

Using the same methodology to compare reduction and assimilation phenomena in spontaneous French and Taiwanese Mandarin

Tzu-ting SU

Laboratoire de Phonétique et Phonologie (UMR 7018), CNRS/Sorbonne Nouvelle, Paris, France

E-mail: tzutingsu@yahoo.fr

ABSTRACT

This article presents acoustic and perceptual results on reduction and assimilation (voicing, nasalisation, simplification, fusion) phenomena of 18 minutes of spontaneous French and Taiwanese Mandarin (TM) using the same methodology. We observed : i) consonants in TM are less resistant to assimilation of voicing and nasalisation, and are more likely to be reduced, ii) vowels are less reduced in TM, iii) simplification and fusion are rather consonant phenomena in French but vowel phenomena in TM. We conclude : i) the pattern of reduction and assimilation is very similar in both languages and seems universal, ii) the importance of reduction and assimilation seems language-specific : a) simplification and fusion seem to be linked to the syllable structure of each language, b) resistance of vowels in TM may be due to the fact that TM is a mono-disyllabic tone language in which the vowel is the carrier of tone.

1. INTRODUCTION

Reduction and assimilation phenomena in spontaneous speech are mostly studied in Indo-European languages for one language at a time, such as English [1], German [2] and French [3]. Inter-languages comparison is difficult, since the criteria are not the same. In this article, we use a same methodology in order to have a strict comparison between languages. We try to answer how far are reduction and assimilation phenomena similar in typologically unrelated languages, such as French and Taiwanese Mandarin (TM). For reduction phenomena, we compare in both languages spatial reduction of phonemes (vowel to be less open and consonant stricture to be less narrow) ; for assimilation phenomena, we compare voicing assimilation, nasalisation, simplification and fusion.

2. METHOD

For each language, the corpus consists of 18 minutes of spontaneous speech uttered by 6 native speakers in a quiet room. The signals were segmented and phonetically labeled on the acoustic analyser Winsnoori [4]. For both languages, we have extracted the 100 first occurrences of the vowel /a/, and the first 100 consonants of each type. Each phoneme was extracted with the preceding and following phoneme. An acoustic analysis is carried out on Winsnoori for consonant reduction and all phenomena of assimilation ; for vowel reduction, a perception test of identification is

proceeded on Sound Forge 4 [5]. The stimuli were repeated 5 times with one second of interval between repetitions and two seconds between stimuli. Four native listeners of both languages were asked to answer if they heard /a/ in each stimulus.

3. RESULTS

3-1. Reduction

3-1-1. Perception of the vowel /a/

Note that both French and TM have a rather dense vocalic system (14 and 13 vowels respectively). The results show a better identification of /a/ in TM than in French : 50% versus 20% on average. The vowel reduction, as least for /a/, seems to be more important in French than in TM [6].

3-1-2 Consonant reduction

a. Obstruent reduction

The consonant reduction “can be seen as a progression down the ‘degree of stricture’ hierarchy: stop → fricative, fricative → approximant, approximant → zero” [1], as observed in historical sound changes; but in at least 4 different languages [3] [7] [8] [9], a stop (particularly the voiced ones [10]) can also be realized “directly” as an approximant.

We do not deal with complete reduction (deletion) of obstruents in this paper (see [11] [12]).

In French, voiced stops may be reduced to fricated stops (with burst, /b/: 6%, /d/: 6%, /g/: 3%) or approximants (/b/: 17%, /d/: 20%, /g/: 18%), 2% of /b/ are reduced also to fricatives. Unvoiced stops tend to be reduced only to fricated stops (/p/: 15%, /t/: 24%, /k/: 9%) or fricatives (/p/: 9%, /t/: 3%, /k/: 3%), but not to approximants, except /k/ in the pronoun *que* (2%). Voiced fricatives, except /v/, are rarely reduced to fricated approximants (with friction, /v/: 20%, /z/: 2%, /ʒ/: 0%) or approximants (without friction, /v/: 16%, /z ʒ/: 0%); unvoiced fricatives /f s ʃ/ are never reduced to approximants.

In TM, the reduction of obstruents is more drastic. Obstruents of each mode (stop, fricative, affricate) can become approximants : un-aspirated stops are reduced directly to approximants (/p/ 5%, /t/ 25%, /k/ 17%) ; aspirated stops, except /ph/, can be reduced to approximants (/th/ 15%, /kh/ 4%) or simplified to aspiration [h] (/th/ 19%, /kh/ 2%). Affricates can be simplified to one of their fricative components except for

/tsh/ (/ts/ 3%, /tʃ/ 4%, /tʃ/ 2%, /tʃh/ 4%, /tʃh/ 3%), or reduced to approximants (/ts/ 10%, /tʃ/ 5%, /tʃ/ 8%, /tsh/ 2%, /tʃh/ 4%, /tʃh/ 6%); aspirated affricates can also be simplified to un-aspirated affricates except /tsh/ (/tʃh/ 3%, /tʃh/ 5%). Fricatives are reduced to approximants, except /s/ (/f/ 7%, /ʃ/ 7%, /ç/ 3%, /x/ 37%). To conclude, in TM, all obstruents are concerned by reduction phenomenon, except /ph/ and /s/. Consonants in complex modes can be simplified to one of their components: aspirated stops into [h], affricates into fricatives, and aspirated affricates into fricatives or affricates.

In comparison with French, a greater vulnerability of obstruents in TM seems evident. In both languages, /s/ is not reduced (universal?).

b. Approximant reduction

An approximant is deleted when reduced (approximant → zero [1]). In our data, in French, the percentages of deletion of approximants are: /m/ 0,5%, /n/ 0%, /l/ 14,2%, /ʁ/ 8,2%; in TM, they are: /m/ 0,5%, /n/ 1,9%, /l/ 6,5%, /z/ (or /ʁ/) 9,5%. Hence, in both languages, nasal approximants are much more resistant to reduction (deletion) than oral approximants.

3-2. Assimilation

3-2-1. Voicing of obstruents

In French, voicing is a distinctive feature of stops and fricatives, therefore phonologically important. We have noticed in our data voicing of unvoiced obstruents and devoicing of voiced obstruents; in both cases, voicing assimilation is essentially regressive. In addition, this assimilation is influenced by the position in a syllable: initial and final positions may lead to a devoicing of voiced obstruents, intervocalic position may lead to a voicing of unvoiced obstruents (phonetic assimilation).

In TM, voicing is not a phonological feature. In our data, all obstruents, phonologically unvoiced, in intervocalic position are susceptible to be voiced phonetically.

The fact that all consonants can become voiced phonetically in TM seems to show a greater vulnerability of consonants in TM compared to French, where voicing of consonants is phonologically constrained.

3-2-2. Nasalisation

French has nasal consonants and vowels. In our data, nasalisation can be progressive or regressive, but concerns almost exclusively stops nasalised by surrounding vowels (ex. /d/ → [n] *plein de, une heure et demi*; /b/ → [m] *c'est bon*.) and rarely /l/ (ex. /l/ → [n] *ressens le plus, mes lentilles*).

TM does not have phonological nasal vowels; nasalisation in TM can only come from nasal consonants. Besides the well-known nasalisation from the nasal in coda position to the preceding vowel (regressive nasalisation /an/, /aŋ/ etc.), we noticed two nasalisations in TM, both are progressive:

- Nasalisation induced by the nasal in coda position (/n/ and /ŋ/) upon the initial consonant of the next

word (ex. /p/ → [m] in /ʃwən pjen/ *by the way*, /t/ → [n] in /tʃən tʁ/ *really*, /k/ → [ŋ] in /iŋkai/ *must*, etc.). Moreover, the consonants affected by nasalisation /p t k th ts tʃ tç tʃh ʃ l z/ are those which are also the more affected by reduction (except for /x/ often reduced but never nasalised); those which are not affected by nasalisation /ph kh tsh tçh f s ç m n/ are also the less reduced.

- Nasalisation induced by initial nasals /m/ and /n/ upon the following vowel (ex. /ni/ *you*, /mən/ *gram. plural*.)

In comparison, nasalisation concerns only stops and /l/ in French but all modes of consonants in TM (though not all consonants), indicating a weaker resistance of consonants to nasalisation in TM.

3-2-3. Simplification of diphthongs, successive consonants and complex consonants

We are interested only in simplification where one part of a segment is deleted (ex. diphthong simplified to monophthong).

In French, 2 consecutive consonants, if identical, may be simplified to a geminated one (where the explosion of the first consonant is deleted) [13] [14]. In our data, this tendency of gemination is not limited to identical stops (such as '*dedans*' where *e* is deleted) but all stops. In addition, it may have a regressive assimilation of voicing (ex. /tb/ → [b:] *petite barre*, /kd/ → [d:] *trucs dedans*, /td/ → [d:] *le fait de, te dire*, etc.).

In TM, complex consonants may be simplified to one of their components (less than 5% except for /th/ in /tha/ *he, she*, cf. 'reduction'); but we observed more often the simplification of diphthongs to monophthongs: in our data, about 12% of each diphthong (/ai/ /ei/ /au/ /ou/) become monophthongs.

In French, it is essentially consonants which are simplified, but in TM, it is mostly vowels and less often consonants.

3-2-4. Fusion

In spontaneous French, [15] has shown that 2 consonants in sequence $v_1C_1C_2v_2$ are sometimes perceived as a single one, merging the 'manner and place' of C_1 and the 'voicing' of C_2 (ex. /ʒs/ → [ʃ], /fz/ → [v], /dv/ → [z]). It is confirmed by our data (ex. /ʒs/ → [ʃ] *je sais pas* /ʒsepɑ/ → [ʃepɑ], *je suis* /ʒsqi / → [ʃqi]; /sd/ → [z] *courses d'orientation* /kuʁsdokʁjɔtasjɔ/ → [kuʁzokʁjɔtasjɔ], *terrasse de café* /teʁasdɔkafɛ/ → [teʁazɔkafɛ]; /vʁ/ → [f] *vraiment* /vʁɛmɑ̃/ → [fɛmɑ̃]). We noticed also a vocalic fusion combining a glide and a vowel, but this fusion is rare. The 'new' vowel has an intermediary colour (ex. /wa/ → [ə] *ça doit faire* /sadwafɛʁ/ → [sadəfɛʁ]) or the colour of the glide (ex. /qi/ → [y] *je suis* /ʒsqi/ → [ʃy], *puis* /pqi/ → [py]). Fig. 1 shows a fusion sequence of /ʒs/ → [ʃ] and /qi/ → [y] in *je suis cache*, where /ʒsqikafɛ/ is realised as [ʃykafɛ].

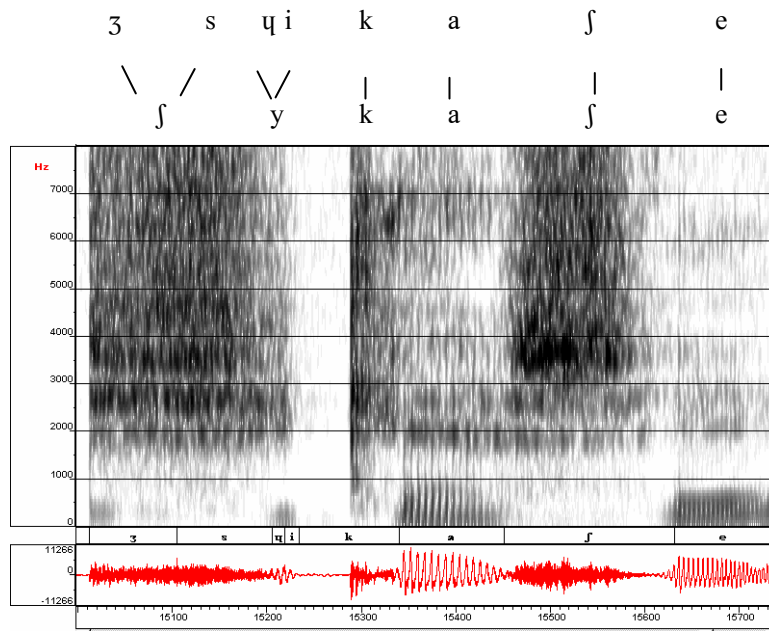


Figure 1: In French, fusion sequence (/ʒs/ → [ʃ] and /ʁi/ → [y]) in *je suis caché* /ʒsɥikaʃe/ realised as [ʃykaʃe].

tʃ	i	j	ou	i	k	ə	tʃ	j	ou	ʃ	i
								∖	/		
tʃ	i	j	ou	i	k	ə	tʃ	ə	ʃ	i	

(quasi-fusion)

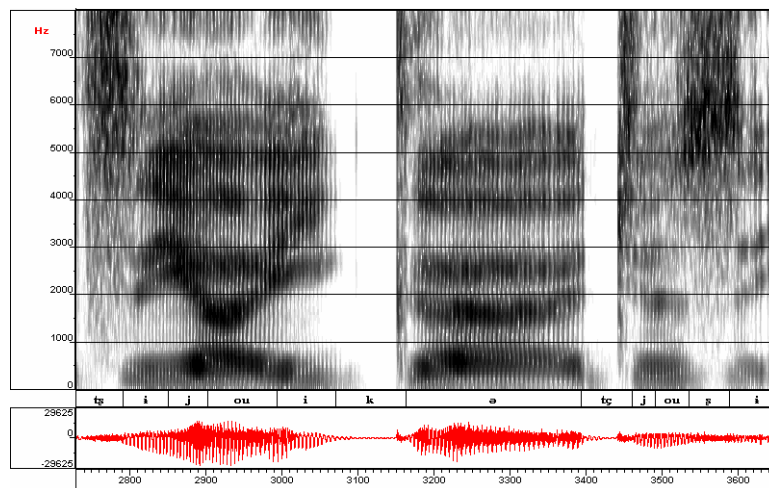


Figure 2: In TM, quasi-fusion form of /jou/ → [ə] in /tʃjou ʃi/ *it is* (3400-3650ms) : /j/ is still visible on the transition of formants of the preceding consonant /tʃ/ (to compare with /jou/ in canonic form in /tʃi jou/ *only*, 2700-3000ms).

In TM, the fusion of ‘glide + vowel’ is more common than in French but not as much as what we expected (12/1655 cases). The pattern is the same : the ‘new’ vowel has the colour of the glide (ex. /wo/ → [u] *me*, /kan tʃɥe/ → [kan tʃɥ] *feel*) or an intermediary colour (ex. /jou/ → [jə] *have*). Quasi-fusions are quite numerous where we can still distinguish each segment by their formants or transitions of formants. Fig. 2 shows a quasi-fusion form of /jou/ → [ə]

in /tʃjou ʃi/ *it is*, where /j/ is still visible on the transition of formants of the preceding consonant /tʃ/. We noticed also a fusion of two vowels with changes of tones (ex. /swo i wo/ *that’s why I ...* → [se o] (tones: 333 → 1 3)).

It seems that just like simplification, fusion is also a rather consonant phenomenon in French but a rather vowel phenomenon in TM.

4. CONCLUSIONS

Simplification and fusion phenomena seem to happen more frequently in consonants in French but vowels in TM. This is probably due to the syllable structure of each language : in French, two consonants can be in sequence but not in TM (except with nasal coda) ; in TM, glides and vowels are more often in sequence than in French.

Compared to French, in TM, consonants are less resistant to phonetic assimilation of voicing and assimilation of nasalisation. Moreover, in TM, consonant reduction is more important and vowel reduction is less important. These points indicate a greater vulnerability of consonants in TM than in French, and confirm our results concerning the deletion of phonemes in spontaneous speech of both languages [9] [10] where consonants are more deleted in TM than in French. The preservation of vowels in TM may be due to the fact that TM is a mono-disyllabic tone language in which the vowel is the carrier of tone.

In both languages, /s/ and nasals are resistant to reduction. The pattern of reduction and assimilation is also very similar in both languages.

Acknowledgements

I would like to thank my supervisor J. Vaissière, and my colleague O. Corbin, for their help.

REFERENCES

- [1] F. Nolan, "Overview of English Connected Speech Processes", AIPUK, Vol. 31, pp: 15-26, 1996.
- [2] K. Kohler, "Segmental reduction in connected speech in German: phonological facts and phonetic explanations", in *Speech production and speech modelling* W.J. Hardcastle & A. Marchal Ed., pp. 69-92. Dordrecht / Boston / London: Kluwer Academic Publishers, 1990.
- [3] D. Duez, "On spontaneous French speech: aspects of the reduction and contextuel assimilation of voiced stops", *Journal of Phonetics*, Vol. 23, pp. 407-427, 1995.
- [4] Winsnoori software, developed by Yves Laprie, <http://www.arts.gla.ac.uk/IPA/ipachart.html>
- [5] Sonic Foundry, Inc. www.sfoundry.com
- [6] J. Vaissière, "The use of allophonic variations of /a/ in automatic continuous speech recognition of French", *Speech Communication Group Working Papers*, MIT, RLE, pp. 15-25.
- [7] A. Butcher, "Some connected speech phenomena in Australian languages : universals and idiosyncrasies", *AIPUK* 31, pp. 83-104, 1996.
- [8] J. Rodgers, P. Helgason & K. Kohler, "Segment deletion in the Kiel Corpus of spontaneous speech", *AIPUK* 32, pp. 127-176, 1997.
- [9] T. Arai, "A case study of spontaneous speech in Japanese", *ICPHS*, vol. 1, pp. 615-618, 1999.
- [10] O. Engstrand & F. Lacerda "Lenition of stop consonants in conversational speech : evidence from Swedish (with a side view on stops in the world's languages)", *AIPUK* 31, pp. 31-42, 1996.
- [11] T.-T. SU "Deletion phenomenon of phonemes in spontaneous Taiwanese Mandarin", *ICPHS*, pp. 1561-1564, 1999.
- [12] T.-T. SU & P. Basset "Language dependent and independent spontaneous speech phenomena", *SPoSS*, pp. 55-58, 1998.
- [13] M. Grammont *Traité pratique de prononciation française*, Delagrave, Paris, 1926.
- [14] J.M.C. Thomas, L. Bouquiaux & F. Cloarec-Heiss *Initiation à la phonétique*, PUF, 1976.
- [15] D. Duez "Consonant sequences in spontaneous French speech", *SPoSS*, pp. 63-66, 1998.