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Presentation · February 2021

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Modelling the realization of variable word-final schwa in Standard French

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Word-final schwa in Standard French

Definition

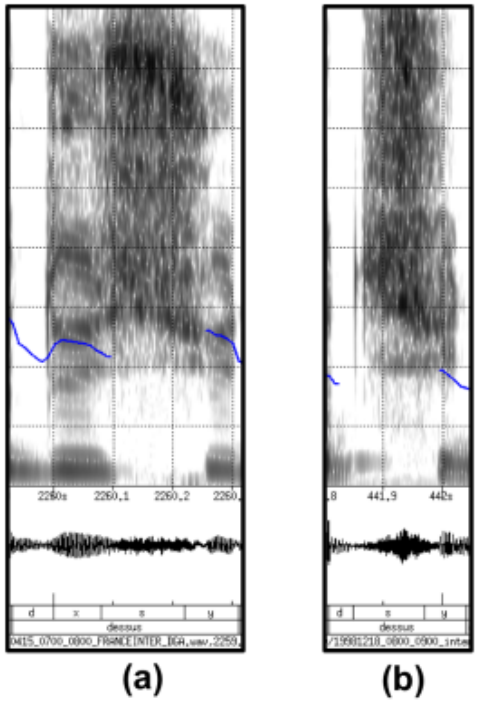
State of the art

Goals of the study

Schwa in Standard French

- French schwa: “e muet”, “e caduc”, “e instable” or “e féminin” (when word-final):
  - centroid vowel
  - weak or reduced
  - noted [ə]
  - restricted to unstressed syllables
  - alternating with zero

  ⇒ highly variable realization



The word "dessus" (/dəsy/, *above*)
(a) with and
(b) without schwa
aligned by the LIMSI speech transcription system
Figure from Wu et al. 2017

Schwa in Standard French

- It can surface
  - word-internally in first syllables
    Ex. [səmɛn], *semaine*, ‘week’
  - word-internally
    Ex. [paʁləmɑ̃], *parlement*, ‘parliament’

⇒ lexical vowel

  - or word-finally
    Ex. [katχə], *quatre*, ‘four’

⇒ epenthetic vowel

Schwa in Standard French: Literature

- Schwa (mainly internal)

  Mende (1880), Grammont (1894), Martinon (1913), Leray (1930), Fouché (1956), Malécot (1955, 1976), Delattre (1951, 1966), Dell (1970), 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” or “parasite e”

  Fónagy (1989), Hansen (1994, 1997) et Hansen & Mosegaard-Hansen (2003)

- Final schwa in non-Standard varieties of French

  Durand & Eychenne 2004, Ranson & Passarello 2012, Eychenne 2019

Schwa in Standard 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 read speech (ETAPE and BREF80)
  - only 2 667 tokens
  - exploring only three factors:
    - the gender of the speaker
    - the relationship between final schwa and graphic <e>
    - the possible re-syllabification of the coda as the onset of the following word

Word-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)

Data and Method

Corpora

Methodology

Data

Corpora for Standard French

- 3 large corpora, manually transcribed:
  - ESTER (Galliano et al. 2005)
    - 80 hours of speech filtered => 40 hours of Standard French
    - aired in 1998-2003
    - broadcast news: prepared, possibly read + formal speech
  - ETAPE 1 et 2 (Gravier 2012)
    - 13.5 hours of radio talks and 29 hours of television shows
    - aired in the 2010s
    - mostly debates and conversations: non-prepared + formal
  - NCCFr (Torreira et al. 2010)
    - 31 hours
    - recorded between 2007 and 2008
    - spontaneous face-to-face interaction between friends: non-prepared + informal

Automated methodology

- Acoustic models and pronunciation dictionaries for an automatic speech recognition system
- Forced alignment with pronunciation variants for schwa realization *vs* non-realization

  (Gauvain et al. 2002, 2005; Hallé & Adda-Decker 2007, 2011)

  Ex. Fr. mode, 'fashion' aligned with the transcriptions [mɔd] or [mɔdə]

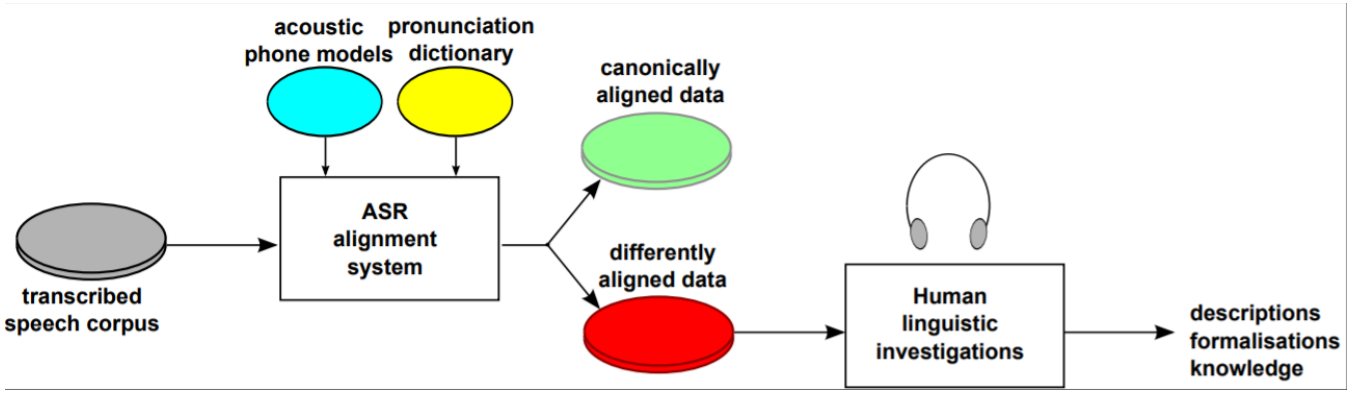


Figure from Adda-Decker & Lamel (2017)

Data

- Total: 124 770 final obstruents (followed or not by schwa)
- Among them: 16 428 word-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

Analyses

- General Linear Model (glm) in R (R DCT, 2008)
  - sociolinguistic factors:
    - speech style (Wu et al. 2016, 2017)
    - speaker gender (Wu et al. 2017, Purse 2019)
    - orthography (Durand & Eychenne 2004, Eychenne 2019)
  - phonotactic and phonological factors:
    - size of the consonant clusters (Grammont 1894, Delattre 1966, Bürki et al. 2011, Wu et al. 2017)
    - nature of the preceding coda (Hansen & Mosegaard-Hansen 2003)
    - immediate right context (Dell 1970, Côté 2000)
- Complementary analyses
    - sonority sequence (Grammont 1894, Dell 1970, Côté 2000, 2002, Bürki et al. 2011, Wu et al. 2016, Brand and Ernestus 2018, Eychenne 2019)
    - speech rate (Grammont 1914, Malécot 1976, Hansen 1994, Bürki et al. 2011)

Results

Sociolinguistic factors

Phonotactic and phonological factors

Complementary analyses

Sociolinguistic factors

- speech style
  - Wu et al. 2016, 2017
- speaker gender
  - Wu et al. 2017, Purse 2019
- orthography
  - Durand & Eychenne 2004, Eychenne 2019

Effect of speech style

- Wu et al. (2016, 2017): The more formal the speech, the more first-syllable schwa realizations
- ESTER = (semi-)prepared, careful, possibly read speech
  vs ETAPE = mixed semi-prepared monologues and several-speaker conversations
  vs NCCFr = casual friendly speech

	No schwa	Schwa	% Schwa
ESTER	39409	8069	17.00
ETAPE	43257	6505	13.07
NCCFr	24887	2071	7.68

- Glm = ESTER as reference
  - the probability to observe a word-final schwa decreases significantly both
    - in ETAPE (estimate = -0.30631, std error = 0.01850, $p < 0.001$)
    - and in NCCFr (estimate = -0.92817, std error = 0.02709, $p < 0.001$)

$\Rightarrow$Word-final schwa consistent with the behavior of first-syllable schwa

Effect of speaker gender

- Wu et al. (2017) = significant difference between male and female realizations of first-syllable schwa *vs* Purse (2019) = no difference for word-final schwa

	Female		Male	
	Number of tokens	% of schwas	Number of tokens	% of schwas
ESTER	10,183	17.50	37,295	16.86
ETAPE	9,646	13.66	40,116	12.93
NCCFr	13,016	8.69	13,942	6.74

- Higher rates in female speech than in male speech
- Bigger difference in less formal speech:

$$\text{ESTER: } \Delta = 0.64\% \; < \; \text{ETAPE: } \Delta = 0.73\% \; < \; \text{NCCFr: } \Delta = 1.95\%$$

$\Rightarrow$Women have a higher rate of schwa realization than men and this difference is statistically significant (estimate = -0.10342, std error = 0.02018, $p < 0.001$)

Effect of orthography

- Durand & Eychenne (2004) = correlation orthography / schwa realization
  - but mostly in conservative Aude-region French *vs* not in more standard varieties such as Basque-country / Vendée-region French
- Purse (2019) = word-final schwa more than twice as often in words ending in a graphic <e> (18% *vs* 7%)

- Results
  - ESTER = 12.83% *vs* 19.53% (Δ=6.70%)
  - ETAPE = 7.83% *vs* 15.38% (Δ=7.55%)
  - NCCFr = 6.17% *vs* 8.95% (Δ=2.78%)

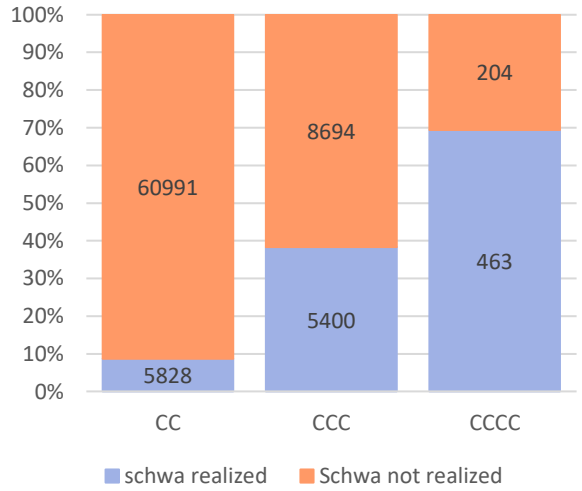
⇒Compared to words without <e>, probability to observe a word-final schwa increases significantly for words with <e>
(estimate = 0.59076, std error = 0.02620, $p < 0.001$)

Phonotactic and phonological factors

- size of the consonant clusters
  - Grammont 1894, Delattre 1966, Bürki et al. 2011, Wu et al. 2017
- nature of the preceding coda
  - Hansen & Mosegaard-Hansen 2002
- immediate right context
  - Dell 1970, Côté 2000

Effect of the size of the consonant cluster

- Grammont (1894) = Three Consonants Rule = the realization of schwa becomes mandatory in most cases when the surface form resulting from the absence of schwa would have 3 or more consonants in a row (Bürki et al. 2011, Wu et al. 2017)



⇒ Compared to CC = 8.72% :

- *vs* CCC = 38.31% (Δ = 29.59%, estimate = 0.28029, std error = 0.04089, $p < 0.001$)
- *vs* CCCC= 69.41% (Δ = 60.69 but not statistically significant: estimate = 0.07212, std error = 0.06934, $p > 0.05$)

Effect of the nature of the coda

- Hansen and Mosegaard-Hansen (2002) on “parasite e” = more after voiced than after voiceless codas
- Laryngeal feature
  - voiceless obstruents are less frequently followed by schwa than voiced ones

    (estimate = -0.36216, std error = 0.01919, $p < 0.001$)
- Manner of articulation
  - fricatives less than stops

    (estimate = 0.63756, std error = 0.01868, $p < 0.001$)
- Place of articulation:
  - Compared to alveolars /t, d, s, z/ :
  - labial /p, b, f, v/ favor schwa realization less

    (estimate = 0.06955, std error = 0.02832, $p < 0.05$)
  - posterior-velar consonants /k, g, ʃ, ʒ/ favor schwa more

    (estimate = 0.09339, std error = 0.02028, $p < 0.001$)

Coda	No schwa	Schwa	% Schwa
d	6605	2076	23.91
v	4374	772	15.00
g	1003	167	14.27
ʒ	4879	671	12.09
b	1848	236	11.32
z	9468	1143	10.77
p	3045	344	10.15
s	19642	1716	8.03
k	19689	1708	7.98
t	18342	1564	7.86
ʃ	2700	211	7.25
f	3275	240	6.83

Nb of schwas after each simplex coda before pause, vowel or simplex onset (all corpora combined)

Effect of the immediate right context

- Data broken into 5 categories: pause, vowel, sonorant, voiced obtruent and voiceless obstruent

	Immediate right context				
	Pause	Vowel	Sonorant	Voiced obstruent	Voiceless obstruent
No schwa	8915	24973	13659	19325	27998
Schwa	3043	2308	1553	1938	2006
% Schwa	25.45	8.46	10.21	9.11	6.69

Nb of schwas for each right context (simplex coda before pause, vowel or simplex onset only, all corpora combined)

⇒Compared to voiceless obstruents, positive correlation before:

- pauses (estimate = 1.20904, std error = 0.04381, $p < 0.001$)
- sonorants (0.15615, std error = 0.02802, $p < 0.001$)
- and voiced obstruents (estimate = 0.11682, std error = 0.02478, $p < 0.001$)

but negative correlation

- before vowels (estimate = -0.12632, std error = 0.04362, $p < 0.01$)

Complementary analyses

- sonority sequence
  - Grammont 1894, Dell 1970, Côté 2000, 2002, Bürki et al. 2011, Brand & Ernestus 2018, Eychenne 2019
- speech rate
  - Grammont 1914, Malécot 1976, Hansen 1994, Bürki et al. 2011

Effect of the sonority sequence

- Sonority Sequencing Principle = “universal hierarchy of complex onset and coda goodness” (Tranel 1999, in Côté 2000):

[-sonorous] obstruents < nasals < liquids < glides < vowels [+sonorous]
(Parker 2011)

- Schwas = more likely to drop if the cluster obeys the Sonority Sequencing Principle (Côté 2000: 112–119; Bürki et al. 2011), in particular in word-final sequences of consonants (Dell 1976, Brand & Ernestus 2018, Eychenne 2019) and in CCC sequences, where the presence of a final liquid (CCL) reduces the rate of schwa realization (Delattre 1951).
- **Limited to C(ə)#C sequences (n=66,479)**
  - NB: data are unbalanced (obstruents only for left context *vs* obstruents and sonorants for right context)

⇒ 6.50% when the sonority is falling
Ex. [dispoziti**f.p**yblik], ‘public system’
vs 8.27% when the sonority plateaus
Ex. [õ**z.ʒ**uʁ], ‘eleven days’
vs 9.47% of the cases when it is rising
Ex. [øʁɔ**p.s**ɑ̃tʁal], ‘Central Europe’

⇒ Results are significant (χ^2=151.22, df=2, p<2.2e-16)

	No Schwa	Schwa	% Schwa
Falling	20312	1411	6,50
Plateau	11766	1061	8,27
Rising	28904	3025	9,47
Total	60982	5497	8,27

Effect of speech rate

- Word-internal schwa: higher speech rate = higher proportion of non-schwa variants
  - Grammont 1914, Malécot 1976, Hansen 1994, Bürki et al. 2011
- Method:
  - Speech rate as the number of phones (consonants and lexical vowels) per second for each speech turn.
  - Number of word-final schwas (non-lexical vowels) is established for each speech turn.
  - A Pearson's test was operated on the data for each corpus.

$\Rightarrow$ Very weak correlations between speech rate and word-final schwa realization in all corpora: ESTER: r=-0.03, ETAPE: r=-0.01, and NCCFr: r=0.20

- Maybe the relevant factor in variation phenomena is not how quick or slow one speaks but how regular the rhythm of the speech is.

Conclusion and Discussion

Summary of the results

Concluding remarks

Bibliography

Summary of the 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/
      - manner of articulation: fricatives favor schwa realization less than stops
      - place of articulation: labial codas favor schwa realization less than alveolars and posterior-velar consonants more
    - Immediate right context: more schwas before pause, sonorants and voiced obtruents that before voiceless obstruents, but less before vowels
- Also:
  - effect of the sonority sequence
  - no effect of speech rate

Concluding remarks

- First extended study of word-final schwa in Standard French
- Benefited from access to large-scale data and automatic speech alignment techniques

$\Rightarrow$ Case in point of what large corpora and automated methodologies can bring to linguistic inquiry of fine-grained free variation

Bibliography

Adda-Decker, M. & L. Lamel. 2017. Discovering speech reductions across speaking styles and languages. In Cangemi, F., Clayards M., Niebuhr O., Schuppler B., & Zellers M. (eds), *Rethinking reduction: Interdisciplinary perspectives on conditions, mechanisms, and domains for phonetic variation*, De Gruyter Mouton

Brand, S. & M. Ernestus. 2018. Reduction of word-final obstruent-liquid-schwa clusters in Parisian French. *Corpus Linguistics and Linguistic Theory*, 0(0), Retrieved 13 Jan. 2020, from doi:10.1515/cllt-2017-0067

Bürki, A., C. Fougeron & C. Gendrot. 2007. On the categorical nature of the process involved in schwa elision in French. *Interspeech*, August 2007, Antwerp, Belgium.

Bürki, A., M. Ernestus, C. Gendrot, C. Fougeron & U. Frauenfelder. 2011. What affects the presence versus absence of schwa and its duration: a corpus analysis of French connected speech. *JASA*, 130, 3980-3991.

Côté, M.-H. 2000. *Consonant Cluster Phonotactics: A Perceptual Approach*. PhD-thesis, MIT.

Delattre, P. 1951. Le jeu de l'e instable intérieur en français. *French review*, 341-351.

Delattre, P. 1966. *Studies in French and comparative phonetics*. La Haye: Mouton.

Dell. F. 1970. *Les règles phonologiques tardives et la phonologie dérivationnelle du français*. PhD thesis, MIT.

Dell, F. 1976. Schwa précédé d'un groupe obstruante-liquide. *Recherches Linguistiques* 4. Université de Paris 8-Vincennes, 75-111

Durand, J. & J. Eychenne. 2004. Le schwa en français : pourquoi des corpus ? *Corpus* n°3 « Usage des corpus en phonologie », 311-356.

Eychenne, J. 2019. On the deletion of word-final schwa in Southern French. *Phonology*, 36.3, 1-35.

Fónagy, I. 1989. Le français change de visage ? *Revue Romane* 24, 2 : 225-254.

Fouché, P. 1956. *Traité de prononciation française*. Paris : Klincksieck.

Galliano, S., E. Geoffrois, D. Mostefa, K. Choukri, J.-F. Bonastre & G. Gravier. 2005. ESTER Phase II Evaluation Campaign for the Rich Transcription of French Broadcast Newshase II Evaluation Campaign for the Rich Transcription of French Broadcast News. *Interspeech* 2005, 2453–2456

Grammont, M. 1894. Le patois de la Franche-Montagne et en particulier de Damprichard (Franche-Comté). IV : La loi des trois consonnes. *Mémoires de la Société de linguistique de Paris* 8: 53-90

Grammont, M. 1914. *Traité Pratique de Prononciation Française*. Delagrave, Paris, 236 pp.

Gravier, G., G. Adda, N. Paulson, M. Carré, A. Giraudel & O. Galibert. 2012. The ETAPE corpus for the evaluation of speech-based TV content processing in the French language. *LREC 8*

Gauvain, J.-L., G. Adda, M. Adda-Decker, A. Allauzen, V. Gendner, L. Lamel & H. Schwenk. 2005. Where are we in transcribing French broadcast news? *Interspeech* 2005, 1665-1668

Gauvain, J.-L., L. Lamel & G. Adda. 2002. The LIMSI broadcast news transcription system. *Speech communication* 37 (1-2), 89–108

Hallé, P. & M. Adda-Decker. 2007. Voicing assimilation in journalistic speech. *16th International Congress of Phonetic Sciences*, 2007, 493–496.

Hallé, P. & M. Adda-Decker. 2011. Voice assimilation in French obstruents: A gradient or a categorical process? *Tones and features: A festschrift for Nick Clements*, De Gruyter, 149–175.

Hansen, A. B. 1994. Étude du E caduc - stabilisation en cours et variations lexicales. *Journal of French Language Studies* 4, 25–54.

Hansen, A. B. 1997. *Le nouveau [ə] prépausal dans le français parlé à Paris. Polyphonie pour Iván Fónagy*, Paris: L'Harmattan, 173–198.

Hansen, A. B. & M. B. Mosegaard-Hansen. 2002. Le e prépausal et l'interaction. In Anita B. Hansen & Maj Brit Mosegaard-Hansen (eds.), *Structures linguistiques et interactionnelles dans le français parlé*. Actes du Colloque international, Université de Copenhague du 22 au 23 juin 2001 (Études romanes 54). Copenhague: Museum Tusculanum Press, 89-109.

Leray, F. 1930. La loi des trois consonnes. *Revue de philologie française* XLII. 161-184.

Malécot, A. 1958. The role of releases in the identification of released final stops: a series of tape-cutting experiments. *Language*, 370–380

Malécot, A. 1976. The effect of linguistic and paralinguistic variables on the elision of the French mute-e. *Phonetica*, 33, 93-112.

Martinon, P. 1913. *Comment on prononce le français*. Paris : Larousse.

Mende, A. 1880. *Étude sur la prononciation de l'e muet*. Londres : Trubner

Parker, S. 2012. Sonority. *The Blackwell Companion to Phonology*. van Oostendorp, Marc, Colin J. Ewen, Elizabeth Hume & Keren Rice (eds). Blackwell Publishing, 2011. Blackwell Reference Online. 12 January 2012

Purse, R. 2019. Variable Word-Final Schwa in French: An OT Analysis. University of Pennsylvania Working Papers in Linguistics, Vol. 25, Issue 1, *Proceedings of the 42nd Annual Penn Linguistics Conference*, Article 22

R Development Core Team. 2008. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing Vienna, Austria. http://www. R-project.org.

Racine, I. & F. Grosjean. 2002. La production du E caduc facultatif est-elle prévisible ? Un début de réponse. *French Language Studies*, 12, 307-326

Ranson, D. & M. Passarello. 2012. L'élision variable du schwa en fin de mot chez des hommes méridionaux : L'effet des consonnes environnantes et de la fréquence de la lexie. *Congrès Mondial de Linguistique Française – CMLF 2012*

Torreira F., M. Adda-Decker & M. Ernestus. 2010. The Nijmegen Corpus of Casual French. *Speech Communication*, Elsevier: North-Holland, 2010, 52 (3)

Tranel, B. 1981. *Concreteness in Generative Phonology. Evidence from French*. Berkeley: University of California Press.

Wu, Y., M. Adda-Decker & C. Fougeron. 2016. Rôle des contextes lexical et post-lexical dans la réalisation du schwa : apports du traitement automatique de grands corpus. *Actes de JEP-TALN-RECITAL* 2016, volume 1 JEP: 633-641

Wu, Y., M. Adda-Decker, C. Fougeron & L. Lamel. 2017. Schwa Realization in French: Using Automatic Speech Processing to Study Phonological and Socio-Linguistic Factors in Large Corpora. *Interspeech* 2017, 3782-3786

Thank you for your attention!