

Automatic detection of schwa in French hypersomniac patients

C. Beaumard, V. P. Martin, Y. Wu, J-L. Rouas, P. Philip



01

Introduction

Excessive sleepiness

= **Accidental risk**



Gold standard to measure excessive sleepiness :

- Hospital
- **Multiple Sleep Latency Test**

→ 5 nap opportunities every 2 hours (9AM-5PM)

Restrictive for the patients
Costly (2000€)

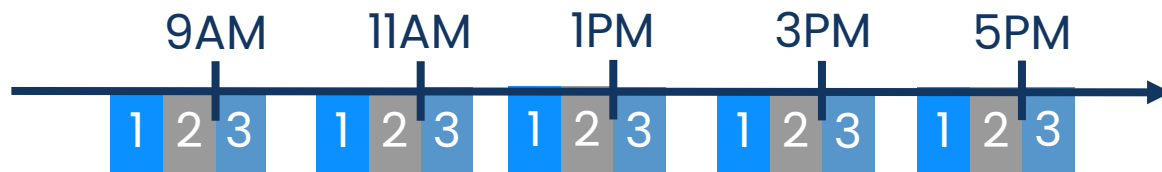
	Measured	WHO
Day	37 à 88.6 dBA	40 dBA
Night	38.7 à 68.8 dBA	30 dBA

01

Introduction MSLTC [7, 8]



20 speakers – 100 read out loud voice samples



Short-term subjective
sleepiness (KSS)



5 different texts
(\approx 250 words)



Sleep latency
(EEG)

01

Introduction

State of the art



Goal: to monitor evolution of sleepiness in ecological conditions

Voice → low-cost measurement, passive data collection

Several features to evaluate sleepiness on read out loud speech:

- Acoustic features [1]
- Reading mistakes [2]
- Errors made by Automatic Speech Recognition [3]
- Reading pauses (duration and localisation) [4]

01

Introduction

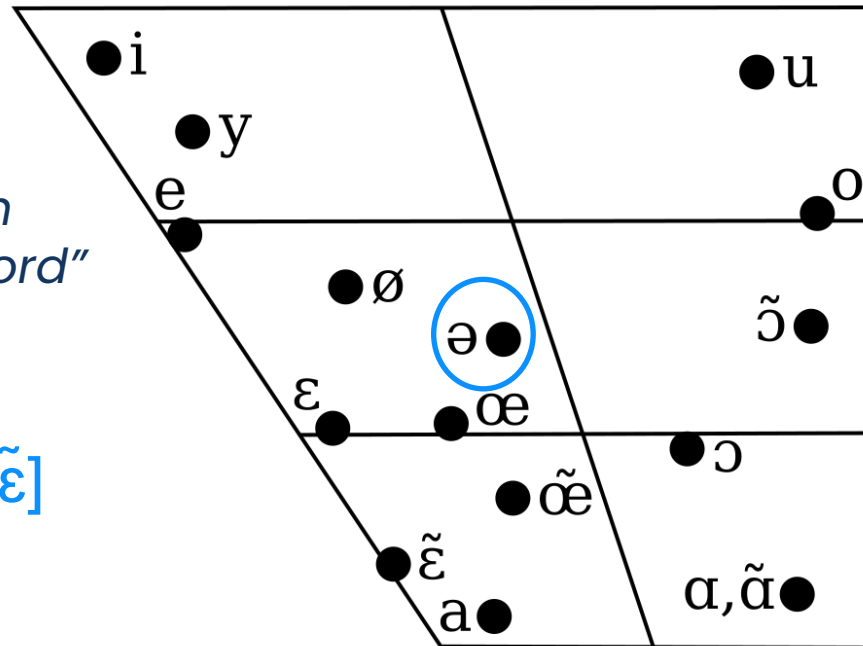
Schwas

[ə]

*“a central vowel that can alternate with
∅ without changing the meaning of the word”
[5, 6]*

*Demain (tomorrow) → [dɛmɛ̃] or [dmɛ̃]
Also used for hesitation!*

Link between sleepiness and schwas?



02

Preliminary study

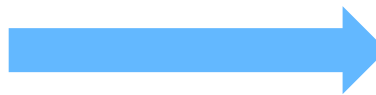
Hand-labelled schwas



Lexique 3.83
[9]

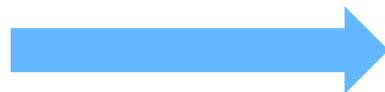
Audio

*J'ai ainsi vécu seul, sans personne
avec qui parler véritablement...*



Presence/
Absence of
schwa

Rm
multivariate
ANOVA



**Intra-speaker variations of %S
linked to obj. and subj. sleepiness**

02

Preliminary study

Objective

Texts

*J'ai ainsi vécu seul, sans personne
avec qui parler véritablement...*



Lexique 3.83
[9]

Phonetic transcription

*/ʒɛ ɛ̃si vɛky sœl sɑ̃ pɛʁsɔ̃n avɛk ki
pɑvle vɛʁitablømɑ̃/*



Phonemes

*/ʒə vɛgavɛ dɔ̃k sɛt
apavɛisjɔ̃/*

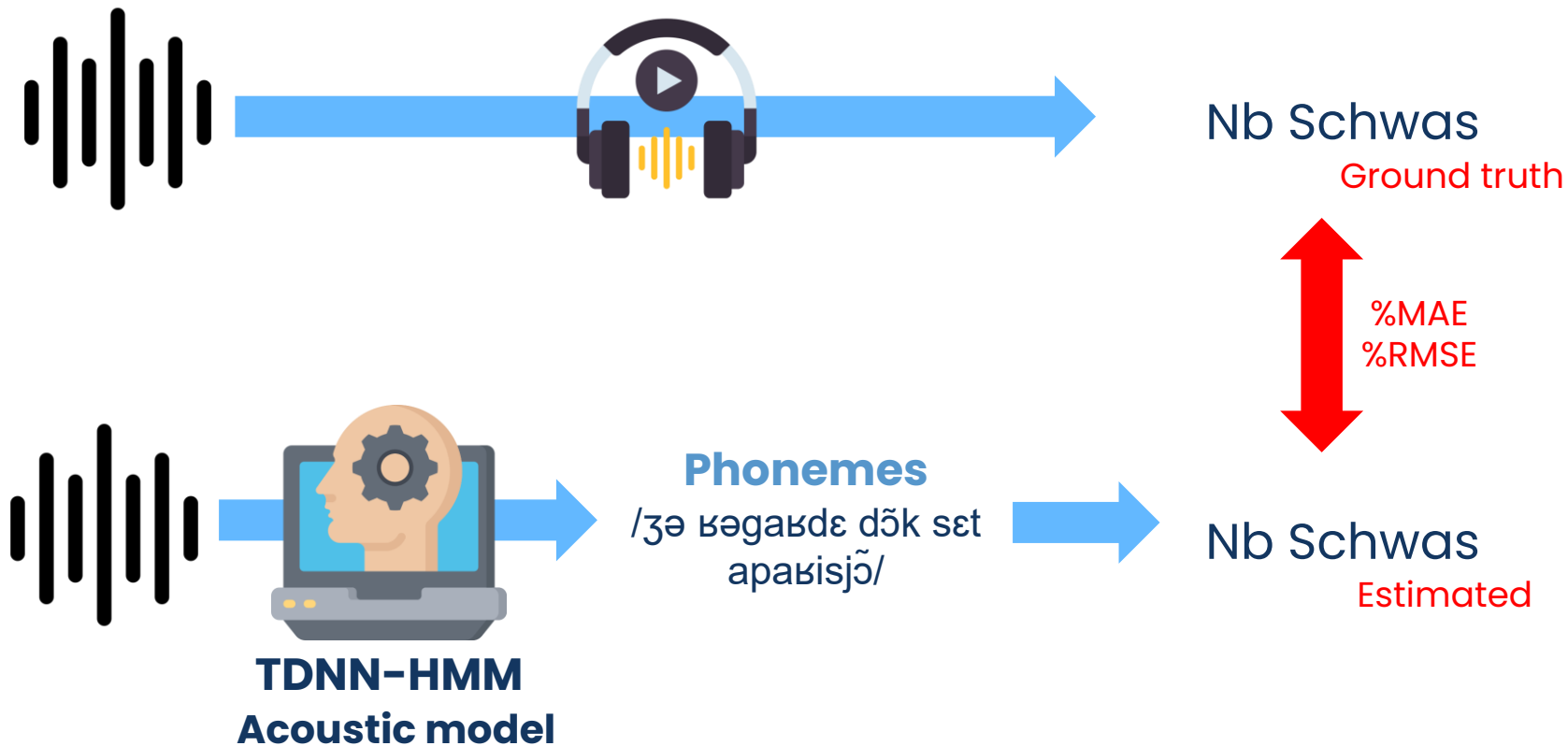


**Automatic Speech
Recognition**

03

Automatic extraction

ASR v1: Acoustic model



03

Automatic extraction

Acoustic model – %MAE and %RMSE

Phoneme	Metric	Text 1	Text 2	Text 3	Text 4	Text 5	All texts
[ə]	%MAE	29.3	11.2	28.4	33.5	50.2	28.3
	%RMSE	35.7	13.5	30.5	36.2	52.0	32.4
[ø]	%MAE	50.0	14.5	44.8	42.6	52.5	40.0
	%RMSE	50.0	14.5	46.3	44.1	42.5	44.6
[œ]	%MAE	2.6	33.3	3.2	20.0	-	12.5
	%RMSE	5.1	36.7	9.7	30.0	-	25.0
[ə]+[ø]+[œ]	%MAE	17.5	9.6	16.5	21.5	28.0	17.8
	%RMSE	23.6	11.4	18.6	23.6	30.7	20.9

03

Automatic extraction

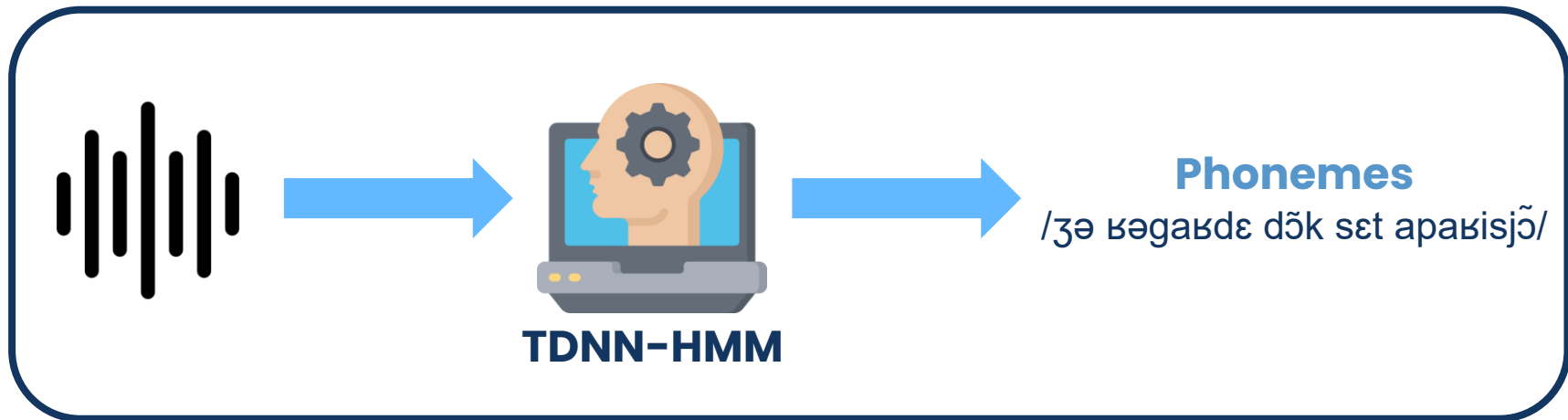
Acoustic model – ANOVA

Factor	[ə]	[ø]	[œ]	[ə]+[ø]+[œ]
Texts	***	***	***	***
Texts:MSLT	–	*	*	–
Texts:KSS	–	***	–	–

03

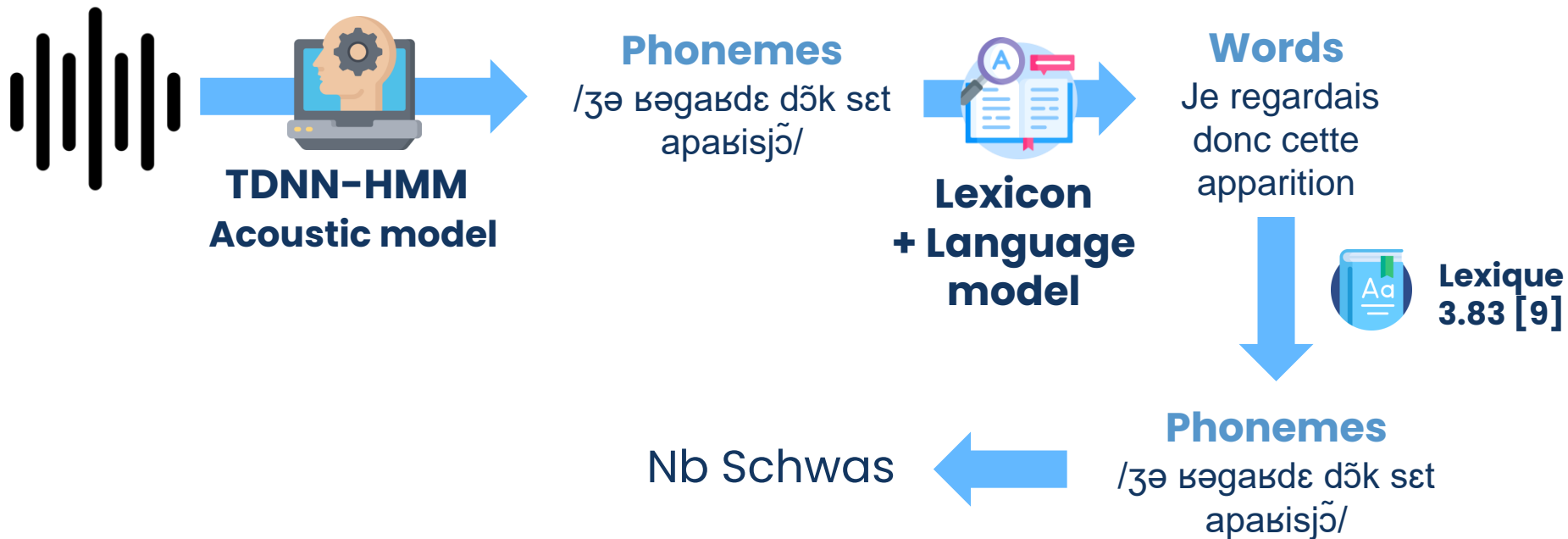
Automatic extraction *Automatic Speech Recognition*

ASR-phonemes



03

Automatic extraction *Automatic Speech Recognition*



03

Automatic extraction

Word-based ASR – %MAE and %RMSE

Phoneme	Metric	Text 1	Text 2	Text 3	Text 4	Text 5	All texts	All texts
[ə]	%MAE	8.9	6.4	11.5	10.2	25.3	11.4	28.3
	%RMSE	12.9	9.5	13.4	13.7	30.2	15.8	32.4
[ø]	%MAE	0.4	17.1	16.7	7.4	11.3	10.8	40.0
	%RMSE	0.1	17.1	21.2	10.3	15.0	16.9	44.6
[œ]	%MAE	2.6	6.7	6.5	25.0	-	8.3	12.5
	%RMSE	7.7	16.7	12.9	35.0	-	20.8	25.0
[ə]+[ø]+[œ]	%MAE	7.5	5.9	7.4	7.8	18.8	8.9	17.8
	%RMSE	10.6	8.8	9.3	11.7	22.4	12.4	20.9

03

Automatic extraction

Word-based ASR - ANOVA

Factor	[ə]	[ø]	[œ]	[ə]+[ø]+[œ]
Texts	***	***	-	***
Texts:MSLT	-	-	-	-
Texts:KSS	-	-	-	-

CONCLUSION



- Link Schwas \leftrightarrow sleepiness
- /!\ lexicons

Future work

- Confirm results on larger samples
- All phonemes
- Spontaneous speech
- Duration, acoustic and temporal properties of phonemes for sleepiness estimation
- Differences hesitations / elisions

Thank you!



colleen-beaumard



colleen.beaumard@labri.fr



References

- [1] Vincent P Martin, et al. Détection de la somnolence dans la voix: nouveaux marqueurs et nouvelles stratégies. 2020.
- [2] Vincent P. Martin, et al. Automatic Speech Recognition systems errors for accident-prone sleepiness detection through voice. In EUSIPCO, pages 541–545, 2021.
- [3] Vincent P. Martin, et al. Automatic Speech Recognition Systems Errors for Objective Sleepiness Detection Through Voice. In Interspeech 2021, pages 2476– 2480, 2021.
- [4] Vincent P. Martin, et al. Does sleepiness influence reading pauses in hypersomniac patients? pages 62–66, 2022.
- [5] Audrey Burki, et al. What affects the presence versus absence of schwa and its duration: A corpus analysis of French connected speech. J. Acoust. Soc. Am., 130(6):3980–3991, 2011.

References

- [6] Jacques Durand. A la recherche du schwa : donnees, methodes et theories. SHS Web of Conferences, 8:23–43, 2014.
- [7] Vincent P Martin, et al. The Objective and Subjective Sleepiness Voice Corpora. LREC, 2020.
- [8] Vincent P. Martin, et al. How to Design a Relevant Corpus for Sleepiness Detection Through Voice? Front. digit. health., 3:686068, 2021.
- [9] Boris New, et al. Lexique 2 : A new French lexical database. Behavior Research Methods, Instruments, & Computers, 36(3):516–524, 2004.