

/ti~/tʃi/ CONTRAST PRESERVATION IN JAPANESE LOANS PARASITIC ON SEGMENTAL CUES TO PROSODIC STRUCTURE

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ABSTRACT

Acoustic analysis of [tʃi] tokens produced in native words by two generations of Japanese speakers reveals a systematic influence of prosodic structure on the duration of frication following the release of consonant closure. This phonetic gradient supports a phonological contrast in loanwords that is absent from the native system. Implications of the data for phonological theories of loanword adaptation are discussed.

Keywords: prosody, sound change, loanword adaptation, phonology, Japanese, affrication

1. INTRODUCTION

In native Japanese words, the contrast between /t/ and /tʃ/ is robust before back vowels (e.g. /ta/ ‘rice paddy’ ~ /tʃa/ ‘tea’; /toosa/ ‘distance’ ~ /tʃoosa/ ‘survey’), but is neutralized before /i/. Evidence for neutralization comes both from alternations (/kat+/itai/ → [katʃitai] ‘want to win’ c.f. /kat/ +/anai/ → [katanai] ‘won’t win’) as well as from the adaptation of early loanwords (e.g. tʃiimu c.1918 >> ‘team’, sutʃiru c.1917>>‘steal’)¹. It has been noted, however, that in more recent loans, the contrast between /ti/ and /tʃi/ is preserved [5, 9]. As borrowings which preserve phonotactically illegal sequences are extremely rare, this case warrants careful study.

Affrication on the release of a coronal stop into a front vowel has been noted for a number of other languages (e.g. Finnish, Romanian, Axininca Campa, Korean, Portuguese). The turbulent airflow in this transition results from the critical aperture maintained between the tongue tip and the alveolar ridge as it moves towards the vocalic target. Maintaining contrast based upon the duration of affrication requires manipulating the temporal and/or spatial properties of the consonantal release in accord with phonological structure. Although it is not obvious from the segmental phonology, I will present evidence from

a production study that suggests that Japanese speakers manipulate these parameters to provide cues to prosodic structure in native words. In loans, however, the same acoustic cues support phonological contrast. I conclude that the active manipulation of frication duration following the release of /t/ in native productions allows for successful adoption of the /ti~/tʃi/ distinction in loans. The general implication for theories of loanword adaptation is that apparent cases of deviant structure in loans may be traced back to non-contrastive aspects of the phonetic system of the borrowing language.

2. METHODS

2.1. Participants

Data was collected from 13 Japanese speakers living in two neighboring Tokyo suburbs. Nine speakers between the age of 50 and 56, *Gen1*, and four speakers between the age of 20 and 23, *Gen2*, participated. *Gen1* participants reported having studied English for 3-5 years in secondary school; *Gen2* were university students and had studied for 5 years in secondary school and 1-2 years at their university. However, just two speakers, one in each age group, reported even basic conversational proficiency in English, and no speaker had spent more than one month in an English speaking country. All participants were native speakers of Tokyo Japanese and were naïve as to the purpose of the experiment.

2.2. Materials

Of the 64 words presented to speakers, 34 contained a coronal stop followed by a high, front vowel; the remaining 30 words were random fillers. Of the 34 target words, 23 were loan words and 11 were native Japanese words.

Following normal orthographic conventions, native words were presented in either Chinese characters (e.g., 道 /miti/ [mitʃi] ‘road’) or

hiragana script (e.g. ちみつ /timitu/ [tʃimitsu] ‘accuracy’) and loans were presented in katakana. Many loan words can be written with either ティ, indicating [ti] pronunciation, or チ, indicating [tʃi] pronunciation. In order to control for this possible confound in stimuli presentation, orthographic variants were counterbalanced across two lists. Each list differed only in which loan words were represented with ティ and which as チ.

2.3. Procedure

Participants were asked to read 64 Japanese words from a printed list within the carrier sentence *doo iu _____ desuka* ‘what kind of _____ is it?’ Acoustic recordings were made in a quiet room using an Olympus DS-10 digital recorder and acoustic analysis was done using Praat [2].

2.4. Analysis

The recordings produced 442 total data tokens (34 words X 13 speakers). Stop closure duration (CD), frication duration (FD) and vowel duration (VD) were measured for CV sequences consisting of a coronal stop consonant and a high, front vowel. To control for measurer bias, each token was measured without knowledge of the stimulus used in the elicitation procedure.

The carrier sentence ensured that all target words were produced after a vowel. The closure duration of target consonants was measured from the offset of voicing of the previous vowel to consonantal release. Frication duration was measured from closure release to the onset of the vowel. In some tokens, two distinct periods of frication could be distinguished: the stop burst, which spread energy across a wide band of frequencies, and a period of frication with more concentrated aperiodic energy at higher frequencies. The FD measure collapses these distinctions encompassing the entire period of aperiodic energy from consonant release to vowel onset. Vowel duration measurements were taken from the onset of voicing to the offset of voicing.

After duration measurements were taken, it became clear that word internal prosodic structure played a role in conditioning frication duration. Prosodic analysis identifying foot structure following the assumptions of recent work on Japanese prosody [8] was conducted for each word in the stimuli set.

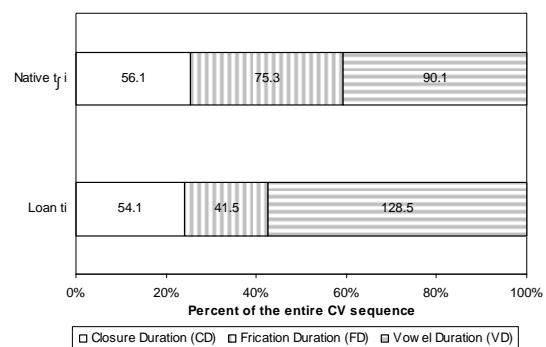
3. RESULTS

3.1. Across Speakers

In order to assess the effect of orthography in stimuli presentation, the FD of loanwords presented to participants as チ, the orthographic variant expected to bias affricated pronunciation, were compared with native tokens using a one-way ANOVA. No significant difference was found [$F < 1$, $p = 0.32$], suggesting that loan [tʃi] is assimilated to native [tʃi].

Figure 1 compares the means of the CD, FD and VD for native [tʃi] and loan [ti] productions. The total duration of the CV sequences (native = 221.4; loan = 224.1) and the consonant closure durations are similar; however, the sequences differ greatly in the contribution of frication duration to the total duration of the syllable (native = 34%; loan = 19%).

Figure 1: The mean duration in milliseconds of native and loan /ti/ sequences across all speakers.



3.2. Effect of prosodic position

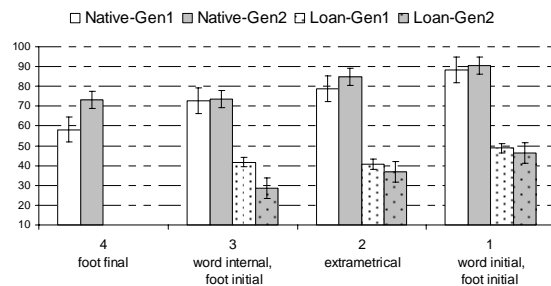
For native words, the prosodic position of the target sequence significantly impacted FD. The mean FD was longest for tokens that were in word initial position (e.g. Native /tii/ ‘rank’, 95ms) and shortest for words that were in the weak syllable of a foot (e.g. Native /miti/ ‘road’, 55ms). Figure 2 shows the mean FD for native tokens in 4 prosodic positions (parenthesis indicates footing) for both age groups:

1. word initial: e.g. (tʃimi)tu ‘accuracy’
2. extrametrical: e.g. (ino)tʃi ‘life’
3. word internal, foot initial: e.g. (un)(tʃin) ‘fair’
4. foot final: e.g. (matʃi)da, a Japanese surname

The general trend across prosodic positions for both groups was for increased frication at the edges

of prosodic word boundaries and at the left edge of foot boundaries. Collapsing across age groups, statistical significance was obtained for comparisons of word-initial tokens with non-word-initial tokens ($p < .001$) and for foot final tokens with foot initial tokens ($p < .005$).

Figure 2: The mean duration in milliseconds of native [tʃi] and loan [ti] sequences across all speakers. Error bars indicate standard error.



Although the effect of prosodic position on loanwords trended in the same direction as the native words, the corpus did not contain any loanwords with [ti] in the weak branch of the foot and none of the remaining comparisons were statistically significant across age groups.

3.3. Effect of Age

All FD measurements were subjected to a two-way analysis of variance having two levels of age (*Gen1*, *Gen2*) and three levels of token type (native, loan [ti], loan [tʃi]). The main effect of age was not significant; however, there was a significant interaction. Pair-wise post-hoc comparisons show that the effect is attributable to loan [tʃi]; Gen2 enhances the loan contrast by increasing FD for [tʃi]: Gen1 = 64.4; Gen2 = 83.8.

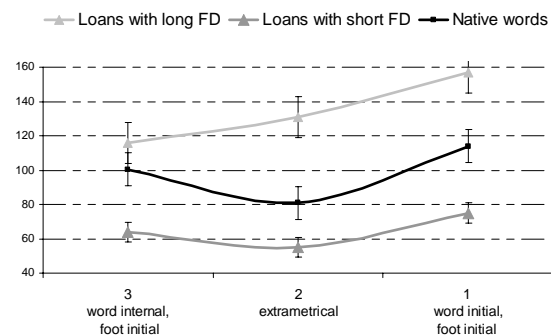
Comparisons of FD word-initially in loans and foot-finally in native words showed significant differences for Gen2 ($p < .01$), but not for Gen1 ($p = .17$). This shows that Gen 1 speakers produce loan [ti] in strong prosodic positions as if it were a native [tʃi] in weak prosodic position. Gen1 speakers, on the other hand, have eliminated the overlap in the [ti]~[tʃi] distributions.

3.4. Within Speaker

Although the average FD for native [tʃi] and loan [ti] productions across the entire group of participants suggests maintenance of contrast (Figure 2), within speaker comparison of loan word productions shows that contrast maintenance

is lexical item specific for some speakers. The most illustrative case of this in the current sample is from speaker06 (age 56; male), who produced roughly half of the loan $\bar{\tau}_i$ (*ti*) stimuli as [tʃi] and half as [ti]. His FD's are plotted by prosodic position in Figure 3. Although data power is greatly reduced for single-speaker analysis, statistical significance was obtained both for comparisons of group means ($df = 10$, $p < .001$) and comparisons across populations for word internal, foot initial tokens ($df = 5$, $p = .04$). It is worthwhile to note that the loans produced with short FD by speaker06 (e.g. /tiin/ 'teenager', /raitingu/ 'writing', /maкетингу/ 'marketing', /sekyuritii/ 'security') all came into the language during the 1970's. Thus, of the $\bar{\tau}_i$ (*ti*) stimuli, this speaker preserves contrast only for recent loans.

Figure 3: Average FD for two distributions of loan words plotted by prosodic position.



4. DISCUSSION

The data reported above show that two different types of phonological information, prosodic structure in native words and lexical contrast in loans, are encoded by the same phonetic cue, FD. Although [ti] is neutralized to [tʃi] in native words, the prosodically conditioned gradience with which native [tʃi] is realized supports a contrast between [ti] and [tʃi] in loans. For Gen1 speakers, I propose that [ti] was preserved in loans by mapping it to the acoustic target of [tʃi] in weak prosodic positions. For Gen2 speakers, on the other hand, which maintain non-overlapping distributions of [ti] and [tʃi], the structure mapping account is less appropriate. For them, the evidence suggests that the contrast was acquired with first language acquisition.

Thus, the emergence of loanword-specific contrast appears to have taken place in two stages. The first generation adopted a weak contrast by mapping [ti] to its closest native counterpart, a [tʃi] in weak prosodic position; the next generation enhances the contrast.

Although sound change need not require a grammatical model if it can be reduced to misperception during acquisition [1, 6], it has been claimed that maintenance of the [ti]~[tʃi] contrast in Japanese loans is a synchronic phenomenon [9]. This seems to be the case at least for Gen1 speakers, exemplified by speaker06 in figure 3. Since the words produced with short FD by this speaker were not yet in the language, we can safely assume that they did not play a role in early language acquisition. Thus, a model of a Gen1 speaker's phonological competence must include the plasticity to acquire /ti~/tʃi/ contrast in loans. Further, this must be accomplished while accounting for the neutralization of other contrasts (e.g. 'writing'/'lighting' → [raitingu], 'food'/'hood' → [Φuudo], 'steal'/'still' → [sutiru]).

The data here suggests that a satisfactory account may be had by appealing to the already existing phonetic continuum (prosodically conditioned, in this case) as the foundation for preservation. The reasoning is as follows: 1) since it is useful in recovering information about prosodic structure, speakers retain sensitivity to FD and 2) this sensitivity provides the basis for analyzing long and short frication durations as contrastive in loans. At the first stage of loan adaptation, the acoustic targets for native [tʃi] in weak positions are used to implement loan [ti].

An account that explains the exceptional preservation of /ti~/tʃi/ by recruiting the existing phonetic continuum effectively rules out preservation of contrasts that lack corresponding phonetic substance in the borrowing language. Non-preservation of, for example, /r~/l/ in loans should follow from a lack of consistent phonetic cues in Japanese, a desirable consequence, as has been demonstrated experimentally [6].

Finally, recent articulatory work has traced prosodic boundary lengthening effects to articulatory slowdown [3, 4]. This could explain the relative length of frication following [tʃi] at the left-edge of the prosodic word and the weaker effects in foot initial and word final position. Further, it may potentially explain the increased

distance between loan [ti] and [tʃi] for Gen2 speakers. Gen2 language learners may interpret the FD in [ti] produced by Gen1 in strong prosodic positions as a boundary-induced effect and respond by further decreasing FD in weak positions.

5. CONCLUSION

The selective preservation of /ti~/tʃi/ in Japanese loanwords is attributed to the presence of prosodically conditioned gradience in the realization of [tʃi] in native words. Evidence that the /ti~/tʃi/ contrast emerged post-critical period necessitates a phonological model with the plasticity to recruit existing phonetic knowledge to support contrast preservation in loans.

6. REFERENCES

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¹ Dates of the first recorded usage are as reported in: Nihon Kokugo Daijiten. 2000-2001. Tokyo: Shogakukan. [The Encyclopedic Dictionary of the Japanese Language, 2nd edition].