Individualized feedback for lexical stress errors

Towards a CAPT system for French learners of German

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Introduction

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1.1 Context: The IFCASL project

The work reported here has been conducted in the context of the ongoing research project "Individualized Feedback in Computer-Assisted Spoken Language Learning (IFCASL)" at the University of Saarland (Saarbrücken, Germany) and LORIA (Nancy, France).

The ultimate goal of the project is to take initial steps toward the development of a CAPT system targeting, on the one hand, native (L1) French speakers learning German as a foreign language (L2), and on the other, L1 German speakers learning French as their L2. To this end, a bidirectional learner speech corpus has been recorded, comprising phonetically diverse utterances in French and German spoken by both native speakers and non-native speakers with the other language as L1 (Fauth et al., 2014; Trouvain et al., 2013).

This thesis will focus exclusively on French L1 speakers learning German as L2. The German-language subset of the IFCASL corpus will be instrumental in training and testing the automatic diagnosis and feedback systems which this work aims to develop. Futhermore, those systems will be designed with a view to contributing to the overall set of software developed in the context of the IFCASL project, such that they will be as compatible as possible with the other tools developed and used by the IFCASL team.

1.2 Objectives

The main objective of this work is to investigate the automatic treatment of lexical stress errors in the context of a CAPT system for French learners of German. This includes, on the one hand, an examination of the ways in which lexical stress errors of the type made by French L1 speakers when speaking German as L2 can be reliably detected and measured automatically, and on the other, an exploration of the types of multimodal feedback on such errors that can be automatically delivered based on

the aforementioned error detection. The intented outcome of these investigations is a prototype CAPT tool which can diagnose lexical stress errors in different ways and present learners with different types of feedback on these errors, such that researchers can use this modular system to study the impact of various assessment and feedback types on learner outcomes, user engagement, and other factors impacting the success of a CAPT system. Once more is known about which diagnosis/feedback types should be delivered to which learners in which situations, this tool could become a useful component to a fully-fledged CAPT system, in which learner models and other intelligent components automatically decide which modules of the tool to activate.

1.3 Thesis overview

Chapter 2 introduces Computer-Assisted Pronunciation Training in the context of pronunciation teaching in foreign-language education and computer-based and intelligent tutoring systems, and outlines the phonetic and phonological differences between French and German as well as the motivation for focusing on lexical stress errors in this work.

Chapter 3 will introduce the systems that have been developed, and the technology used to build them.

Chapter 4 will detail the system for assessing learner speech in terms of lexical stress errors.

Chapter 5 will describe the multimodal feedback options that the system can deliver.

Chapter 6 will summarize the contributions of this work and outlines some interesting future directions to build on these contributions.

Background and related work   2

2.1 Computer-Assisted Pronunciation Training

In the field of second-language education, pronunciation has traditionally been given less attention than other areas such as grammar or vocabulary (Derwing and Munro, 2005). One reason for this may be that pronunciation is best taught through one-on-one instruction, which is not often possible in the traditional classroom setting. Hence the attraction of Computer-Assisted Pronunciation Training (CAPT) systems, which have the potential to automatically provide highly individualized analysis of learner errors, and feedback on how to correct them and achieve more intelligible and native-like pronunciation in the target language (Witt, 2012).

2.1.1 Pronunciation in foreign language education

2.1.2 Computer-based and intelligent tutoring systems

2.1.3 Survey of existing CAPT systems?

2.2 Towards CAPT for French learners of German

2.2.1 Phonetic and phonological comparison

Segments

Prosody

Lexical stress   What is lexical stress (Cutler, 2005)

Lexical stress in French vs. German (Cutler, 2005) (Peperkamp and Dupoux, 2002; Dupoux, 2001; Dupoux and Sebastián-Gallés, 2008)

Other factors

2.2.2 Targeting lexical stress errors

Learners of a foreign language typically make a wide variety of pronunciation errors, at both the segmental level (e.g. errors in producing certain individual phones of the target language) and the prosodic level (e.g. errors in the speaker's intonation contour or the duration of certain syllables or words). As it is not possible to address all of these in an automated system, one of the first aims of this work is to identify a single type of error which is well suited to being addressed via a CAPT system targeting French L1 learners of German as the L2.

To guide this selection, we may consider a set of three criteria that such an error must meet. First, the error must be produced with a some degree of frequency by French L1 speakers in their production of L2 German, as it would be a misuse of resources to design a system which addresses an error that is seldom made by learners. Secondly, the given error must have a significant impact on the perceived intelligibility of the learner's speech; as the ultimate goal of the system is to help learners communicate more effectively in the L2, an error which is commonly made but nevertheless does not impede understanding of the learner's L2 speech, and thus does not hinder communication in the L2, is not an ideal target. Finally, in order for the CAPT system to provide any meaningful diagnosis of and feedback on the error, it must lend itself to reasonably accurate and reliable detection through automatic processing.

Figure 2.1: Criteria for selecting errors to target in a CAPT system.

As illustrated in 2.1, the best error to target with the CAPT system will fulfill all of these criteria, rather than only one or two of the three. For example, vowel quality errors (e.g. an L1 French speaker producing a German /ə/ as [œ]) may occur frequently in the L2 speech and may be relatively easy to detect automatically, but

may not have a great impact on the intelligibility of the L2 German speech. On the other hand, equally frequent vowel quantity errors (e.g. the L1 French speaker producing a German long /eː/ as [e]) may have a greater impact on intelligibility in some cases, but may be more difficult to reliably identify automatically.

Analysis of the typical and expected errors described in in terms of these criteria reveals that lexical stress errors are a strong candidate for treatment via CAPT, and will therefore be the focus of the prototype CAPT system described in this thesis. The remainder of this section justifies the selection of this type of error by describing how it fulfills the aforementioned criteria as well or better than any other error type.

Frequency of production

(Cutler, 2005)

(Peperkamp and Dupoux, 2002; Dupoux, 2001; Dupoux and Sebastián-Gallés, 2008)

Impact on intelligibility

(Warren et al., 2009)

(Magen, 1998)

Stress errors may affect perception of segmental errors; errors in stressed syllables are more noticeable (Cutler, 2005)

Feasibility of automatic detection

(Engwall, 2012; Delmonte, 2011)

(Bonneau and Colotte, 2011)

(Shahin et al., 2012)

2.3 Summary

System overview?

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4.1 Related work

Lots of Nancy references

Duong et al., 2011

Probst et al., 2002

4.2 Automatic segmentation of nonnative speech

4.2.1 Segmentation via forced alignment

4.2.2 Evaluation of system accuracy

4.2.3 Coping with segmentation errors

Mesbahi et al., 2011, Orosanu et al., 2012

4.3 Prosodic analysis

4.3.1 Pitch

4.3.2 Duration

4.3.3 Intensity

4.4 Comparison of native and nonnative speech

Probst et al., 2002

4.4.1 Using a single reference speaker

Manually selecting a reference

Automatically selecting a reference

4.4.2 Using multiple reference speakers

4.4.3 Using no reference speaker?

Duong et al., 2011

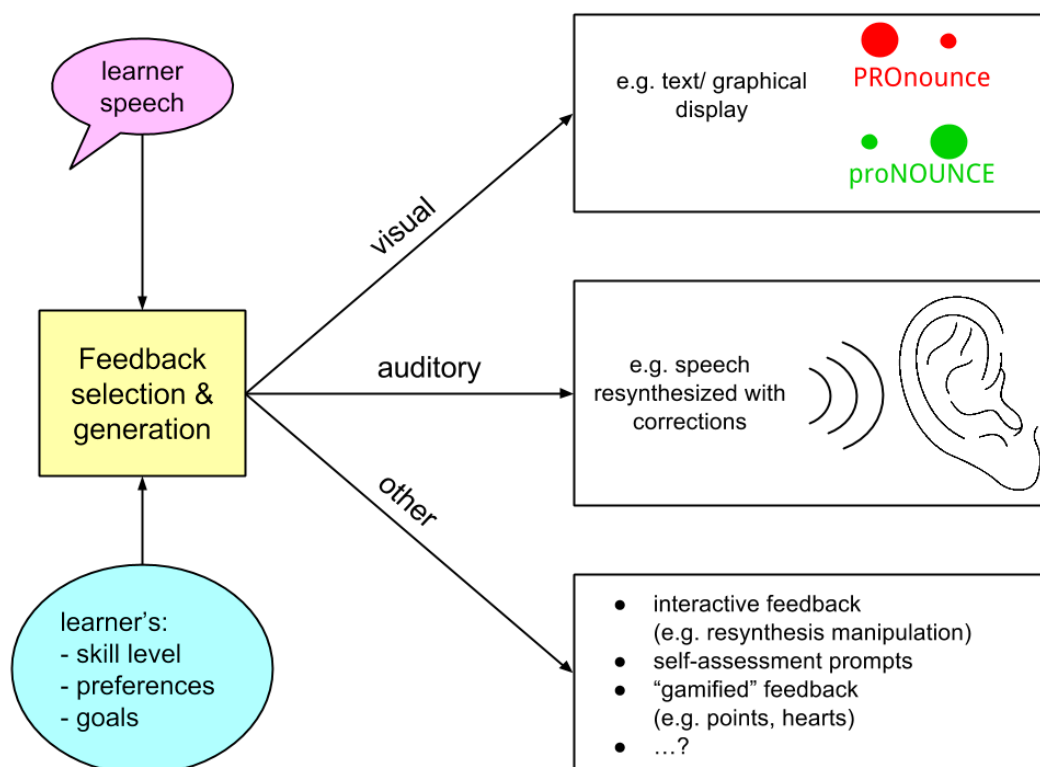## 4.5 Summary

Feedback on lexical stress errors

Figure 5.1: Delivery of prosody feedback in different modalities.

5.1 Related work

Sitaram et al., 2011 Bonneau and Colotte, 2011

5.2 Visual feedback

5.2.1 Stylized text

5.2.2 Graphical representations of prosody

5.2.3 Visualizations of the speech signal

Conclusion and outlook 6

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