

Evidence for phonetic adaptation of loanwords: an experimental study

Inga Vendelin & Sharon Peperkamp

Laboratoire de Sciences Cognitives et Psycholinguistique, EHESS-ENS-CNRS & Université de Paris 8
Inga.Vendelin@ens.fr, Sharon.Peperkamp@ens.fr

1 Abstract

Japanese loanword adaptations show an asymmetry in the treatment of word-final [n] in words from French and English, respectively: while word-final [n] is adapted as a moraic nasal consonant in loanwords from English, it is adapted as a geminate nasal followed by an epenthetic vowel in loanwords from French. We provide evidence that this asymmetry originates in the way Japanese speakers perceive word-final [n] in French and English. Indeed, in a forced choice task with non-words, Japanese listeners perceived an epenthetic vowel significantly more often in stimuli produced by French speakers than in stimuli produced by American English speakers. In the former, the final nasal consonant was longer and had a more important vocalic release than in the latter; the perception of an epenthetic vowel correlated with the length and intensity of the nasal consonant and its release, showing that listeners are sensitive to fine phonetic detail. We conclude, then, that the adaptation of word-final [n] in loanwords reflects phonetically minimal transformations that apply during speech perception.

2 Introduction

When borrowed by a language, words of foreign origin mostly do not preserve their original shape but get adapted to the sound system of the borrowing language. In phonological approaches to loanword adaptations, whether rule-based or constraint-based, the driving force behind the adaptations is the aim to make non-native words conform to the surface phonological structure of the native language. Indeed, loanword adaptations are mainly transformations that apply to foreign forms that would be ill-formed if they were borrowed without modification (see, among many others, Hyman 1970; Yip 1993; Paradis & Lacharité 1997). There are, however, several cases of loanword adaptations that appear to be 'unnecessary', in the sense that they do not repair some ill-formed structure. For instance, in Korean, loanwords from English that end in a voiceless stop are often adapted with an aspirated stop followed by an epenthetic vowel (especially if the preceding vowel is tense) (Kang 2004).

- (1) a. [pæt^hi] < 'bat'
b. [tɛk^hi] < 'deck'
c. [hip^hi] < 'hip'

These transformations are unexpected, since native words can end in a voiceless stop, as shown in (2).

- (2) a. [pat] 'field'
b. [kæk] 'guest'
c. [tʃip] 'house'

Kang (2004) provides evidence that the presence versus absence of epenthesis depends upon phonetic factors. In particular, given that final stops are strictly unreleased in Korean, epenthesis is more likely if the stop is released in the English source form, which depends upon - among other things - the tenseness of the preceding vowel. In her OT-account, the adaptations are driven by constraints that require perceptual similarity between the phonetic form in the source language and that in the borrowing language.

In this paper, we study a similar case of an unexpected adaptation pattern. That is, in on-line adaptations of French words ending in [n], Japanese speakers transform [n] into a geminated nasal followed by an epenthetic vowel (Shinohara 1997).

- (3) a. [duan:u] < Fr. *douane* [dwan] ‘customs’
 b. [pisin:u] < Fr. *piscine* [pisin] ‘swimming pool’
 c. [puuroçen:u] < Fr. *prochaine* [proʃɛn] ‘next-FEM’

These transformations are unexpected, since native words can end in a moraic nasal consonant, as shown in (4).

- (4) a. [teN] ‘point’
 b. [hoN] ‘book’
 c. [nip:oN] ‘Japan’

Moreover, both on-line adaptations of English words (5a) and integrated loanwords from English (5b) conform to this native pattern and fail to show epenthesis.

- (5) a. [suukuuriiN] < ‘screen’
 [napukiN] < ‘napkin’
 b. [çaiN] < ‘shine’
 [kotoN] < ‘cotton’

We explore the hypothesis that small phonetic differences in the realization of [n] in English and French are responsible for the observed asymmetry. Specifically, word-final [n] is longer and has a stronger release in French than in English, which might be interpreted perceptually by Japanese speakers as the presence of a vowel.

The present hypothesis is couched within the framework of Peperkamp & Dupoux (2003), which states that all loanword adaptations are phonetically minimal transformations that apply in perception. Their proposal is based on psycholinguistic evidence that all aspects of non-native phonological structure, including segments, suprasegments, and syllable phonotactics, are systematically distorted during speech perception. That is, non-native sound structures are assimilated to ones that are well-formed in the native language (Kirilloff 1969; Goto 1971; Massaro & Cohen 1983; Dupoux et al. 1997, 1999; Hallé et al. 1998; Pitt 1998), both by monolinguals and by bilinguals (Pallier et al. 1997, 2001; Sebastián-Gallés & Soto-Faraco 1999; Dupoux, Peperkamp & Sebastián-Gallés in preparation). Moreover, these perceptual assimilations are reflected in loanword adaptations. For instance, French speakers have difficulties perceiving stress contrasts (Dupoux et al. 1997, Dupoux, Peperkamp & Sebastián-Gallés 2001), and in loanwords, stress is systematically adapted to the native pattern of word-final stress (e.g. [wikénd] ‘weekend’). Peperkamp & Dupoux (2003) thus argue that loanword adaptations originate in perceptual assimilations. Psycholinguistic models of speech perception contain a phonetic decoding module, in which non-native segments are assimilated to the closest available phonetic category (Kuhl 2000; Best 1994). In order to account for the perceptual assimilation effects in case of non-native phonotactics and suprasegmental structure, Peperkamp & Dupoux (2003) propose that the phonetic decoding module takes complete word forms rather than individual segments as its input. All loanword adaptations, then, whether they concern changes in segmental, suprasegmental, or phonotactic structure, reflect the process of perceptual assimilation during phonetic decoding.

In order to test the hypothesis that the Japanese adaptations in (3) and (5) are the result of perceptual assimilation, we carried out an experiment in which monolingual speakers of Japanese performed a forced choice task on orally presented stimuli spoken by native speakers of French and American English.

3 Experiment

3.1 Stimuli

Twenty-two items of the form CVN, were created. The vowels used were [i], [ɛ], [ɔ] and [a]. All items respected the phonotactic structure of Japanese, French, and American English, and most were non-words in both French and English. All items were read in isolation by two male and two female native speakers of French and American English.¹ None of our French speakers had Southern French accent, where final consonants are systematically followed by schwa. All items were recorded on a DAT-recorder, digitized at 16000 Hz, and stored on a computer disk.

The mean durations of the French and the American English stimuli were 515 ms and 631 ms, respectively, representing a significant difference ($F(158,1)=69.6$, $p<.0001$). There were also highly significant differences in the relative mean durations of the vowel (French: 27.9 %, English: 49.6 %, $F(158,1)=472.8$, $p<.0001$) and those of the final nasal (either released or not) (French: 49.5 %, English: 31.2 %, $F(158,1)=266.4$, $p<.0001$).

French stimuli got a vocalic release in 100 % of the cases and English stimuli in 73.6 % of cases, again representing a significant difference ($F(158,1)=31.2$, $p<.0001$). The relative mean duration of the release – if present – was 19 % in French and 13.7 % in English stimuli ($F(142,1)=51.9$, $p<.0001$). French releases all had vocalic formants and can be classified as a schwa. English releases had vocalic formants (although to a lesser extent than in the French ones) when produced by female speakers, whereas in case of male speakers the release was better characterized as an aspiration. Finally, the mean intensities of French and English releases were significantly different: 63.7 dB and 56 dB, respectively ($F(142,1)=144.5$, $p<.0001$).

3.2 Procedure

For the main part of the experiment, we created 22 blocks, one per item, consisting of eight tokens each.² Tokens were randomly shuffled within the blocks and separated by 5-second silences. The main part was preceded by a short training phase, where subjects were presented with three different CVN stimuli, pronounced by a native speaker of Russian and separated by 10 second silences. During the experiment, subjects had to use answer sheets, which contained six answer options for each token. In Japanese the duration of vowels and consonants is used phonemically. Thus, the answer sheet contained all six logically possible options for each test item: [CVN], [CV:N], [CVnu], [CVn:u], [CV:nu], and [CV:n:u]. These options were transcribed in Romanji alphabet. Subjects completed a forced choice task: after listening to a token, they had to chose on their answer sheet one candidate word which in their opinion was the closest to the word they had heard. At the end of each block, subjects had to press a button to start listening to the next block.

¹ The English speakers produced the vowel [a] as a back vowel, i.e. [ɑ].

² There were actually 12 tokens per item, but in this paper we only report on the results for eight tokens. The remaining four were either produced by the French speakers and contained a nasal vowel instead of the sequence VN, or they were produced by the American English speakers and contained the vowel [i] instead of [ɪ].

3.3 Subjects

Nine native speakers of Japanese with no prior knowledge of French were tested in Tokyo, Japan. All subjects but one, who had lived in the US from the age of 3 to 10 years, had no linguistic experience in an English speaking country. The whole experiment lasted about 25 minutes. Subjects were from 23 to 35 years old (mean: 29).

3.4 Results and discussion

For the purposes of the present article, we are only interested in the presence versus absence of epenthesis (and not in the gemination of the nasal consonant and/or the preceding vowel). Results obtained on the answer sheets were therefore coded as belonging to two groups: one containing answers without epenthesis, i.e. [CVN], [CV:N], and the other containing answers with epenthesis, i.e. [CVnu], [CVn:uu], [CV:nu], and [CV:n:uu]. The mean percentages of answers with epenthesis for the four French speakers and the four American English speakers, respectively, are shown in Table 1.

Table 1. Mean percentages of answers with epenthesis by speaker

		% epenthesis	S.E.
French	speaker A	90.9	2.62
	speaker B	95.9	1.47
	speaker C	98.4	1.07
	speaker D	99.0	0.67
	<i>Mean</i>	<i>96.1</i>	<i>1.15</i>
English	speaker E	37.3	4.01
	speaker F	43.8	7.14
	speaker G	66.1	4.85
	speaker H	88.2	3.85
	<i>Mean</i>	<i>58.8</i>	<i>3.97</i>

The mean percentages of answers with epenthesis were submitted to a repeated measures ANOVA with the intra-subject factor Language (French vs. English). The analysis showed a highly significant effect of Language ($F(7,1)=106.4$, $p<.0001$), due to the fact that French stimuli yielded more epenthetic responses than English ones. Restricted analyses showed that there was a significant effect of Speaker for both the French stimuli ($F(7,1)=7.7$, $p<.001$) and the English stimuli ($F(7,1)=38.3$, $p<.0001$). A regression analysis showed that epenthesis is best predicted by two factors: the duration of the nasal and its release (if present) ($R\text{-Squared}=0.41$, $F(1,158)=109.9$, $p<.00001$), and the intensity of the nasal and its release multiplied by its duration ($R\text{-Squared}=0.46$, $F(1,158)=133.8$, $p<.0001$).

These results show that Japanese subjects perceive an epenthetic vowel at the end of CVN-items significantly more often when produced by French speakers than when produced by American English speakers. In particular, the presence versus absence of the epenthetic vowel depends upon fine phonetic details such as the length and the intensity of the nasal consonant and its release. These results are in accordance with the hypothesis that the different treatments of French and English loanwords, with an epenthetic vowel appearing in the former but not in the latter, originate in phonetic decoding during speech perception. Whereas all four French speakers produced stimuli that yielded invariably very high percentages of epenthetic responses, there was important variability among the four American English speakers, and two of them yielded more than 50% epenthetic responses. This variability might be due to the fact that the stimuli were recorded in isolation. A better way to obtain the stimuli might be to record them using a frame phrase. This would also make the experimental results more comparable to the loanword adaptation data, in that loanwords are likely to be embedded within phrasal contexts when entering the borrowing language. We are currently running the same experiment with stimuli recorded in frame phrases.

4 Conclusion

In phonological approaches to loanword adaptations, the surface form of the source language represents the input to the adaptation process, which makes the foreign form conform to the phonotactic structure of the borrowing language (Jacobs & Gussenhoven, 2000, Paradis & Lacharité 1997, Hyman, 1970). The different treatment of French and English words by Japanese speakers is puzzling for such an approach for two reasons. First, French and English words ending in [Vn] represent identical surface forms; consequently, they should yield the same adaptation patterns. Second, given that Japanese words can end in a moraic nasal consonant, the appearance of an epenthetic vowel in loanwords from French seems unmotivated.

One way to resolve these puzzles would be to argue that the difference in adaptations is due to differences between French and English. In particular, French, but not English, has a lexical contrast between [Vn] and [Ṽ]. French words ending in [Ṽ] are adapted as [VN] in Japanese (Shinohara 1997); therefore, it might be the case that the bilingual speakers who provided the on-line adaptations in Shinohara (1997) applied epenthesis to words ending in [Vn] in order to preserve the original French contrast. However, in our perception experiment, Japanese monolinguals with no knowledge of French show the same patterns of adaptation.

Another possible phonological explanation would be to suppose that loanwords from French are adapted to a default pattern in Japanese. Apart from the fact that it would remain unclear why such a default pattern would not be applied to English words, this hypothesis is not supported by lexical data from Japanese. Indeed, words ending with [n:u] are very rare and those ending with [N] are extremely common in Japanese (Kimihiro Nakamura, personal communication). If a default pattern were applied, then it would probably be the ending [N].

The absence of a pertinent phonological analysis suggests that the adaptation patterns do not result from phonological transformations. Rather, following Peperkamp & Dupoux (2003), we argue that they reflect perceptual assimilation, according to which foreign words are assimilated to the phonetically closest legal surface structures of the native language. We have shown that French and English stimuli ending in [n] differ with respect to both the length and intensity of the nasal consonant and its release, and that these differences account for the absence versus presence of an epenthetic vowel in the responses of our Japanese subjects. What remains to be shown is that word-final [n] in English is phonetically closest to the Japanese moraic nasal [N], which has a variety of phonetic realizations word-finally, including [ŋ], a nasalized copy of the preceding vowel (Shibatani, 1990), or [ũ] (Shinohara, 1997), whereas word-final [n] in French is closest to the Japanese sequence [n:u].

We conclude that the process of loanword adaptation is guided by perceptual assimilation which exploits the principle of minimal phonetic distance and is sensible to fine phonetic details of foreign speech. Further research is needed to study perceptual assimilation mechanisms and their application to loanword adaptation process. The reported experiment paradigm, based on controlled phonetic material and accompanied by phonetic analysis, offers an excellent framework to carry out such research.

4.1 Acknowledgments

Research for this paper was funded by a grant from the CNRS ('Cognition et Traitement de l'Information'). We would like to thank Emmanuel Dupoux for discussion, Kimihiro Nakamura for testing the subjects, and Ellenor Shoemaker for practical assistance.

5 References

- Best, C. (1994) The emergence of native-language phonological influences in infants: A perceptual assimilation model. In J. Goodman & H. Nusbaum (eds.) *The development of speech perception: The transition from speech sounds to spoken words*. Cambridge, MA: MIT Press. 167-224.
- Dupoux, E., C. Pallier, N. Sebastián-Gallés & J. Mehler (1997) A destressing "deafness" in French? *Journal of Memory and Language* 36, 406-421.
- Dupoux, E., K. Kakehi, Y. Hirose, C. Pallier & J. Mehler (1999) Epenthetic vowels in Japanese: A perceptual illusion? *Journal of Experimental Psychology: Human Perception and Performance* 25, 1568-1578.
- Dupoux, E., S. Peperkamp & N. Sebastián-Gallés (2001) A robust method to study stress 'deafness'. *Journal of the Acoustical Society of America* 110, 1606-1618.
- Dupoux, E., S. Peperkamp, Sebastián-Gallés, N. (in preparation). The perception of stress by French-Spanish bilinguals. Part 1: Late bilinguals.
- Goto, H. (1971) Auditory perception by normal Japanese adults of the sounds "L" and "R". *Neuropsychologia* 9, 317-23.
- Hallé, P., J. Segui, U. Frauenfelder & C. Meunier (1998) Processing of illegal consonant clusters: a case of perceptual assimilation? *Journal of Experimental Psychology: Human Perception and Performance* 24, 592-608.
- Hyman, L. (1970) The role of borrowings in the justification of phonological grammars. *Studies in African linguistics* 1, 1-48.
- Jacobs, H. and K. Gussenhoven (2000) Loan phonology: perception, salience, the lexicon and OT. In: J. Dekkers, F. van der Leeuw, and J. van de Weijer (Eds.) *Optimality Theory. Phonology, Syntax, and Acquisition*. Oxford : Oxford University Press, pp.193-210.
- Kang, Y. (2004). Perceptual similarity in loanword adaptation: Adaptation of English post-vocalic word-final stops to Korean. *Phonology* 20, 219-273.
- Kiriloff, C. (1969) On the auditory perception of tones in Mandarin. *Phonetica* 20, 63- 67.
- Kuhl, P.K. (2000) A new view of language acquisition. *Proceedings of the National Academy of Sciences* 97, 11850-11857.
- Massaro, D. W. and M. M. Cohen (1983). Phonological context in speech perception. *Perception & Psychophys* 34(4), 338-48.
- Pallier, C., Colomé, A. & N. Sebastian-Gallés. (2001) The influence of native-language phonology on lexical access: Concrete exemplar-based vs. abstract lexical entries. *Psychological Science*, 12(6), 445-449.
- Pallier, C., L. Bosch, & N. Sebastián-Gallés. (1997) A limit on behavioral plasticity in speech perception. *Cognition*, vol. 64, pp. B9-17.
- Paradis, C. & D. LaCharité (1997) Preservation and minimality in loanword adaptation. *Journal of Linguistics* 33, 379-430.
- Peperkamp, S. & E. Dupoux (2003) Reinterpreting loanword adaptations: the role of perception. *Proceedings of the 15th International Congress of Phonetic Sciences*.
- Pitt, M. A. (1998). Phonological processes and the perception of phonotactically illegal consonant clusters. *Perception & Psychophysics* 60(6), 941-51.
- Sebastián-Gallés, N. & S. Soto-Faraco (1999). Online processing of native and non-native phonemic contrasts in early bilinguals. *Cognition* 72(2), 111-23.
- Shibatani, M. (1990). Japanese. In: Comrie, B. (ed). *The world's major languages*. New York: Oxford University Press. pp 855-880.
- Shinohara, S. (1997) *Analyse phonologique de l'adaptation japonaise de mots étrangers*. PhD dissertation, Université de Paris III.
- Yip, M. (1993) Cantonese loanword phonology and Optimality Theory. *Journal of East Asian Linguistics* 2, 261-291.