

Language Contact and Phonological Contrast: the case of coronal affricates in Japanese loans

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1.0 Ontogeny versus diachrony in contact-induced change

This paper introduces language contact data to address the relationship between stability in the grammar of the individual and changes in the language of the community. The central research question is whether language change can be reduced to the transmission of language across generations, which I will refer to as diachronic change, or whether individuals maintain the plasticity to effectively alter their grammar in response to environmental stimuli over the course of their adult lifetime, which I will refer to as ontogenetic change.

The case study reported on here examines phonological contrast in Japanese loanwords. In most cases, contrasts that do not exist in the native vocabulary are neutralized in words borrowed from English. Since Japanese lacks, for example, a contrast between /r/ and /l/, the English words *lighting* and *writing* are both borrowed as /raitɪŋgu/, neutralizing the contrast. Recently, however, it has been reported that the contrast between /t/ and /tʃ/ before high front vowels, which is non-existent in the native vocabulary, is being preserved in some loans (Shibatani 1990, Ito and Mester 1995, Bybee 2001, Smith 2006). This fact raises two related questions:

- 1) How did the contrast come about? Was it borrowed by a generation of speakers (ontogenetic change) or emerge with the acquisition of L1 (diachronic change)?
- 2) Why is it that this contrast (as opposed to /r/ and /l/, for example) is selectively preserved?

The field of Generative Phonology, which has a history of using loanword data to test grammatical analysis, offers two disparate answers for the first question. One approach is to understand the emergence of new phonological contrasts as a consequence of language acquisition (see Lahiri et. al. to appear for a recent exposition of this position). Children learning the ambient language may construct qualitatively different grammars from previous generations due to an influx of loanwords or direct contact with a second language. A prediction of this approach is that true phonological contrast can only be borrowed across a generation. Adult speakers, under this account, are expected to map loanwords to a set of contrasts which exist in the native language. A competing view, developed by Smith (2004, 2006, to appear), claims that speakers construct a representation of loanwords that allows for special preservation of contrast without

affecting the native (non-loan) grammar. Neither of these theories, however, makes specific predictions as to which contrasts will be preserved (question 2 above).

A second issue is that generative theories of phonology, which focus on describing the knowledge of individuals, typically do not consider the role that social factors may play in the spread of innovative forms through a community. Language change at the level of the community is necessarily slower than ontogenetic changes in the individual. Even if the grammar maintains the plasticity to represent a novel contrast, whether or not the form will be incorporated into the language of the community depends ultimately on sociolinguistic factors. Past work on phonetic variation in Japanese has shown vowel devoicing to be conditioned by sociolinguistic variables such as age and gender (Yuen 1997, Imai 2004). Since increased affrication in /tʃ/ relative to /t/ correlates with voicelessness of the following high vowel, it is reasonable to consider the role that age and gender may have on expressing the emerging *ti~tʃi* contrast. This study investigates two generations of speakers in a Japanese community and identifies quantitatively different responses to expressing the /t~/tʃ/ contrast. Analysis of social factors reveals a distributional pattern consistent with a sound change in progress (Guy et al 1986) and, when considered in conjunction with the linguistic factors that condition variation and the etymological record of individual words, leads us towards principled answers to questions (1) and (2) above.

Evidence from a token-based analysis of age-stratified acoustic data suggests that the older group (age 50-56), *generation one*, henceforth GEN-1, acquired the *ti~tʃi* contrast ontogenetically. For some of these speakers, the contrast is preserved in words that entered the language during adulthood but neutralized in those that entered the language during childhood. This pattern never occurs for the younger group (20-23), *generation two*, henceforth GEN-2. Rather, consideration of the overall distribution of /t/ and /tʃ/ suggests that the younger generation acquired the contrast with their first language. Thus, the answer to the first question is that, at least for some GEN-1 speakers, the contrast was borrowed synchronically.

A possible answer to the second question arises from an analysis of linguistically conditioned variation in native productions of /tʃi/. For all speakers in the study, the degree of frication produced in both /ti/ and /tʃi/ sequences, which we find to be the most consistent cue distinguishing these sequences, is conditioned by prosodic structure such that stronger prosodic positions (i.e. heads of feet, accented syllables) have more frication than weaker positions. For GEN-1 speakers, however, productions of /ti/ and /tʃi/ in loans overlap the range of frication durations conditioned by prosody in native words. That is, it appears that prosodically conditioned variation in the realization of native /tʃi/ is recruited to express the contrast between /ti/ and /tʃi/ in loans. Thus, the new phonological distinction in loans is parasitic on an already existing (though non-contrastive) phonetic continuum (see also Shaw 2007a). We conclude by suggesting that it is the presence of this variation in the realization of the native category that allows for the preservation of contrast in loans, providing a principled answer for question (2) above.

The broader implication is that, although contact-induced phonological change is a possible ontogenetic phenomenon, it is restricted in a principled way by the grammar of the borrowing language.

Beyond the implications for phonological theory, the current work is of general interest to the study of language contact. The community investigated is not in direct regular contact with native English speakers, but, rather, is recipient to English loan forms diffused through normalized usage in society. As such, it provides a case of language contact which is insulated, to a degree, from the confounds of cross-cultural contact and can provide a reasonable baseline for more complicated interactions. The main finding, that the ontogenetic borrowing of phonological contrast is possible, but limited by the native grammar, leads to predictions regarding which contrasts are acquirable by a given monolingual community. By understanding the degree to which indirect contact can affect a grammar, we are in a better position to quantify the additional effects of direct interaction with the source language, addressing more complicated cases involving emigrant speech communities, 2nd language acquisition and bilingualism.

2.0 /t/ and /tʃ/ in Japanese

The affrication of coronal consonants before high front vowels is a widely attested, phonetically motivated phenomenon. Although affrication in this environment is often attributed to palatization, typically understood as a change in the spatial properties of the consonantal closure, it has also been attributed in some languages to temporal aspects of articulation. Kim (2001, 2004, 2007) has argued that this is the case in Korean, providing articulatory and acoustic evidence that affrication in this environment is a side effect of the tongue tip moving from an alveolar closure toward the target of /i/. In addition to the multiple articulatory paths, there is also evidence that affrication may contribute to the perceptual distinctiveness of coronal consonants (Cole and Iskarous 2001).

Languages that contrast affricated and non-affricated stop consonants in the environment preceding high vowels, such as the English minimal pairs *tease* and *cheese*, resist the phonetic naturalness of affrication where it would obscure the phonological contrast. On the other hand, languages that do not rely on affrication for phonological contrast are free to take advantage of both the heightened perceptual cues and (presumably) reduced effort of affricated coronals before high vowels.

Phonological evidence for the neutralization of /t/ and /tʃ/ before /i/ is available both from morphophonemic alternations and early loanword adaptations. The verbal paradigm in (1) and (2) illustrates that /t/-final roots surface as [tʃ] only when followed by an /i/-initial suffix, as in the desiderative (1b), (2b) and the polite form (1d), (2d).

- 1) /kat/ ‘win-ROOT’
 - a) kat-eba ‘win-CONDITIONAL’
 - b) katʃ-itai ‘win-DESIDERATIVE’
 - c) kat-anai ‘win-NEGATIVE’
 - d) katʃ-imasu ‘win-POLITE’
 - e) kat-oo ‘win-VOLITIONAL’

- 2) /mot/ ‘hold-ROOT’
 - a) mot-eba ‘hold-CONDITIONAL’
 - b) motʃ-itai ‘hold-DESIDERATIVE’
 - c) mot-anai ‘hold-NEGATIVE’
 - d) motʃ-imasu ‘hold-POLITE’
 - e) mot-oo ‘hold-VOLITIONAL’

Neutralization of /t/ and /tʃ/ is further evidenced by the adaptations of loanwords borrowed in the late 19th and early 20th century. The English loans *team* (circa 1918) and *cheese*, for example, were both historically borrowed with the affricate /tʃi/. At least as early as 1990, however, it was noted that “many younger speakers have begun to pronounce forms such as *party* and other recent loans with [t] (Shibatani 1990).” Even before the advent of the internet, non-Chinese loanwords had been steadily increasing in Japan. Shibatani reports an increase in the number of loanwords in the dictionary from 1.4% in 1859 to 3.5% in 1956 to 7.8% in 1972.

In 1991, the Japanese Ministry of Education¹ issued an official declaration on the orthographic representation of loanwords. The document established orthographic conventions for representing a number of foreign contrasts, including the affrication distinction before high vowels. The document included *tea* and *volunteer* as examples of loanwords that should be written with the contrast preserving variant. It also stipulated, however, that loanwords customarily written with the contrast neutralizing orthography such as *echiketto* ‘*etiquette*’, *suchiimu* ‘*steam*’ and *purasutikku* ‘*plastic*’ will continue to be written with contrast neutralizing orthography. Even for a single word, both orthographic variants often persist. Table 1 shows the number of Google hits (as of December, 2004) for the orthographic variants of the English loanwords *team* and *teen*. While the contrast preserving variant *ti* is preferred at nearly a 9:1 ratio for *teen*, the more established loan, *team*, is still much more frequently represented using the contrast neutralizing *chi*².

¹As reported in: 平成三年六月二十八日 [June 28, 1991] 外来語の表記 [Declaration on Foreign Words] 内閣告示第二号 [Ministry Bulletin Issue 2]

² Throughout this paper romanized forms of Japanese words reflect their most frequent Japanese kana representations. Thus, *chiimu*, will be used for ‘team’ and *tiin* for ‘teen’. Whether or not orthographic differences are faithfully reproduced in pronunciation is an empirical question to which we return in section 4.0.

Table 1: The frequency of orthographic variants in Google hits for two Japanese loanwords.

Japanese Orthography	Romanization	English Gloss	Google Hits
チーン ティーン	chiin tiin	'teen(ager)'	59,400 455,000
チーム ティーム	chiimu tiimu	'team'	10,400,000 66,700

Although the mapping from Japanese orthography to pronunciation is often straightforward, given the variation in orthography and the potential influence of language policy, it is problematic in the case of /ti/ to assess the pronunciation of speakers from the orthographic representation. For this reason, an acoustic study of the target sequences was conducted.

3.0 Methods

3.1 Participants

Data was collected from 13 native speakers of Japanese living in two neighboring Tokyo suburbs. Nine speakers between the age of 50 and 56, GEN-1, and four subjects between the age of 20 and 23, GEN-2, participated. Of the 13 total participants, 11 were female and 2 were male (one male in each age group). GEN-1 participants reported having studied English for 3-5 years in secondary school; GEN-2 participants 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 none had spent more than one month in an English-speaking country. All subjects had been living near Tokyo for at least 20 years and were naïve as to the purpose of the experiment.

3.2 Materials

Participants were asked to read 64 Japanese words within the carrier sentence *doo iu _____desuka* ‘what kind of_____’. Of the 64 words in the list, 34 contained a coronal stop followed by a high, front vowel. The remaining 30 words were random fillers. Of the 34 target words (see appendix A), 23 were loan words and 11 native³ Japanese. The list of 64 words was randomized.

Nine of the 13 speakers read words from printed lists; three speakers from the 50-56 group read the same list from a computer screen because they were unable to read the font size on the printed sheet. Recordings were made in a quiet room using an Olympus DS-10 digital recorder and acoustic analysis was done using Praat (Boersma and Weenink 2006).

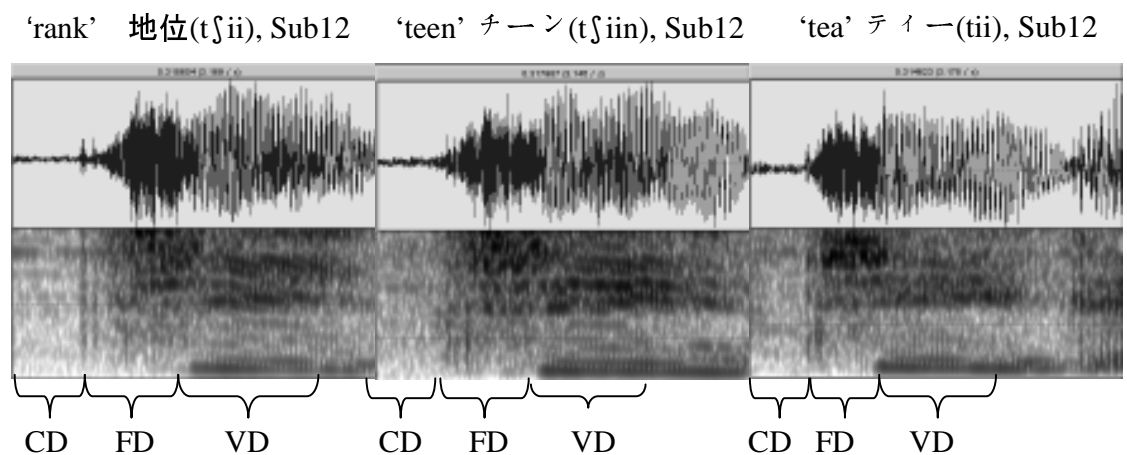
³ For the purposes of this analysis and throughout this paper, the word “native” is used to refer to Japanese words of both Yamato and Chinese origin. Although there are certain systematic differences in the sound structure of Sino-Japanese and Yamato-Japanese words (see Ito and Mester 1995 for discussion), they both lack [ti] sequences systematically and, therefore, serve as an appropriate control condition for the study of recent loans from Indo-European languages.

To account for orthographic variation, the use of the Japanese kana for /ti/ and for /tʃi/ were counterbalanced across tokens within each group so that each speaker's list contained half of the target words with *ti* and half with *chi* and all target words were represented equally as *ti* and *chi* within each of the two age groups. Thus, the two lists administered differed only in the orthographic representation of the target token. All subjects produced the same set of native Japanese tokens, which will serve as a control for the loan productions.

3.3 Measurements

The recordings produced 442 total data tokens (34 words X 13 subjects). 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 in each token. Representative measurements are labeled in Figure (1).

Figure 1: sample spectrogram measurements for three tokens from one subject.



The carrier sentence ensured that all target words were produced after a vowel. The CD of the target consonants was measured from the offset of voicing in the preceding vowel to the onset of the stop burst, evidenced by aperiodic energy across a broad spectrum of frequencies. The FD measure included both the stop burst and following frication period ending with the onset of voicing, as indicated by periodicity in the wave form and distinct formant structure. Although in some tokens the burst could clearly be distinguished from the frication period intermediate between the burst and the onset of the vowel, in other tokens it was more difficult to demarcate the burst from frication. This difficulty was compounded by the quality of the recordings, which were field quality as opposed to lab quality. For these reasons we decided to collapse the burst and following frication period into a single measure so that all of the measures included in the analysis are based upon clear spectral landmarks.

4.0 Results

4.1 The language community

Analysis of the contrast across speakers confirms impressionistic reports that the /ti~/tʃi/ distinction is neutralized in native words and preserved in loans, where the orthographic system has developed to represent it (see section 2). Collapsing across generations, the primary phonetic difference between /t/ and /tʃ/ tokens is the duration of frication following the stop release.

Since loanwords were represented to participants orthographically as both *ti* and *chi* in lists counterbalanced by subject, loans represented as *chi* were compared to native *chi* tokens using a one-way ANOVA. No significant difference was found ($F(1, 295) = .999, p = 0.32$), suggesting that, whether native or loan, orthographic *chi* is pronounced as [tʃi].

The comparison of primary interest, however, is that of *chi* and the new orthographic variant *ti*. All tokens represented by *chi* orthographically (both loan and native) were compared to tokens represented by *ti* using a one-way ANOVA. The difference between *chi* and *ti* tokens across the entire population was significant ($F(1, 448) = 101, p < .001$). Figure 2 shows the means for both categories.

Figure 2: The mean measurements for CD, FD, and VD across all speakers for native /tʃi/ tokens and loan /ti/ tokens.

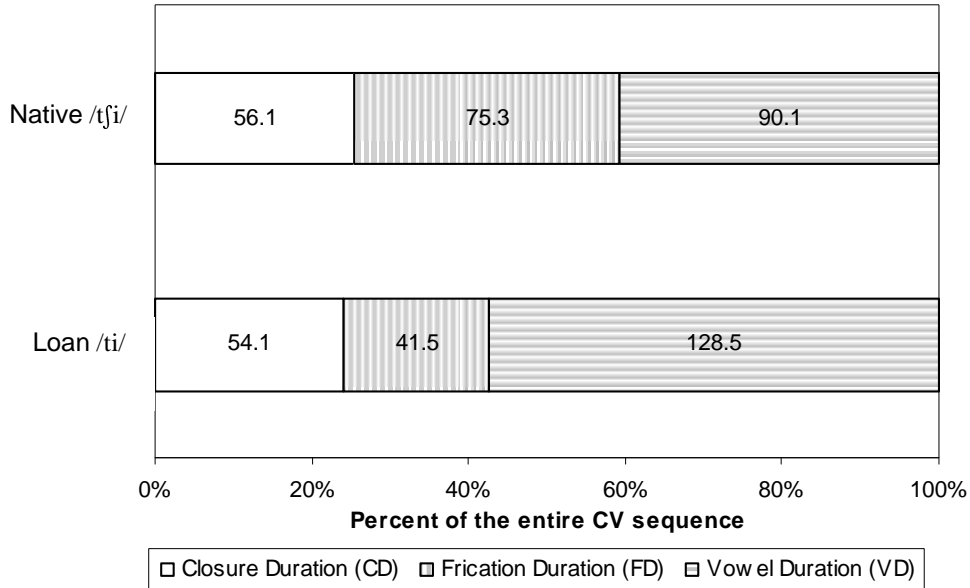


Figure 2 shows that, although the total duration of the CV sequence containing loan /ti/ and native /tʃi/ is roughly the same, there is a tradeoff between the duration contributed by the frication period and the duration contributed by the vowel. Native

/tʃi/ has a longer frication period and a shorter vowel; loan /ti/ has a shorter frication period and a proportionally longer vowel.

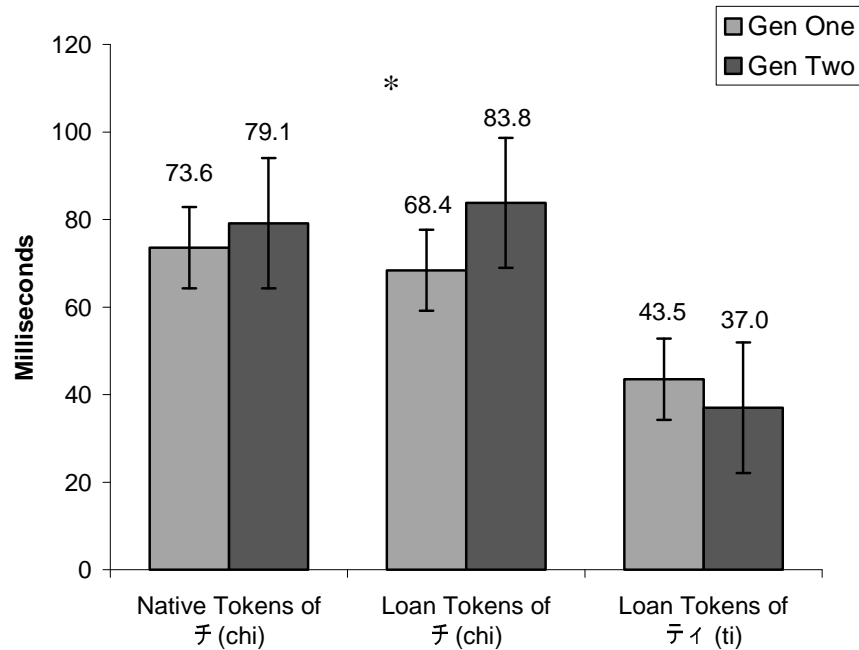
4.2 Results: Social Factors

Having established from the pooled data that there is a significant difference in the production of /ti/ and /tʃi/ by the community as a whole, this section looks at the distribution of this contrast across age and gender. Our expectation is that contrast maintenance will not be uniform, but, rather, will follow the profile of a sound change in progress. Guy et. al. (1986) claim that increased use of an innovating language variety by younger speakers, women, and members of lower/middle class society are predictive diagnostics of a change in progress. Since our corpus is based on the speech of a single middle-class community, we are unable to comment on the class-based distribution of the innovative form; however, we will look here at the effects of age and gender before looking more closely at the linguistic factors that condition variation in section 5.

4.2.1 Age

Frication duration measurements were subjected to a two-way analysis of variance having two levels of age (GEN-1, GEN-2) and three levels of token type (native, loan *chi*, loan *ti*). Only the token type effect and the interaction of age and token type were significant at the .05 level. Pair-wise post-hoc comparisons found that the significant interaction is attributable to differences in the means of loan *chi* across generations. Figure 3 compares mean FD across generations with significant results indicated by asterisk. The significant increase in FD for loan *chi* and the decrease in FD for loan *ti* show that GEN-2 is enhancing the contrast between /ti/ and /tʃi/ in loans above and beyond GEN-1.

Figure 3: Comparison of frication duration across generations. Bars indicate standard error.

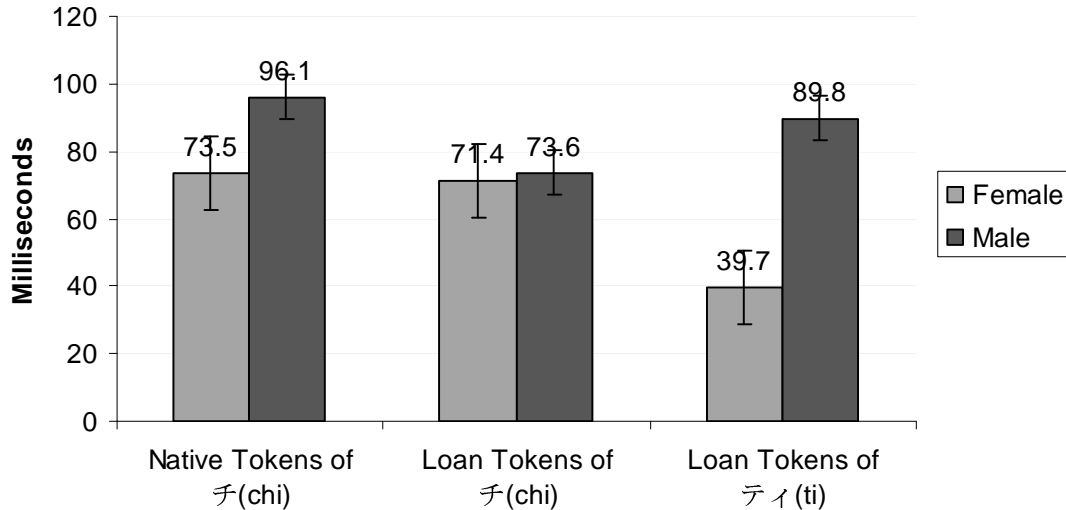


4.2.2 Gender

The frication duration measurements were subject to a two-way analysis of variance having two levels of gender (male, female) and three levels of token type (native, loan *chi*, loan *ti*). All the effects, gender ($F(1, 449) = 22.73, p < .001$), token type ($F(2, 449) = 4.66, p < .05$) and the interaction of gender and token type ($F(2, 449) = 7.15, p < .05$) were significant at the .05 significance level.

The main effect of gender indicates that the mean frication durations were significantly different between the females ($M=61.1, SD=33.2$), and males ($M=85.3, SD=30.8$). The significant interaction, however, indicates that the gender difference in FD is not evenly distributed across the different token types. Figure 4 shows that the largest difference in FD between male and female speakers is in the production of loan tokens.

Figure 4: Comparison of frication duration across gender. Error bars indicate standard error.



Generalization across a small sample, such as the one reported here, is risky, and further examination of the male subjects in this study suggest that the statistically significant FD found across gender lines are probably not related to gender per se, but are a combined effect of age and gender. As Table 2 shows, the males in the study did not perform as a homogeneous group. On the contrary, the GEN-2 male (age 20) produces extremely different /ti/ and /tʃ/ while it appears from examination of the means in table 2 that the GEN-1 male (age 50) neutralizes the contrast.

Table 2: Comparison of male speakers across generation

	Loan words (ti)		Native words	
	Mean	S.D.	Mean	S.D.
Generation II (Age 20)	29 ms	(7.79)	103 ms	(20.50)
Generation I (Age 56)	94 ms	(37.2)	96 ms	(21.87)

Since the general trend across speakers is for preservation of the ti~tʃi contrast in loans, the apparent neutralization of contrast by the GEN-1 male in the group requires explanation.

One possibility is that frication duration is a sociolinguistic variable, freely manipulated by members of this speech community. In this case, we expect the neutralizing male to be consistent across tokens (since the social context for elicitation was stable). A comparison of standard deviations between these two speakers suggests

that this is likely not the case. The large standard deviation for the older male suggests an inconsistency across loan tokens that is not present for the younger male.

A second possibility is that the older speaker has acquired the contrast more recently than other speakers in the study. If the new sound /ti/ can be learned without forcing a perceptual reorganization of existing categories, we would expect older words (words that came into the language earlier) to be more likely to surface as [tʃi] than words that came into the language more recently. Under this hypothesis, words represented orthographically by *ti* might fall into two phonemic categories /ti/ and /tʃ/. We will test the predictions of this hypothesis by conducting a token-based analysis of this speaker in section 6.2. First, however, it is necessary to understand the linguistic factors that might condition frication duration independently of historical or sociolinguistic factors, which we take up in section 5.

5.0 Results: linguistic factors

Results presented in section 4.0 collapsed all tokens of a particular phoneme into a single category for analysis. It is possible that this methodology obscures sub-patterns and inconsistencies in the data. Further, if the preservation of contrast is a change in progress, as suggested by the direction of the heterogeneity with respect to age and gender, then the change is predicted to proceed more quickly in favorable linguistic environments (Guy et al, 1986). In this section, we look at variation across words and identify the linguistic factors that condition FD in /ti/ and /tʃi/ sequences. After identifying the factors that condition FD in native words in 5.1, we will apply the analysis to loan words in 5.2 and see the same set of conditioning factors at work. In section 6.0, we will reconsider the effect of age in light of the linguistic factors conditioning variation.

5.1 Native words

Collapsing across all subjects, the graph in Figure 5 orders the native tokens from most to least FD in /tʃi/ sequences. The two words with the greatest FD, *chii* and *chimu*, both have a pitch accent on the syllable beginning with the target phoneme. We adopt recent proposals on Japanese prosody (Yamada 1990, Haraguchi 1991, Shinohara 2000, Tuchida 2001), which analyze the language as employing left-headed (trochaic) feet built right to left with final syllable extrametricality, and the additional assumption that feet are left-aligned to morpheme boundaries (McCarthy and Prince 1993, see also appendix A for a prosodic analysis of the stimulus set). Applying these assumptions, we see that the most fricated outputs of /tʃi/ in native words are in the strong syllable of the foot (i.e. *chimu* >> *michi*, where '>>' denotes 'more frication'). Further, Japanese words, both foreign and loan, either bear one pitch accent or are fully unaccented (Kubozono 2006). Of the words in Figure 5 in which /ti/ is in the strong syllable of the foot, accented syllables have systematically longer frication than the unaccented syllables (i.e. *chimu* >> *chimitu*). Thirdly, all else being equal, syllables closer to the initial syllable in the word have more frication than subsequent syllables (i.e. *chii* >> *ichiru*). Lastly, extrametrical

syllables have longer frication duration relative to other unaccented syllables (i.e. inochi >> kenchiku).

The one exception to the generalizations regarding FD reported above comes from the only verb in the word list *ochiru* ‘to fall’, which is not surprising since systematic differences in the prosody of nouns and verbs are common in both Japanese and cross-linguistically (see Smith 2001 for discussion). A summary of the linguistic factors conditioning FD with examples for each comparison is given in Table 3.

Figure 5: Native words ordered by frication duration

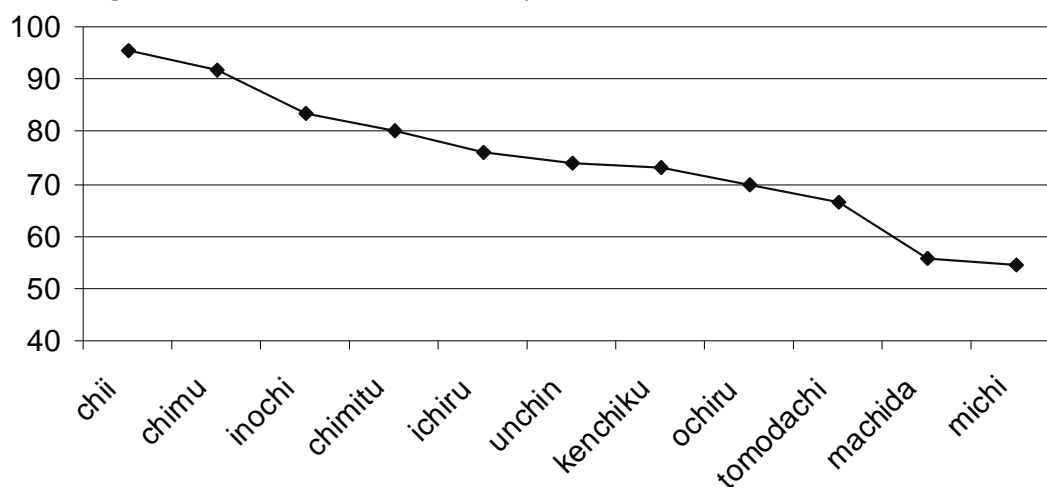


Table 3: The left column states generalizations regarding relative frication duration between two constituents and the right two columns list specific examples of the generalization.

$(P_1 \gg P_2)$, where ‘>>’ = ‘more frication’	P_1 Examples	P_2 Examples
strong syllables >> weak syllables $\sigma_s \gg \sigma_w$	(chii), (chim u), (chimi)tu, i(chir u), (un)(chin), (ken)(chiku)	(tomo)(dachi), (machi)da, (michi)
accented syllables >> unaccented syllables $\sigma_a \gg \sigma$	(chii), (chim u), i(chir u),	(un)(chin), (ken)(chiku), (tomo)(dachi), (machi)da, (michi)
left-edgedness >> right-edgedness $\sigma_n \gg \sigma_{n+1}$	(chii), (chim u), >> i(chir u), o(chir u) (chimi)tu >> (un)(chin), (ken)(chiku)	
extrametrical >> footed, unaccented $\langle \sigma \rangle \gg \sigma$	(ino)chi	(chimi)tu, (un)(chin), (ken)(chiku), (tomo)(dachi), (machi)da, (michi)

The discovery that prosodic position conditions frication duration in Japanese is one of a long list of prosodically conditioned segmental effects discovered in a wide

range of languages identified since Kahn's (1976) study of English syllable structure. The effects of extrametricality and syllable position, however, can be anticipated from other work on Japanese. Although Japanese is perceived by native speakers to be isochronous with respect to the mora (Vance 1987), phonetic measurements show that the initial mora of words tends to be phonetically longer than subsequent moras (Port et. al. 1987). Similarly, analysis of extrametrical syllables has also uncovered an increase in duration over footed syllables (Teranishi 1980 as cited in Poser 1990). These effects of general syllable length are very likely related to the increase in FD in these positions.

The linguistic factors conditioning frication duration, we will argue, have important implications for the study of the emerging /t~/tʃ/ contrast in Japanese loans. The average production of native words ranged between 95 ms of frication for *chii* and 55ms for *michi*, with a mean of 75ms (Figure 2). If the frication duration of loan words is subject to the same effects of prosody, given a mean frication duration of 42ms (Figure 2), then /ti/ and /tʃi/ tokens across speakers will overlap considerably, leading to neutralization in some environments. Unraveling which speakers neutralize in what words will provide the key to understanding how this novel phonological contrast made its way into the language.

5.2 Loan words

Figure 6 shows the average frication duration across subjects by token for loanwords with /t/ in a strong syllable⁴. As in the native words, the duration of frication is subject to considerable gradience, spanning from 60ms in *tii* to 30ms in *chippu*. Further, the same set of factors used to explain the gradience in native words can go a long way towards accounting for the relative length of frication in loans. Of the words with /ti/ in a strong syllable, those with the greatest frication were accented and in initial position (*tii*, *tiimu*, *chiketto*, *tiin*); the next most frication was found in *suchiru*, which is accented but in the second syllable, and *tiiruumu*, which is unaccented, but in the leftmost syllable of the word; the remaining words all cluster between 30-40ms and, with three exceptions (*tiida*, *tinpanii*, *chippu*)⁵, have /t/ at least two syllables from the left edge of the word.

⁴ There were no loanwords in the stimulus set that had /ti/ in a weak syllable. All loan tokens were either in the strong syllable of a foot or extrametrical (see appendix A for prosodic analysis of the stimulus set).

⁵ Although I will not pursue an analysis of the exceptions here, the following factors may be relevant: 1) *chippu* is the only word in the study that has consecutive vowels in devoicing environments. As such, the first vowel is somewhat special in that it is a voiced vowel between two voiceless consonants (c.f. *chiketto* with one devoiced vowel) and would devoice if it was not for the following devoiced vowel (Tuchida 2001). It's a reasonable possibility that the unnatural maintenance of voicing affects the frication duration of the previous consonant. 2) *tiida* and *tinpanii* are the lowest frequency words in the study (as indicated by Google hits). Although there were no general effects of frequency, it has been suggested in the literature that frequency of use may correlate with degree of nativization (Ito and Mester 1995)

Figure 6: the frication duration of loanwords with /t/ in strong syllables

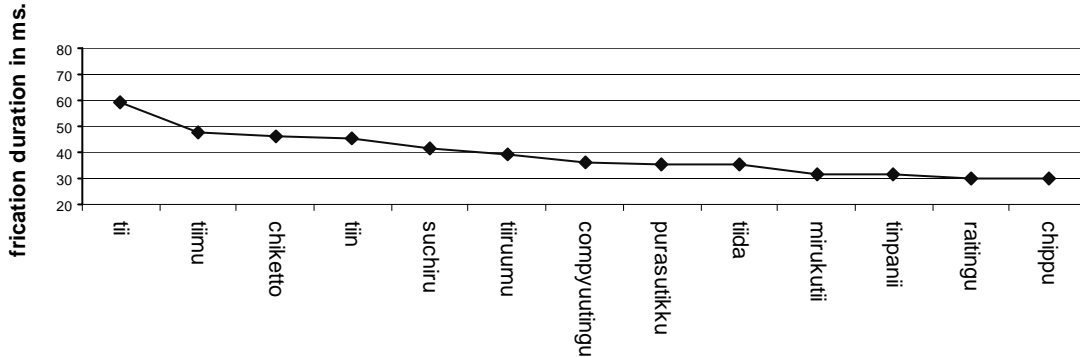
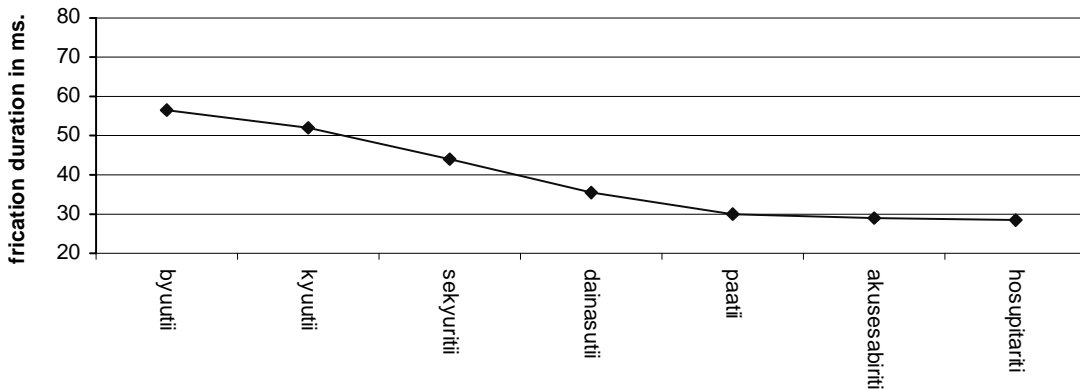


Figure 7 shows the average frication duration across subjects for loanwords with /t/ in extrametrical syllables. Since they are not footed, these syllables cannot be accented. Thus, the only factor that predicts the relative frication duration is proximity to the initial syllable. The extrametrical syllables closest to the left edge of the word are in disyllabic *byuuti* and *kyuuti* and, indeed, have the greatest frication duration. These are followed by the four-syllable words *sekyuriti* and *dainasuti* which are in turn followed by even longer words *akusesabiriti* and *hosupitari*. The one exception to the generalization is *paati*, which, at two syllables is predicted to be longer than *sekyuriti* and *dainasuti*.

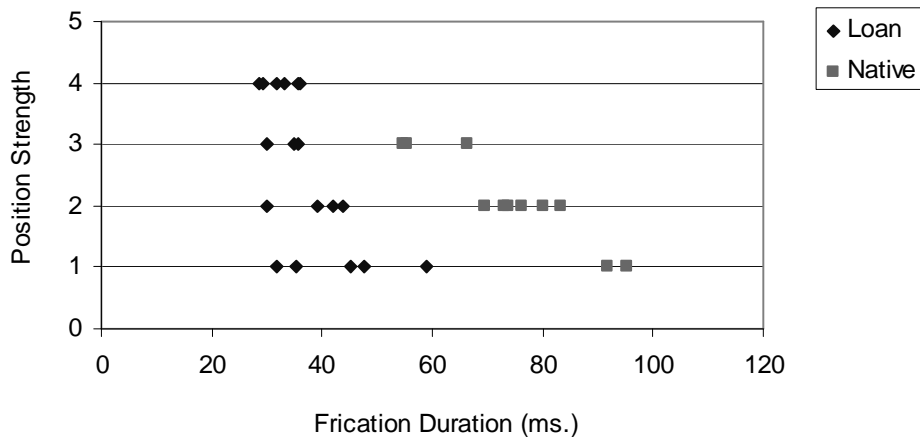
Figure 7: the frication duration of loanwords with /t/ in extrametrical syllables



As illustrated by Figures 4-7, where the stimulus sets allow comparison, the general trends identified for native words hold for loan words as well. FD is conditioned by prosodic position and distance from the left edge of the word. Further, the average frication duration of some /t/ words is actually longer than for some /tʃ/ words. This is illustrated in Figure 8, which plots the average FD of /ti/ and /tʃi/ for all the words in the

study against the positional strength of the target syllable⁶. The chart shows that contrast between /t/ and /tʃ/ is only achieved if the primary cue distinguishing the categories is relativized to prosodic position. At each step on the positional strength scale, there is a contrast of at least 20ms in frication; however, if we view the categories as independent of prosodic positions, then there is distributional overlap.

Figure 8: The average frication duration produced by all speakers for loanword [ti] and native word [tʃi] tokens plotted against the positional strength of the target sequences.



In this section, we identified a number of factors that condition the realization of the phonemes /t/ and /tʃ/ before /i/. Speakers produce a consistent contrast between these categories when they are in analogous prosodic positions, but the complete distribution of /t/ overlaps with /tʃ/; /ti/ in strong positions is produced with more FD than /tʃi/ in weak positions. The observations discussed in this section, however, have been true of the language population as a whole, holding for the average FDs produced by 13 speakers from two different generations. In the next section, we return to the issue of cross-generational differences and find that understanding how prosody effects FD holds the key to addressing the ontogeny vs. diachrony issue raised at the outset.

6.0 Age revisited: adult plasticity and phonetic enhancement

Section 5.0 identified a number of linguistic factors that condition FD in /ti/ and /tʃi/ sequences. In this section we revisit the effect of age on FD in light of these results and uncover clear generational differences that were obscured by the analysis in 4.2.1 which failed to take positional strength into account.

6.1 A generation gap

⁶ Position strength is represented by whole numbers 1-4 (where 1 is the strongest position, an accented syllable in the first syllable of the word, and 4 is the weakest). See appendix B for definitions of strength categories.

In section 4.2.1 (Figure 3), we took a first look at age as a possible conditioning factor of frication duration. Comparing /ti/ tokens from loanwords produced by GEN-1 and GEN-2 yielded no significant difference. When we looked at the average frication duration by word in section 5.0, however, we saw that some loanwords contained a /ti/ sequence produced with greater FD than some sequences of /tʃi/ in native words. The chart in Figure 9 isolates GEN-1 speakers in comparing the FD of loan and native tokens relativized to positional strength; figure 10 does the same for GEN-2.

Recall that Figure 8 showed that, collapsing across the entire speech population, there was an overlap in FD between /ti/ and /tʃi/ sequences. Figure 9 and 10 show that although both GEN-1 (Figure 9) and GEN-2 (Figure 10) speakers maintain a contrast between /ti/ and /tʃi/ in each position, GEN-1 produces the sequences with overlapping FD while GEN-2 produces the sequences without overlap. Thus, the overlap between FD that we saw in the population as whole can be attributed solely to GEN-1 speakers.

Figure 9: The average frication duration produced by **GEN-1** speakers for loan [ti] and native [tʃi] tokens plotted against the positional strength of the target sequences.

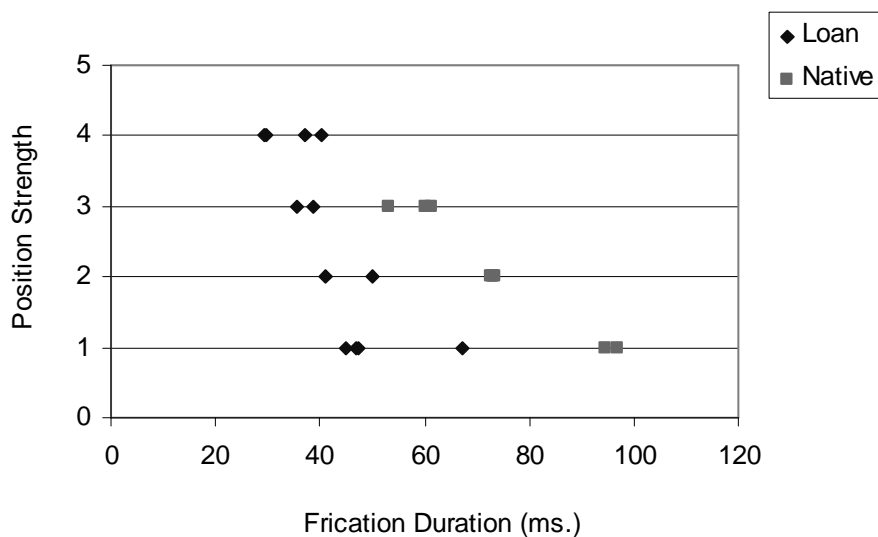
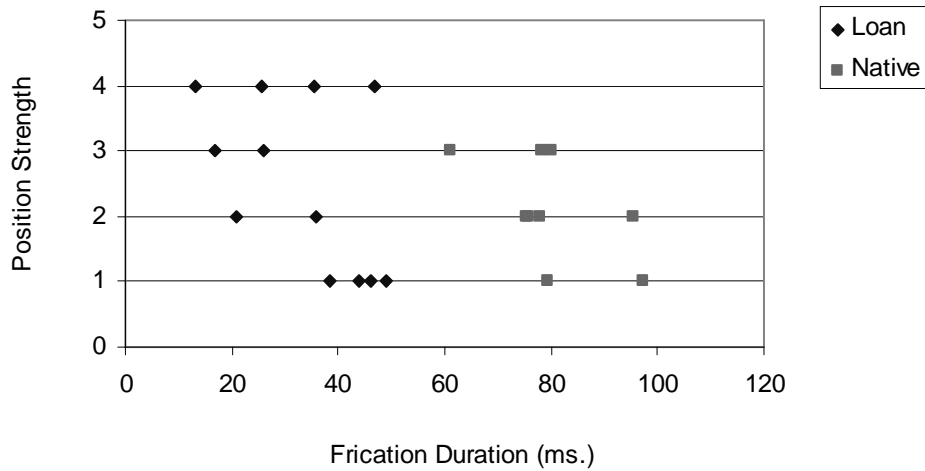


Figure 10: The average frication duration produced by **GEN-2** speakers for loanword [ti] and native word [tʃi] tokens plotted against the positional strength of the target sequences location.



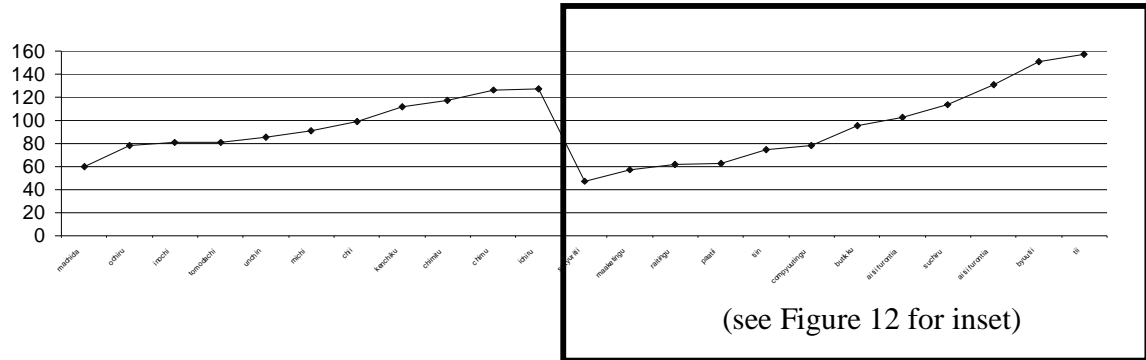
The preservation of contrast between /t/ and /tʃ/ in the environment of /i/ for GEN-2 is evidenced by a sharp divide between categories at around 60ms of frication. This contrasts with the plot of GEN-1 speakers, which has both loanwords with greater than 60ms of frication and native words with less. From a perceptual standpoint, then, a token with less than 60ms of frication is unambiguously /t/ only if produced by a GEN-2 speaker. If produced by a GEN-1 speaker, it could just as easily be a /tʃ/ in weak prosodic position. Thus, while GEN-2 speakers show distinct categories of /t/ and /tʃ/ before /i/, GEN-1 speakers have overlapping categories that distinguish contrast only if relativized to prosodic position. What can account for this difference in profile? To investigate this question further, we turn to the GEN-1 subject with the most overlap between categories.

6.2 Profile of a synchronic borrower

As illustrated in section 4.2.2 (Table 2), the male representative of the GEN-1 group produced similar mean frication durations for both native and loan stimuli. Although this fact by itself suggests that he does not have a contrast between /ti/ and /tʃi/, the suspiciously high standard deviation warrants a closer look. We hypothesized at the end of section 4 that the high variance in this measure may be due to the differentiation of words orthographically expressed as *ti* into separate /ti/ and /tʃi/ categories. The chart in Figure 11 plots the frication duration of /t/ in all target words produced by this subject. The native words are on the left, ordered from least to greatest frication duration; the loanwords are on the right, also ordered from least to greatest frication duration. Although the slope of the line connecting points in Figure 11 is similar for native and loan words, the extrema are quite different. The range of frication durations for native words runs from 127ms in strong prosodic positions to 60ms in weak positions. In loans, however, strong positions are produced with 157ms of frication duration and, more

interestingly, weak positions are produced with just 47ms, which falls within the group range for /ti/ (see Figure 6,7).

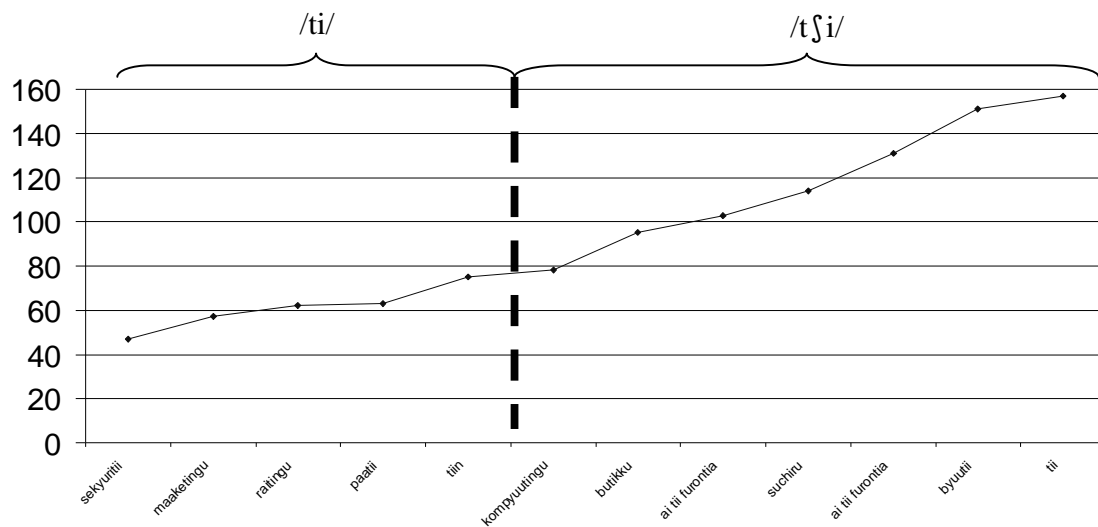
Figure 11: The frication duration of all target words produced by one GEN-1 subject. The native words are on the left ordered from least to greatest frication. The loan words are on the right also ordered from least to greatest frication duration.



To take a closer look at the tokens that are produced within the /t/ range, the graph in Figure 12 isolates the loanwords, just the right-hand portion of Figure 11. Building on the findings for the population reported in the previous section, we expect prosody to systematically condition the range of variation within a category. Figure 12 shows, however, that these expectations are born out rather curiously. Unexpectedly, the prosodic strength hierarchy recycles in the middle of the slope. The word with the greatest frication, *tii*, is both accented and initial, placing it ahead of accented targets in the second syllable (e.g. *suchiiru*), which are in turn more fricated than the unaccented second syllable /ti/'s in *ai tii furontia*⁷ and *butikku*. Both *byuutii* and the final syllable in *ai tii furontia* are extrametrical, but, as predicted, *byuutii* has a longer frication period by virtue of its proximity to the left edge of the word relative to *ai tii furontia*. This pattern accounts for only the right half of the slope in Figure 12. After *kompyuutingu* the prosodic strength hierarchy repeats. That is, *tii* has /t/ in a strong prosodic position just as *tii* did. Both accented and word-initial, the /t/ in *tii* is in the strongest possible prosodic position. Further, the next two words, *paatii* and *raitingu*, are in the number two slot in the strength hierarchy. The /ti/ in *paatii* is extrametrical, but, like *byuutii*, being just one syllable from the left edge, it is in the strongest possible extrametrical syllable. Similarly, *raitingu*, with an accented second syllable /ti/ is just one step down on the strength hierarchy from *tii*. The words with the shortest frication, *maakekingu* and *sekyuriti* are at the bottom of the strength hierarchy. We saw for native words that FD is predictable from the prosodic strength of the syllable. This generalization carries over straight-forwardly to this speaker only if we posit two sound categories for loan sequences orthographically represented as /ti/. The proposed category boundary is marked with a dotted line in Figure 12.

⁷ The word *ai tii furontia* is listed twice because it has two target sequences, one in the second syllable and one in the final syllable. The second syllable has longer frication duration than the final syllable.

Figure 12: The frication duration of all loan words produced by the GEN-1 male subject.



Thus, if we consider the linguistic factors that condition gradience within a category, the data strongly suggest that, for this speaker, a sound treated uniformly in the source language maps to two separate categories. The *ti* in *tii* maps to a different category than the *ti* in *tiin*. Figure 11 shows, however, that both of these loan *ti*'s overlap heavily (though not completely) with native productions.

The difference between the GEN-1 speaker data in Figure 12 and the general trend for GEN-1 speakers, therefore, is not neutralization versus preservation. Rather, it appears that all speakers from GEN-1 acquired the contrast in at least some words. The speaker in Figure 12, however, treats two sets of *ti* tokens in loans as categorically different.

Why should the contrast be confined to certain words? This fact is compatible with two explanations: 1) the speaker learned the contrast during L1 acquisition, but simply misclassified some /ti/-tokens as /tʃ/ or 2) the speaker acquired an L1 without a /ti~/tʃ/ contrast, but learned the contrast later in life. Evidence that the latter of these possibilities is correct can be mustered by looking at the etymological record of the loanwords produced as [ti].

Of the five words produced with the least frication, *tiin*, *paatii*, *raitingu*, *maaketingu* and *sekyuritii*, only *paatii* was in the language when the speaker was born⁸. According to the unabridged Japanese dictionary (Nihon Kokugo Daijiten 1970-1976, 2000-2001), the next word to come into the language was *maaketingu*, in 1975, well into the adulthood of all GEN-1 speakers in the study. Thus, although the contrast is restricted to loanwords in even the second generation speakers, for this particular speaker,

⁸ The speaker was 56 years old when data was collected in 2004.

the contrast is further restricted to recent loanwords or, more precisely, those that entered the language after 1975.

There appears to be two effects of language contact on this speaker's grammar. Using the effect of prosodic position on FD as a diagnostic for sound category boundaries, we identified a partition in the speaker's production of *ti* into two categories. In one category, the maximum frication duration exceeds that of the native category in analogous prosodic position; in the other, the FD is far less than the native category in comparable positions. The FD in this second category comes closest to approximating the source language and is realized in words that came into the language well after the speaker's critical period. Further, the FD separating these categories is of a magnitude that is used for contrastive purposes elsewhere in the language (e.g. the maintenance of the *t~tʃ* contrast before back vowels as in /*ta*/ 'rice paddy' and /*tʃa*/ 'tea'). Thus, the first consequence of language contact is the emergence of a new sound sequence, /*ti*/, which contrasts minimally with the native sequence /*tʃi*/ . A second consequence is the phonetic drift within the loan categories. The loanwords produced as [*tʃi*] have even greater frication than native [*tʃi*] such that, as shown in Figure 12, the native word /*tʃii*/ 'rank' is produced with 100ms of frication while the loanword /*tii*/ 'the letter T' is produced with 157ms, different still from /*tiin*/ 'teen(ager)', produced with 76ms. Thus, in addition to the formation of a new sound category, the loan categories of /*ti*/ and /*tʃi*/ also appear to be drifting away from each other. This reflects a larger cross-generational trend. Recall that even when collapsing across prosodic positions GEN-2 produced loan [*tʃi*] with greater FD and loan [*ti*] with less FD than GEN-1 (see Figure 3).

Taken together the two effects of language contact apparent in this speaker's productions provide insight into the process of phonological contrast borrowing. First, GEN-1 produces a weak contrast between /*ti*/ and /*tʃi*/ in loan words by mapping these sequences to prosodically conditioned allophones of native /*tʃi*/ (see Shaw 2007b for formal implementation). Second, once contrasting categories are formed, the phonetic realization of the categories is slowly pushed apart. This second effect can be observed both on a small scale within individuals (Figure 11, 12) and on a larger scale across generations (Figure 3, 9, 10).

7.0 Conclusion

At the outset of this paper, we raised two questions regarding the emergence of the phonological contrast between /*ti*/ and /*tʃi*/ in Japanese. The first is whether the contrast emerged within the grammar of the individual or across a generation. The evidence presented in section 6.2 suggests that the contrast was borrowed initially by GEN-1 speakers, but was in large part parasitic on the allophonic variation used to express the native sequence /*tʃi*/ in different prosodic positions (see Shaw 2007a for further discussion). The weak contrast produced by GEN-1 speakers was subsequently enhanced by GEN-2 speakers. The second question was why the *ti~tʃi* contrast was

selectively preserved. Contrast preservation in loanword adaptation is not normal. As table 4 shows, there are numerous cases in Japanese in which phonological contrasts from the source language are neutralized. In response to this question, we hypothesized that the presence of a non-contrastive phonetic continuum (i.e. allophonic variation) may be prerequisite for borrowing phonological contrast. By this hypothesis, the neutralization of contrasts in Table 4 is due to a lack of variation in corresponding native sequences.

Table 4: Distinct English forms which map to the same phonetic form in Japanese.

English word		Japanese adaptation	
orthography	IPA	Orthography	IPA
a. writing	ɹaɪtɪŋ	ライティング	ɹaɪtɪŋgu
b. lighting	lɑɪtɪŋ		
c. steal	sti:l	スチール	suti:iru
d. still	sti:l		
e. food	fud	フード	ɸuudo
f. hood	hʌd		

Both of these conclusions stem from an analysis of phonetic data that considers the phonological structure of the target words, the age of the speakers and the etymological record of the loans. Although it was not apparent in our first look at age as a factor conditioning FD (see 4.2.1), looking at the effect of age within prosodic position revealed clear differences between the phonetic profiles of GEN-1 and GEN-2 populations. GEN-1 speakers produce /ti/ and /tʃi/ with overlapping FD distributions and with contrast maintenance relativized to prosodic position. For these speakers, loan /ti/ in prosodically strong positions is produced with the same temporal properties as native /tʃi/ in prosodically weak positions. GEN-2 speakers, however, produce distinct FD's for /ti/ and /tʃi/ regardless of prosodic position. Our evidence for ontogenetic borrowing came from an analysis of a GEN-1 speaker with lexically specific preservation of /ti/. Understanding the effect of prosodic position on FD allowed us to first identify a category boundary between loan [ti] and loan [tʃi] and subsequently recognize the contrast preserving [ti] productions as loans that entered the language during adulthood.

In sum, we have produced phonetic evidence that phonological contrasts can be borrowed and that they can be borrowed by mature adult speakers even without substantial direct contact with the source language. The evidence presented suggests that the necessary prerequisite is a phonetic continuum to which the non-native contrast can be mapped. As such, the range of contrasts which can be incorporated via this type of ontogenetic borrowing may be limited to the range of allophonic variation present in the borrowing language.

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Appendix A: Stimulus List

Bold syllable denotes the presence of a pitch accent; Romanization of loanwords below is based on the most frequent orthographic variant; *italicized* vowels are in devoiced environments.

<u>Japanese (Romanization)</u>	<u>Assumed Footing</u>	<u>Gloss</u>	<u>Type</u>	<u>/ti/ syllable strength</u>
地位 (chii)	(t fi)	‘rank’	Native	1
痴夢 (chimu) ⁹	(t fi mu)	‘foolish dream’	Native	1
命 (inochi)	(ino)chi	‘life’	Native	2
ち密 (chimitu)	(t fi mi)tu	‘precision’	Native	2
一縷 (ichiru)	i(t fi ru)	‘gleam’ (i.e. gleam of hope)	Native	2
運賃 (unchin)	(un)(t fi n)	‘freight’	Native	2
建築 (kenchiku)	(ken)(t fi ku)	‘architecture’	Native	2
落ちる (ochiru)	o(t fi ru)	‘to fall’	Native	2
友達 (tomodachi)	(tomo)(dat fi)	‘friend’	Native	3
町田 (machida)	(mat fi)da	a surname	Native	3
道 (michi)	(mit fi)	‘road’	Native	3
ティー (tii)	(tii)	‘tea’	Loan	1
チケット (chiketto)	(t fi)(ket)to	‘ticket’	Loan	1
スチール (suchiru)	su(t fi ru)	‘steal’, ‘still’	Loan	2
チーム (tiimu)	(tii)mu	‘team’	Loan	1
ミルクティー (mirukutii)	miruku(tii)	‘milk tea’	Loan	4
アクセサビリティ (akusesabiriti)	akusesa(bi)riti	‘accessibility’	Loan	4
ティーダ (tiida)	(tii)da	‘Tiida’	Loan	1
ビューティー (byuutii)	(byuu)tii	(Japanese car)	Loan	1
キューティー (kyuutii)	(kyuu)tii	‘beauty’	Loan	1
ホスピタリティ (hosupitariti)	hosupi(tari)ti	‘cutie’	Loan	4
セキュリティ (sekyuritii)	se(kyuri)tii	‘hospitality’	Loan	2
ティンパニー (tinpanii)	(tin)panii	‘security’	Loan	1
ITフロンティア		‘timpani’	Loan	2
(ai tii furontia)	(ai) (tii) fu(ron)tia	‘IT frontier’	Loan	2
ティールーム (tiiruumu)	tii(ruu)mu	‘tea room’	Loan	2
チップ (chippu)	(t fi p)pu	‘tip’, ‘chip’	Loan	1
コンピューティング		‘computing’	Loan	4
(kompyuutingu)	kompyuu(tin)gu			
ティーン (tiin)	(tiin)	‘teen(ager)’	Loan	1
ダイナスティ (dainasuti)	dai(nasu)ti	‘teen(ager)’	Loan	3
ライティング (raitingu)	rai(tin)gu	‘Dynasty’ (TV program)	Loan	3
パーティー (paatii)	(paa)tii	‘writing’	Loan	2
マーケティング (maakingu)	maa(ke)tingu	‘party’	Loan	4
ブティック (butikku)	(bu)tikku	‘marketing’	Loan	3

⁹ novel compound

プラスチック (purasuchikku)

purasu(**tjik**)ku

'plastic'

Loan

4

Appendix B: Prosodic Strength Categories

Note: moras are counted from the left morpheme boundary

- 1 = extrametrical syllable in the 3rd mora or accented syllable in the 1st mora
- 2 = extrametrical syllable in the 4th mora, unaccented syllable in the 1st mora, or an accented syllable in the 2nd mora
- 3 = extrametrical syllable in the 5th mora, unaccented syllable in the 2nd mora, or an accented syllable in the 3rd mora
- 4 = extrametrical syllable in the 6th or later mora, unaccented syllable in the 3rd mora or accented syllable in the 4th mora