L1-L2*map*: a tool for multi-lingual contrastive analysis

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ABSTRACT

The present article describes the development of L1-L2*map*, a multi-lingual contrastive analysis tool. It uses the phoneme inventories of a large number of languages, but also contains more detailed phonetic information. An example of this is the information about the syllable positions in which the sounds can occur in a given language, which is very useful for computer-assisted pronunciation training (CAPT). The tool is available through a wiki and can be extended to include new languages. The result from contrastive analysis is used in CAPT to guide language learners through pronunciation exercises depending on their native language.

Keywords: contrastive analysis, Norwegian, multi-lingual, phonetic detail, positional variants.

1. INTRODUCTION

In language classes, pronunciation teaching is usually either geared towards a learner group with one common native language, or is unspecific as to the native language of the learners. The former is more typical of a classroom situation for foreign language teaching (i.e. for teaching a language which is spoken outside the country where the class is taking place), where the learners usually have the same native language background and study the same foreign language (e.g. English classes in Norway). The latter situation is common in the country where the target language is spoken, where learners with different native languages participate in language courses together. In the case at hand, the Norwegian language courses at NTNU are attended by speakers of German, Mandarin Chinese, Russian, Farsi, French and many other languages.

Clearly, a teaching situation where the course participants have different language backgrounds does not allow a clear focus on the pronunciation problems that one can expect on the basis of their native languages. In practical classroom situations, the teacher does not normally have an in-depth knowledge of the phonetics of all course participants' native languages, and there often is not enough time in class to give corrective feedback to individual language learners. A computer-assisted pronunciation training (CAPT) system selecting exercises on the basis of a contrastive analysis [10] of each learner's native language and the target language has therefore been developed for Norwegian, in order to solve both problems, at least to some extent[1] [8]. Our aim is to guide each individual foreign language learner through a minimal set of exercises dependent on his/her native language.

In this article we present L1-L2*map* [9], a tool for contrastive analysis which takes the phoneme inventories of a large number of languages as a starting point. We describe some of the consequences which the use of a *multi-lingual* contrastive analysis (CA) has on the level of phonetic detail that language learners are expected to deal with, and we argue for the use of syllable position information.

2. L1-L2*MAP*

Almost 1400 language learners per year participate in the Norwegian courses at NTNU. Using L1-L2*map* it is possible to determine an individualized pronunciation training trajectory for each L2 learner, selecting only relevant exercises.

L1-L2*map* is based on UPSID [11], a publicly available database which contains the phoneme inventories of 451 languages, and has been extended with other language data. L1-L2*map* is freely accessible and can be extended to include new languages. The CAPT system we have developed uses Norwegian as the target language, but it is also possible to select any other language in the database as the target language.

[1] Another approach, followed by Helmer Strik and his colleagues in the DISCO project, uses an automatic analysis of recordings of the learner at the start of the (Dutch) language course to determine the pronunciation errors that need remediation (p.c.).

The contrastive analysis in L1-L2*map* first and foremost aims at communicative effectiveness, but because it is based on a multi-lingual database it contains inherent phonetic detail which makes it possible for the learner to aim for a more near-native pronunciation. The contrastive analysis hypothesis (CAH) as presented in [10] claims that all problems in learning a foreign language can be explained from transfer problems induced by the learner's native language. It is now generally accepted that this claim is too strong, and that there are other factors which determine the difficulty language learners have with acquiring new sounds [13,4,1,5,12]. We should stress, though, that the work presented here is motivated by the practical needs of the Norwegian learners at NTNU, and does not aim to resolve these issues in L2 research. There is no doubt that a contrastive analysis remains the first step to predicting listening and pronunciation problems, and we can hope that, by using all features which can be distinctive in *some* languages, we arrive at a set of perceptually salient properties which can help L2 learners not only to be communicatively effective, but also to reduce their foreign accent.

The function of L1-L2*map* is to serve as a platform which allows researchers with a phonetic or phonological background to make language data available in a format that can be used directly by technologists in CAPT. L1-L2*map* is a generally accessible tool, where any user can access the data, while a group of specialists have the responsibility for inserting data about their native language and/or other languages that they have near-native phonetic-linguistic competence for.

2.1. Choice of phonemic representation

The representation of phonemes in the description of a language directly affects the output of the contrastive analysis. UPSID categorizes the oral and nasal stops /t/ and /n/ in Mandarin as alveolar, and these sounds are therefore different from Norwegian where they are categorized as dental. [7] on the other hand categorize Mandarin /n/ and /t/ as dental, and thus the same as in Norwegian. Acoustically there is very little difference, and there may also be variation within a language.

2.2. Level of phonetic detail

For any given language, the UPSID database only lists sounds that are distinct phonemes. These are specified for all features that are required to phonemically distinguish that sound from another sound in at least one language in the database (this seems to be true at least for the consonants). This makes the UPSID specifications redundant, containing sub-phonemic phonetic detail for individual languages. An example is the feature [ASPIRATION]: Even though aspiration is, strictly speaking, redundant for the distinction of voiceless /p,t,k/ from voiced /b,d,g/ in Norwegian or English (accepting that we use [VOICED] as a phonological feature to distinguish these phoneme classes), these sounds must be specified for [ASPIRATION] because this feature is needed to distinguish the four plosive classes for each place of articulation in, for example, Hindi. This means that a contrast-ive analysis of the languages which takes all features into account will show that for example Dutch, French or Italian learners of Norwegian or English – who have *un*aspirated voiceless plosives in their native language – will have to learn to aspirate their voiceless plosives. This seems sensible because native speakers of Norwegian or English might (mis)hear unaspirated voiceless plosives as their voiced counterparts, since aspiration is an important perceptual cue for voiceless plosives. On the other hand, the use of the feature [ASPIRATION] in the database means that English and Norwegian learners will have to learn not to use aspiration when producing voiceless plosives in Dutch, French or Italian, even though there is probably no danger of their voiceless plosive realizations being perceived as different phonemes, only of being heard as accented, which, in all likelihood, would not affect the learners' communicative effectiveness.

2.3. Allophonic variation within a language

Despite the detailed specification of the phonemes in UPSID, the inventory does not offer all the information an L2 learner needs in order to achieve communicative effectiveness. The examples given below are familiar ones, reflecting different learn-ing goals that need to be considered in a CAPT system. L1-L2*map* must incorporate this information in its database so that it can be accessed in the contrastive analysis.

2.3.1. Positional allophonic variation

Standard German (so-called *Hochdeutsch*) uses different allophones of the phoneme /x/, which is pronounced [C] word-finally after front vowels and consonants as well as word-initially before front

vowels, while it is [x] after back vowels. Only the latter variant is listed in UPSID, and therefore a contrastive analysis does not reflect the allophonic variation. If language learners only use the [x] variant, this will probably not influence their communicative effectiveness strongly, especially since some Alemannic dialects use the velar (or uvular) variant in all positions. Learners of German should preferably acquire both sounds if they are not part of their native inventory, though: A lack of differentiation between the two variants will be perceived by native speakers as a strong foreign (or dialectal) accent. We have therefore added both variants in our database. This decision parallels the use of the feature [ASPIRATION] to specify voiceless plosives in languages where it is redundant: the allophonic variants are specified because they can signal a phonemic distinction in other languages.

2.3.2. Positional phonemic restrictions

The use of another *phoneme* from the target language instead of the appropriate one is perceived as a mispronunciation, and can potentially lead to confusions between the members of a minimal pair. Both English and Vietnamese have /f/ in their phoneme inventories. From this, it could wrongly be concluded that this sound requires no attention in pronunciation teaching, but the opposite is true. Since /f/ does not occur syllable-finally in Vietnamese, Vietnamese learners of English generally replace it by [p], which *is* possible word-finally in their native language. The words in the pair "leaf"–"leap", for instance, would sound the same when spoken by a naive Vietnamese learner of English. Information about positional variants has been inserted into L1-L2*map* for some languages, and their occurrence in syllable-initial, nuclear and final positions can be visualized in the map. Acknowledged experts can be given writing privileges so they can add this information for other languages.

2.3.3. Positional surface realization

The difference between so-called underlying phonemes and their realization after the application of a phonological rule can also lead to mispronunciations. A well-known example of positional variants are the plosives in English and German. Both languages have fortis /p,t,k/ and their lenis counterparts /b,d,g/ in their inventories. The pronunciation of these sounds at the beginning of a word is sufficiently similar to achieve successful communication. Since German has a phonological process of final devoicing (G. "Auslautverhärtung"), the underlying lenis plosives /b,d,g/ will be identical to [p,t,k] in syllable-final positions (making *"Rad"* and *"Rat"* homophones in Standard German), while in English they will be realized as lenis consonants. As a result of the incorrect application of the final devoicing rule, German learners who are not aware of this may pronounce the English words "bed" and "bet" identically. English learners of German who are not aware of the German rule for final devoicing may fail to apply the rule, resulting in mispronunciations of words with final lenis plosives. As these examples show, L2 learners will benefit from the specification of some systematic phonetic detail in L1-L2*map*.

3. EXTENDING L1-L2*MAP*

There are several ways to extend L1-L2*map*. Inclusion of more systematic phonetic detail and the addition of prosodic information can help L2 learners to aim for near-native pronunciation. The addition of a multi-lingual contrastive analysis, comparing the target language with a large number of source languages, will make the system even more useful for language teachers. Due to space constraints, we cannot go into details here, and only mention some possible extensions.

3.1. Systematic phonetic detail

To allow L2 learners to acquire near-native pronunciation, it is important to make systematic phonetic detail accessible to the extent that is possible in a CAPT system. Examples of systematic detail are preaspiration, which is typical for post-vocalic voiceless plosives in at least some Norwegian dialects [3], vowel quality differences and differences in diphthongization of long vowels. Ideally, of course, speech technological approaches should be used to evaluate L2 learners' pronunciation, rather than leaving it up to the learners to evaluate themselves, since they differ greatly in their perceptual acuteness to systematic phonetic detail.

3.2. Prosody

In addition to segmental differences, incorrect prosody can signal a foreign accent. Prosodic information about a large number of languages is available in [6]. Information about the complexity

of possible syllable structures (simple, moderately complex or complex), stress (fixed or weight-sensitive), rhythm (trochaic, iambic, dual, undetermined, no rhythmic stress) and lexical tone (no tone, simple, complex) in the database is not specific, but can still be used to lead L2 learners to relevant exercises if the source language is categorized into another (less complex) group than the target languages. But it must be pointed out that the information in [6] cannot predict all possible problems, and may in fact predict no problems when actually these do occur for L2 learners: van Dommelen and Husby [2] for instance showed that Chinese speakers (complex tone system) are not much better than German speakers (no tones) at learning the Norwegian lexical tones (simple tone system). This cannot be predicted from the general information available in [6]. Nevertheless the information in [6] does provide a good starting point for guiding L2 learners to useful prosodic exercises.

3.3. Multi-lingual contrasts

Besides a comparison of two languages, it is easy to extend the system with a feature which allows the user, for instance a CAPT developer or especially a language teacher, to compare the target language with all languages in the database or with a relevant subset (for example all course participants' native languages) to find the most relevant problems the learner group as a whole is facing. By representing unfamiliar L2 sounds with varying transparency, the most challenging sounds (least transparent background) can be distinguished from sounds that are difficult to recognize and pronounce for only *some* learners (most transparent background).

4. SUMMARY AND CONCLUSION

L1-L2*map* is a useful tool for developers of CAPT systems for any language, as well as for language teachers. The tool allows the insertion of new languages and/or dialects, and outputs useful information about the phones which L2 learners need to acquire. This information can be used in CAPT systems (or in classroom teaching) to guide individual L2 learners through relevant exercises.

In a contrastive analysis for CAPT, the level of phonetic detail represented in the sound inventories determines the requirements on the learner's pronunciation on a scale from communicative efficiency to (near-)native pronunciation. The choice of our approach to CAPT, with a multi-lingual contrastive analysis, was shown to have some important implications for the level of detail in the language learners' pronunciation training. By setting the level of segmental detail to one which specifies any sound that can be part of a phonemic distinction in a language, even if it is not distinctive in the language(s) under consideration, more detail may be presented than is necessary to achieve communicative effectiveness. Some of this detail, however, as is the case for aspiration in Norwegian for instance, is normally addressed in pronunciation teaching, presumably because of its perceptual salience.

5. REFERENCES

[1] Abrahamsson, N. 2004. Fonologiska aspekter på andraspråksinlärning och svenska som andraspråk. In Hyltenstam, K.,, Lindberg, I. (eds.), *Svenska som andraspråk – i forskning, undervisning och samhälle* (pp. 79-116). Lund: Studentlitteratur.

[2] van Dommelen, W., Husby, O. 2009. Perception of Norwegian word tones by Chinese and German listeners. In: Watkins, M.A., Rauber, A.S., Baptista, B.O. (eds.), *Recent Research in Second Language Phonetics/Phonology: Perception and Production.* Newcastle upon Tyne: Cambridge Scholars Publishing.

[3] van Dommelen, W., Holm, S., Koreman, J. 2011. Dialectal feature imitation in Norwegian. *Proc. 17th ICPhS* (accepted).

[4] Eckman, F.R. 1977. Markedness and the contrastive analysis hypothesis. *Language Learning, 27*(2), 315-330.

[5] Flege, J. E. 1995. Second language speech learning: Theory, findings, and problems. *Speech perception and linguistic experience: Issues in cross-language research*, 233-277.

[6] Haspelmath, M., Dryer, M.S., Gil, D., Comrie, B. (eds.). 2008. *The World Atlas of Language Structures Online.*, Ch. 12-17. Munich: Max Planck Digital Library. Available online at http://wals.info, accessed on 23.02.2011.

[7] Husby, O., Jin, F. 2006. *Innføring i kinesisk for nordmenn, innføring i norsk for kinesere.* Trondheim: Tapir akademisk forlag.

[8] Husby, O., Øvregaard, Å., Wik, P., Bech, Ø., Albertsen, E., Nefzaoui, S., Skarpnes, E., Koreman, J. 2011. Dealing with L1 background and L2 dialects in Norwegian CAPT. *Proc. SLaTE workshop 2011* (submitted).

[9] Koreman, J., Bech, Ø., Husby, O., Wik, P. 2011. L1-L2map. *http://calst.hf.ntnu.no/L1-L2map*

[10] Lado. R. 1957. *Linguistics across cultures: Applied linguistics for language teachers*. Ann Arbor: University of Michigan Press.

[11] Maddieson, I. 1984. *Patterns of Sounds*. Cambridge: Cambridge University Press.

[12] Major, R. 2001. *Foreign accent: The ontogeny and phylogeny of second language phonology*. Mahwah: Lawrence Erlbaum Associates.

[13] Odlin, T. 1989. *Language Transfer*. Cambridge: Cambridge University Press.