fr. *robe* 'dress' pronounced *ro[p]*
  - Schwa realization in Standard French [6, 7]  
Ex. Fr. *ju[p]* pronounced *ju[pə]*
  - Liaison realization in Standard French [8, 9]  
Ex. Fr. *Il est [-] à Paris* vs *Il est [t] à Paris*,  
'He is in Paris'

# One case study: final schwa in French

- French schwa: “e muet”, “e caduc”, “e instable” or “e féminin” (when word-final):
  - centroid vowel
  - weak or reduced
  - noted [ə]
  - alternating with zero
  - restricted to unstressed syllables
- It can surface
  - word-internally in first syllables
    - Ex. [səmən], *semaine*, ‘week’
  - word-internally
    - Ex. [parləmã], *parlement*, ‘parliament’
  - or word-finally
    - Ex. [katxə], *quatre*, ‘four’

# Schwa in French: Literature

- Schwa (mainly internal)
  - Mende (1880), Grammont (1894), Martinon (1913), Leray (1930), Fouché (1956), Malécot (1955, 1976), Delattre (1966), Dell (1985), Côté (2002), Racine & Grosjean (2002), Bürki et al. (2007), Wu et al. (2016, 2017)
- Final schwa after branching codas only
  - Dell (1970, 1976), Brand & Ernestus (2018)
- Phrase-final schwa in Parisian French, also called « pre-pausal schwa »
  - Fónagy (1989), Hansen (1997, 2003) et Hansen & Mosegaard-Hansen (2003)
- Final schwa in non-Standard varieties of French
  - Durand & Eychenne 2004, Ranson & Passarello 2012, Eychenne 2019

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# Final schwa in French: Literature

- Only one study about schwa
    - in word-final position
    - after all kinds of word-final codas
    - in Standard French
    - using large corpora
- ⇒ Purse (2019)
- Yet, limited:
    - 2 corpora of journalistic speech (ETAPE and BREF80)
    - only 2 667 tokens
    - Exploring only two factors:
      - the relationship between final schwa and graphic <e>
      - the possible re-syllabification of the coda as the onset of the following word



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# Final schwa: Goals

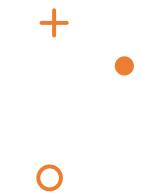
- Fill a methodological gap: introspection *vs* large corpora
- Fill a descriptive gap:
  - Investigate word-final position vis-à-vis schwa behavior:
    - after all 12 obstruents of Standard French /p, t, k, f, s, ʃ, b, d, g, v, z, ʒ/
    - before various, refined right contexts
    - in several speech styles
    - on extended data (110+ hours of speech / 120K+ tokens)



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# Final schwa: Corpora

- 3 large corpora, manually transcribed:
  - ESTER [10]
    - 80 hours of speech filtered => 40 hours of Standard French
    - aired in 2003, 2005 and 2009
    - broadcast news: prepared, possibly read + formal speech
  - ETAPE 1 et 2 [11]
    - 13.5 hours of radio talks and 29 hours of television shows
    - aired in the 2010s
    - mostly debates and conversations: non-prepared + formal
  - NCCFr [12]
    - 31 hours
    - recorded between 2007 and 2008
    - spontaneous face-to-face interaction between friends: non-prepared + informal



# Final schwa: Methodology

- Acoustic models and pronunciation dictionaries for an automatic speech recognition system
- Forced alignment with pronunciation variants [13, 14, 15, 16] for schwa realization vs non-realization
  - On the reliability of such methods for schwa, see [17, 18]

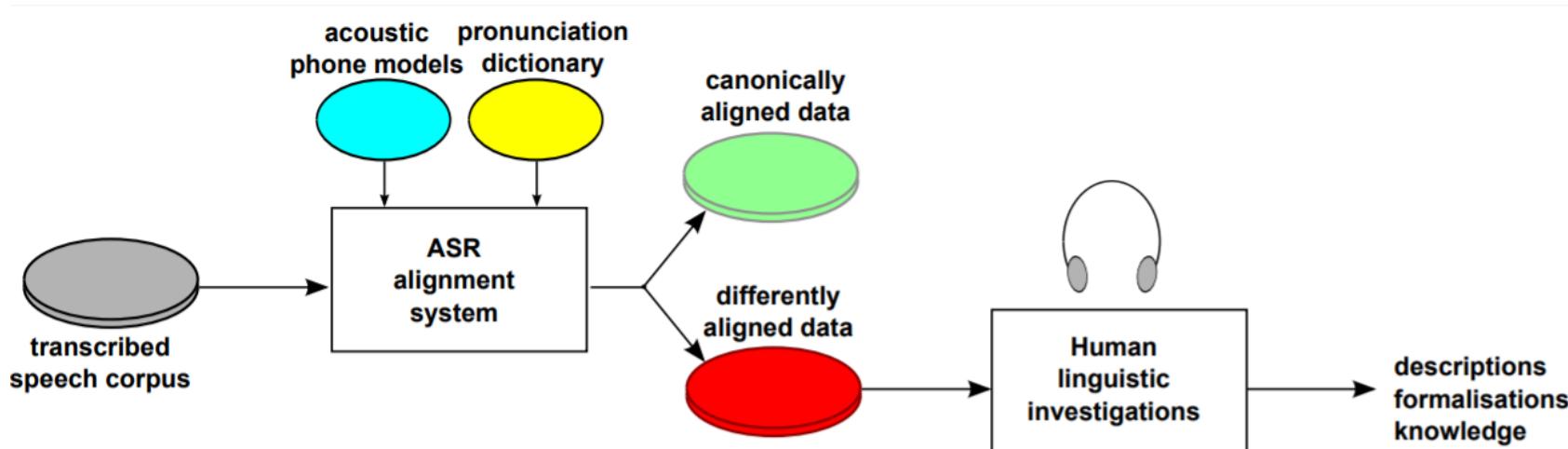


Figure from [19]

# Final Schwa: Data

- Total: 124 770 final obstruents (followed or not by schwa)
- Among them: 16 428 final schwas (13.20%)
  - 6283 (13%) in ETAPE // Purse (2019): 15% dans ETAPE et BREF80
  - manual verification on a subset: 92.3% reliable

	b	d	g	v	z	ʒ	p	t	k	f	s	ʃ	Total
ESTER	832	3901	416	1667	4288	2693	1492	9808	9563	1428	9887	1539	47514
ETAPE	1032	4513	524	2020	5205	2755	1634	9911	9561	1512	9921	1710	50298
NCCFr	509	1839	328	1792	1692	1025	476	7348	6120	814	4346	669	26958
Total	2373	10253	1268	5479	11185	6473	3602	27067	25244	3754	24154	3918	124770

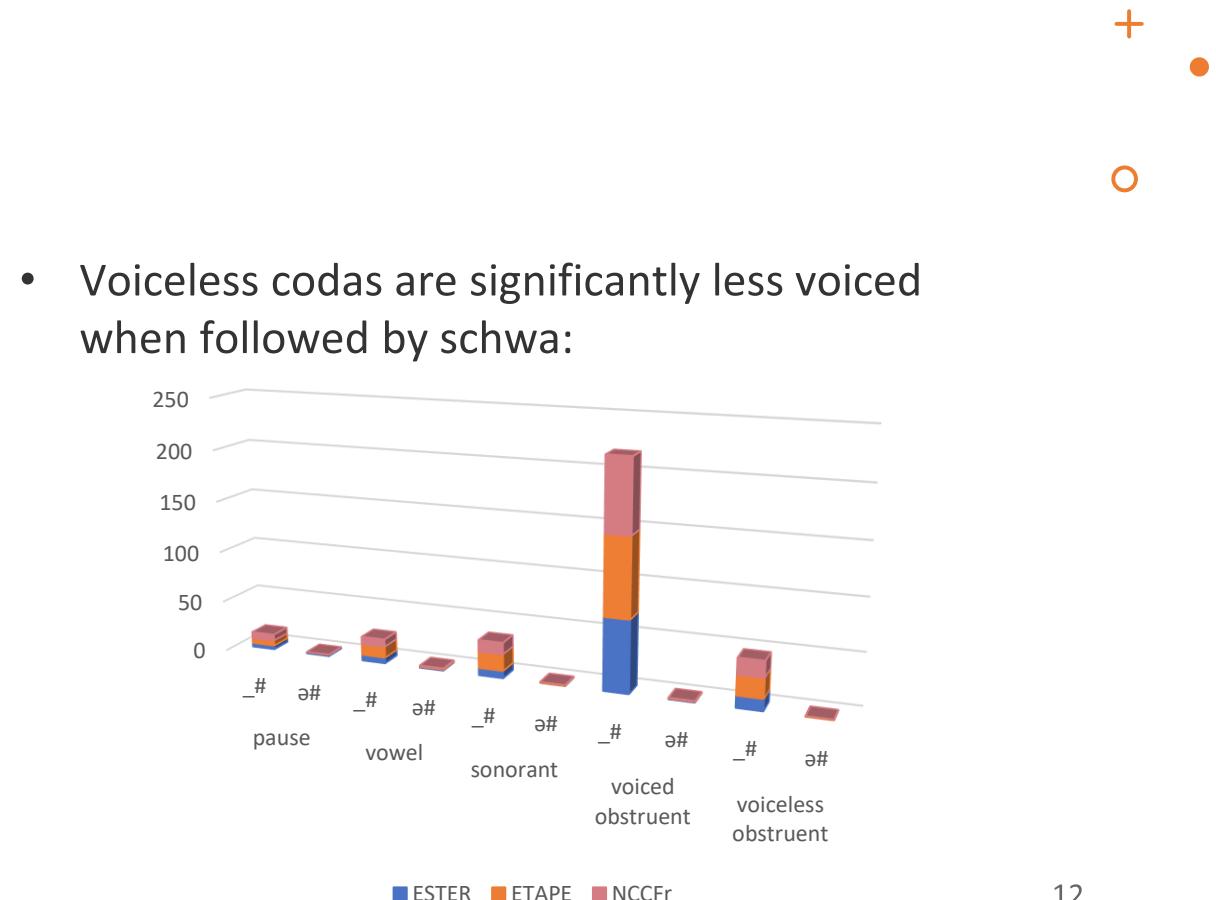
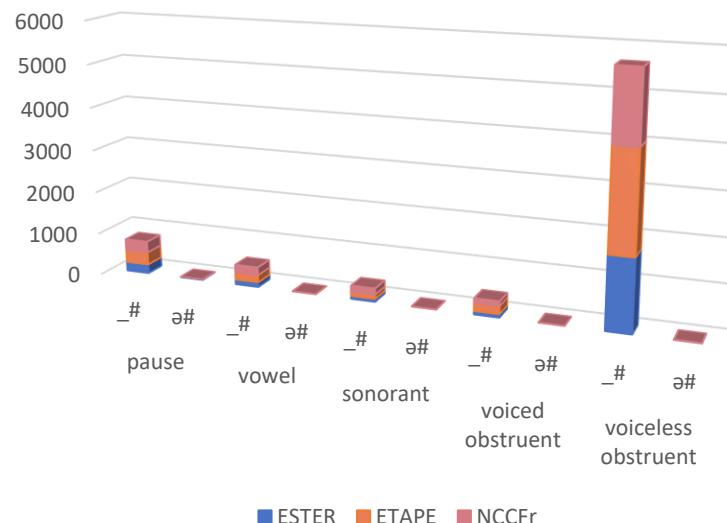
# Final Schwa: Some results

- General linear model = effect of...
  - ... sociolinguistic factors:
    - speech style: the more formal the speech, the more schwa realization
    - speaker gender: more schwa realizations in female speech in all speech styles
    - orthography: written <e> = more schwa realizations
  - ... phonotactic and phonological factors:
    - size of the consonant cluster: the more consonants in a row, the more schwa realizations
    - nature of the preceding coda:
      - laryngeal feature: voiced codas /bdgvzʒ/ are more followed by schwa than voiceless ones /ptkfsʃ/
      - place of articulation: labial codas favor schwa realization less than alveolars and posterior-velar consonants more  
⇒ /d/ is the consonant most followed by schwa vs /f/ the least
    - Immediate right context: more schwas before pause, sonorants and voiced obtrusives than before voiceless obstruents, but less before vowels
- Also: effect of...
  - the sonority sequence
  - speech rate



# Final schwa: some results

- Fruitfully combines with other studies:
- Schwa blocks adjacency effects:
- Voiced codas are significantly less devoiced when followed by schwa:
- Voiceless codas are significantly less voiced when followed by schwa:



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# Final Schwa: Possible impact

- Linguistics
  - Better knowledge of French schwa [6, 7]
- Technology
  - Improvement of pronunciation dictionaries [19]
  - Improvement of forced-alignment methodologies [20]
- And beyond:
  - Schwa pronunciation correlated with emotions [21, 22]



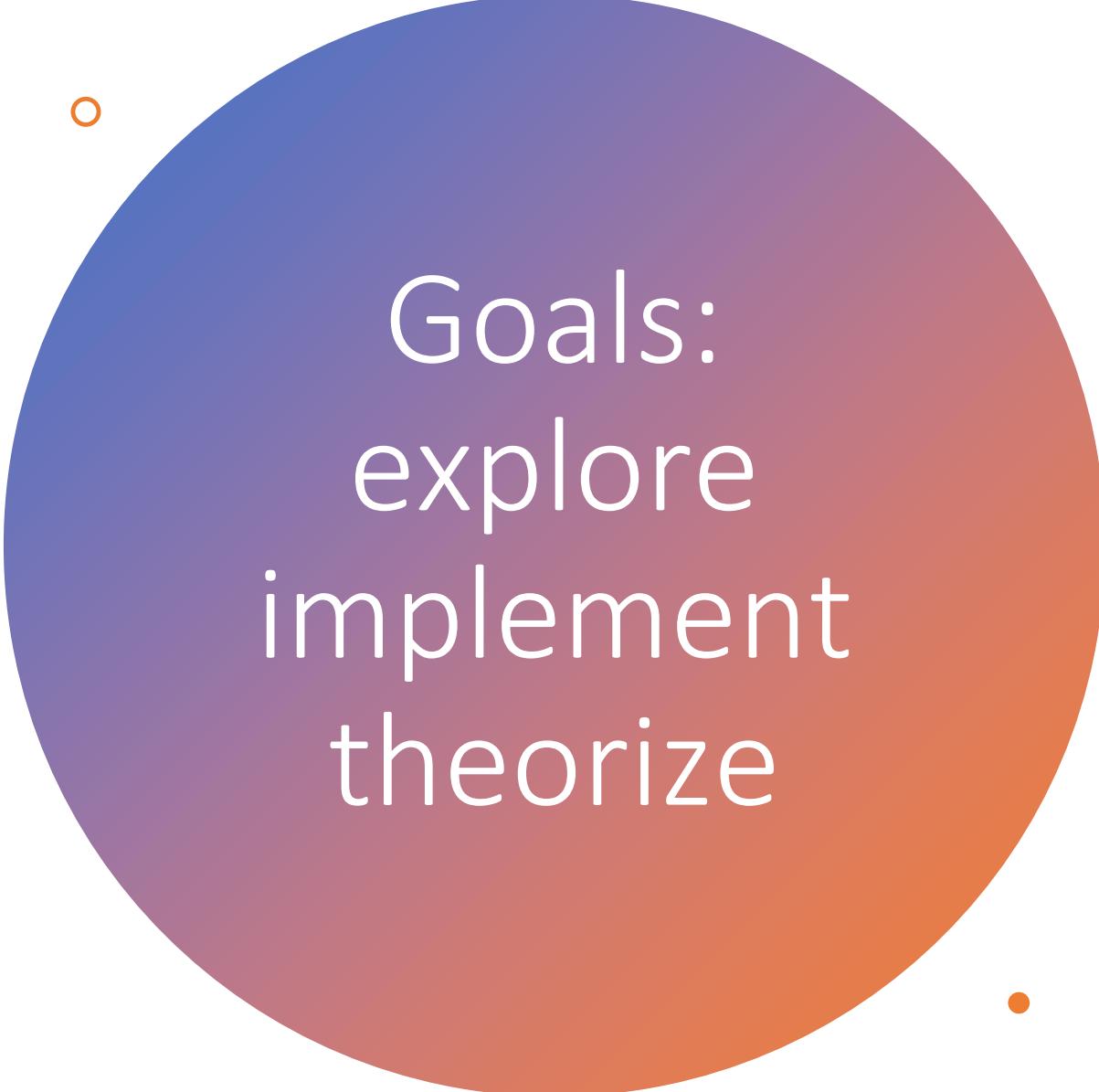
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# Why use phonetic detail in OTELO?

- We know that:
  - phonetic variation depends on lexical status. [23, 24]
    - Ex. Fr. *Je l'évite* vs *Je lèvite*.
  - phonetic variation depends on word frequency. [25, 26, 27, 28]
    - Ex. Fr. *repère* vs *repaire*
  - linguistic perception relies on lexical access. [29]
    - Ex. Fr. *C'est pas grave.*
  - linguistic perception relies on phonetic environment. [23, 30, 31, 32]
    - Ex. *jupe bleue*

⇒ Hypothesis: Fine-grained variation can help disambiguation.

⇒ Apply fine-grained phonetic analyses to morpho-syntactically and semantically annotated corpora (ontologies).



# Goals: explore implement theorize

- Exploration:
  - Which phonetic parameters allow to disambiguate homophones in oral data?
  - Which phonetic parameters can be exploited automatically?
- Implementation:
  - How far can fine linguistic considerations go?
  - More generally, can this linguistic expertise contribute to the automation of language processing?
- Theorization:
  - What can we learn from potential use of fine acoustic cues in language processing, both in machines and in humans?

# Methodology: big-data phonetics and ontologies

- Merge information:
  - Phonetics: manually transcribed corpora with automatically aligned pronunciation variants (LISN)
  - Semantics, syntax: ontologies (Télécom Paris-Tech)

⇒ Build on all our linguistic, psycholinguistic, socio-phonetic knowledge
- Analyze:
  - Qualitative analyses & quantitative models (statistics)
  - Data-driven experimentation
- Produce a set of exploitable parameters:
  - segment duration: *Je l'évite* vs *je l'élève* [33]
  - frequency: *repère* vs *repaire* [34, 35]
  - segment position in the word: *les galas* vs *l'égala* [36]
  - Role of orthography: *fausse* vs *fosse* [37]
  - Etc.



# Expected benefits of the OTELO project

- **Application:** Use the relevant parameters to help speech recognition technologies to clarify ambiguous inputs.
- **Theory:** Useful for many research areas
  - Linguistics:
    - Micro-diachrony: Will two homophones evolve similarly or not and why? What is the impact of “higher-level” (grammatical, syntactic, semantic) linguistic knowledge in the spreading of variational patterns across the language?
    - What is the role of semantics? of frequency? of lexical context? Etc.
  - Psycholinguistics:
    - How humans exploit fine phonetic cues is a fruitful research question to better understand human language processing, both in production and perception.
  - Language technologies:
    - Homophones as a case study to improve our technologies thanks to fine phonetic parameters.

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• Thank you for your attention!