Automatic diagnosis and feedback for lexical stress errors in non-native speech: Towards a CAPT system for French learners of German

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Lexical stress

Some syllable(s) in a word more accentuated/prominent[1]

um·FAHR·en	vs.	UM·fahr·en
to run over		*to drive around*

- German: variable stress placement, contrastive stress[1]
- French: no word-level stress, final syllable lengthening[2]

Goal: Computer-Assisted Pronunciation Training (CAPT) for lexical stress errors for French learners of German

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[1] A. Cutler. "Lexical Stress". In: *The Handbook of Speech Perception*. Ed. by D. B. Pisoni and R. E. Remez. 2005, pp. 264–289.

[2] M.-C. Michaux and J. Caspers. "The production of Dutch word stress by Francophone learners". In: *Proc. of the Prosody-Discourse Interface Conference (IDP)*. 2013, pp. 89–94.

Outline

Motivation

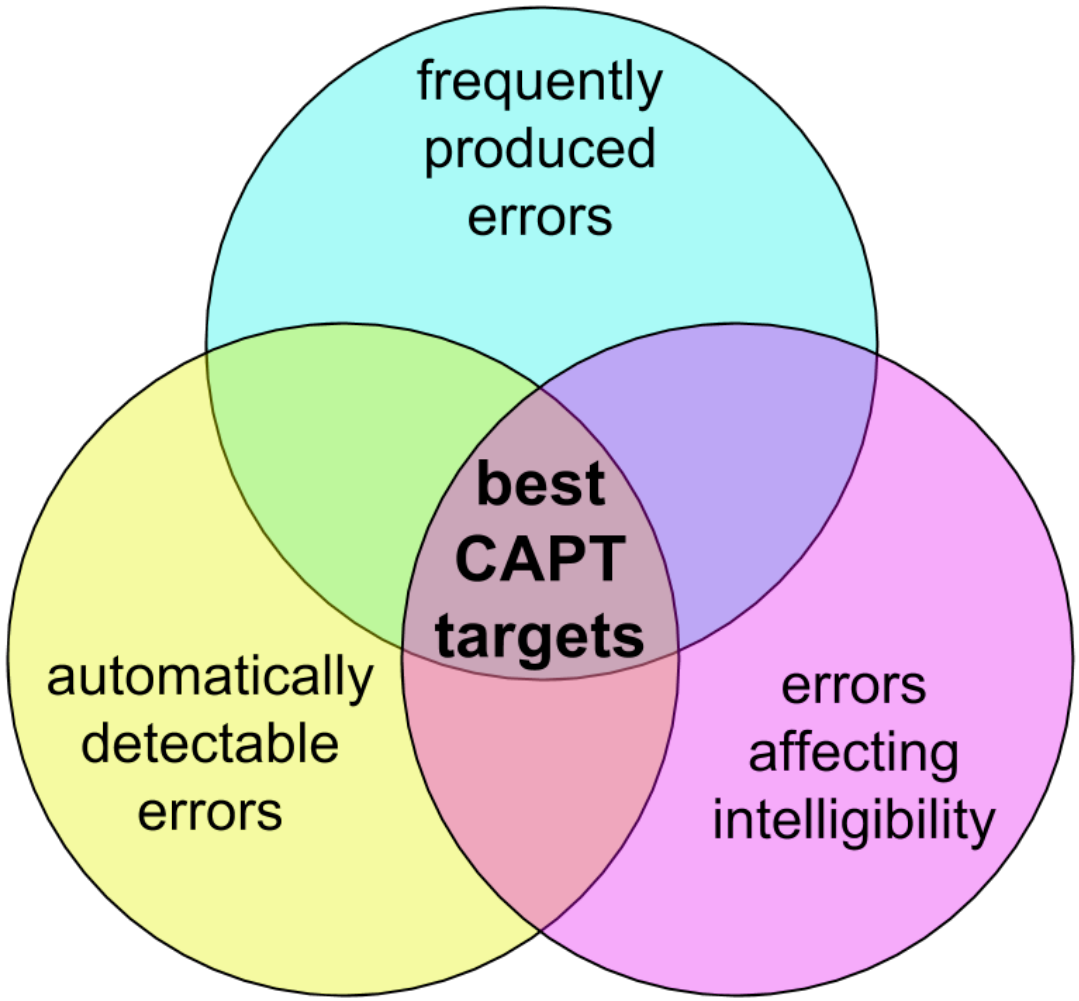
Lexical stress errors by French learners of German
- Annotation of a learner speech corpus
- Inter-annotator agreement
- Errors

Error diagnosis
- Word prosody analysis
- Diagnosis by comparison
- Diagnosis by classification

Feedback
- Implicit
- Explicit
- Self-assessment

The de-stress CAPT tool

Figure: Criteria for selecting errors to target in a CAPT system.



Motivation

Lexical stress errors seem to be:

- Frequently produced by French learners of variable-stress languages[1,2]
- More important for intelligibility in L2 German than other types of errors[3]
- Possible to identify automatically by comparison[1] or classification[4]

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[1] A. Bonneau and V. Colotte. "Automatic Feedback for L2 Prosody Learning". In: *Speech and Language Technologies*. Ed. by I. Ipsic. InTech, 2011.

[2] M.-C. Michaux. "Exploring the production and perception of word stress by French-speaking learners of Dutch". In: *Workshop on Crosslinguistic Influence in Non-Native Language Acquisition*. 2012.

[3] U. Hirschfeld. *Untersuchungen zur phonetischen Verständlichkeit Deutschlernender*. Vol. 57. Forum Phoneticum. 1994.

[4] Y.-J. Kim and M. C. Beutnagel. "Automatic assessment of American English lexical stress using machine learning algorithms". In: *SLaTE*. 2011, pp. 93–96.

Lexical stress errors in learner speech

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- How reliably can human annotators identify errors in learner utterances?
- How frequently are errors actually produced by French learners of German?

Error annotation

Data: IFCASL corpus of French-German L1/L2 speech[1]

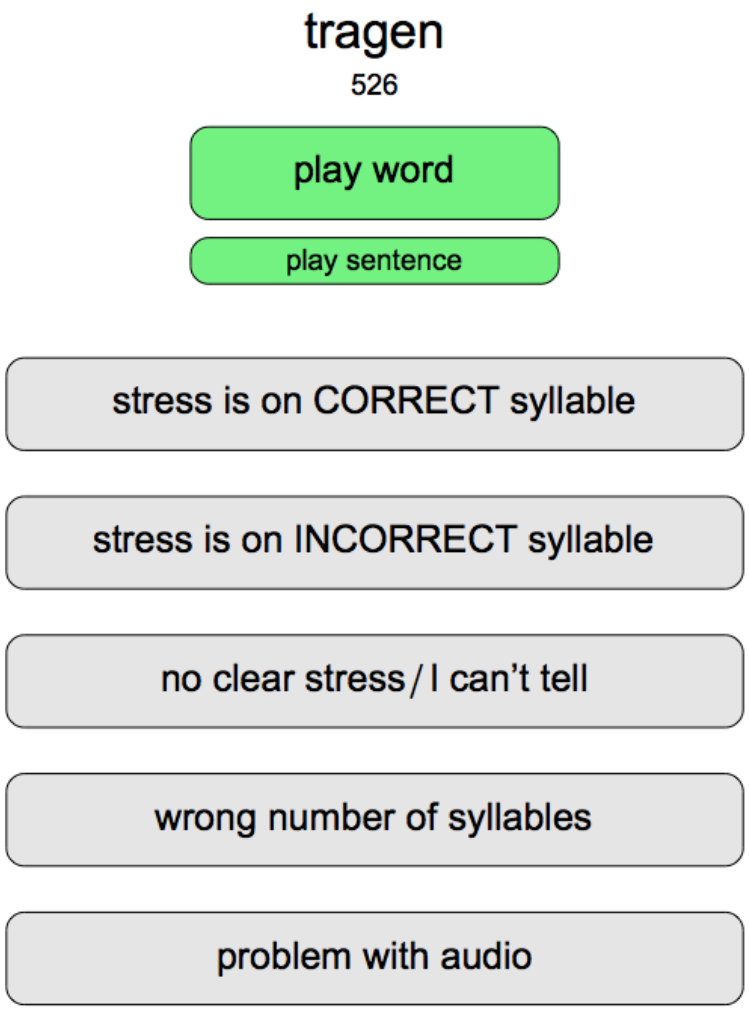
- German utterances by French and German speakers
- Word- and phone-level segmentations (syllable level added automatically)
- Selected 12 word types (bisyllabic, initial stress)
- Dataset: 668 word utterances by 55-56 speakers

Annotators (15 in total):

- L1: 12 German speakers, 2 English, 1 Hebrew
- Expertise: 2 Experts, 10 Intermediates, 3 Novices
- Annotated 3 word types in 1 $\sim$15 min. session

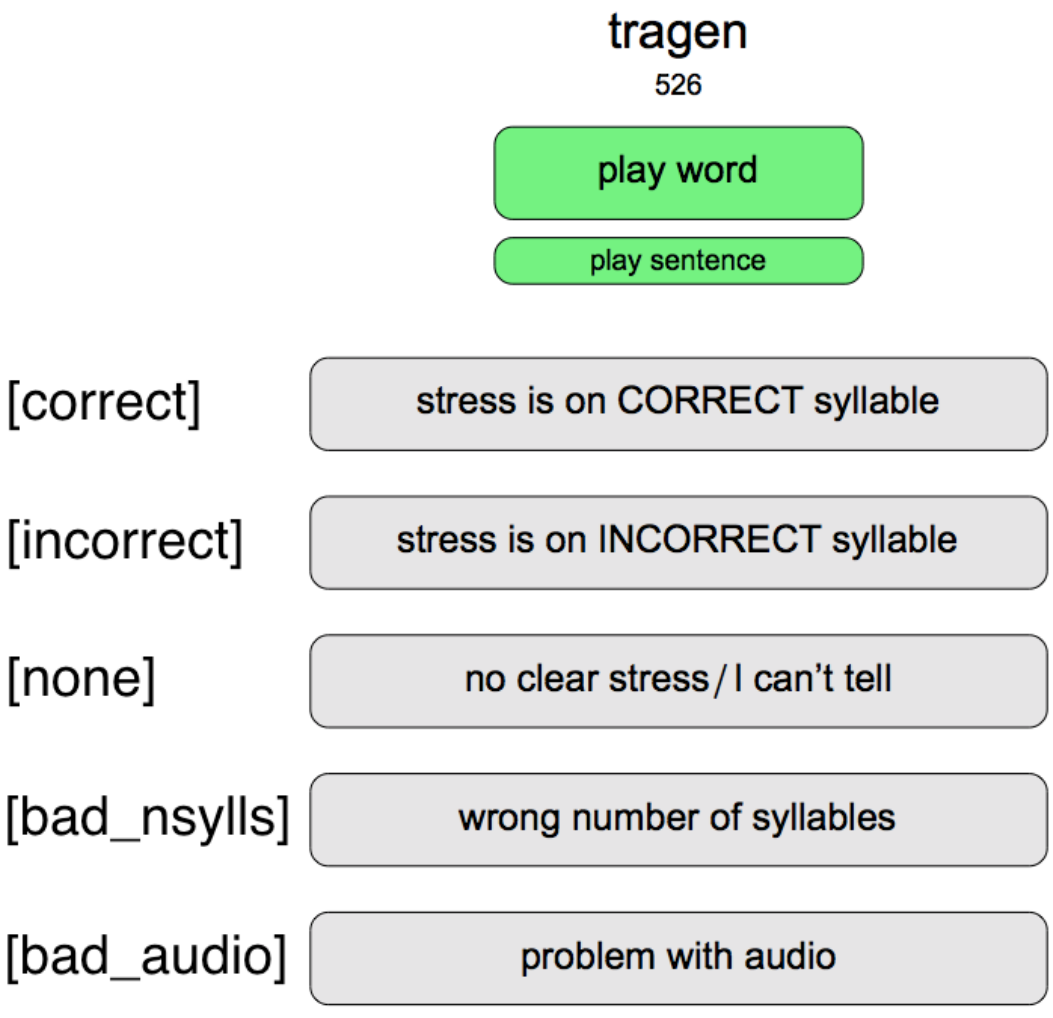
[1] C. Fauth et al. "Designing a Bilingual Speech Corpus for French and German Language Learners: a Two-Step Process". In: *9th Language Resources and Evaluation Conference (LREC)*. Reykjavik, Iceland, 2014, pp. 1477–1482.

Figure: Praat annotation tool



Error annotation

Figure: Praat annotation tool



Inter-annotator agreement

How reliably can human annotators identify errors in learner utterances?

- Agreement calculated for each overlapping pair
- Quantified by:
  - Percentage agreement: N agreed/N both annotated
  - Cohen's Kappa[1] (κ): accounts for chance agreement
- Overall agreement represented by mean, minimum, median, and maximum of all pairwise values

[1] J. Cohen. "A Coefficient of Agreement for Nominal Scales". In: *Educational and Psychological Measurement* 20.1 (Apr. 1960), pp. 37–46.

Inter-annotator agreement

Table: Overall pairwise agreement between annotators

	% Agreement	Cohen's κ
Mean	54.92%	0.23
Maximum	83.93%	0.61
Median	55.36%	0.26
Minimum	23.21%	-0.01

- Generally low agreement ("fair"[1] mean κ)
- Large variability between annotators
- Not explained by L1/expertise groups

[1] J. R. Landis and G. G. Koch. "The measurement of observer agreement for categorical data." In: *Biometrics* 33.1 (1977), pp. 159–174.

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