Issues in Loanword Adaptation: a Case Study from Thai*

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Abstract

In this paper we review the results of a study of an 800 word corpus of loanwords from English into Thai and consider their relevance for models of loanword adaptation. The discussion focuses on the context-free adaptation of consonants; the correspondences between the voiceless aspirated, voiceless unaspirated, and voiced stops of the two languages; adaptations to accommodate Thai's CRVC syllable template; and the selection of a tone for the loanword.

Key Words: loanwords, phonological similarity, experimental phonology

1. Introduction

In the past decade we have seen the study of loanwords evolve from a minor curiosity to a phenomenon meriting serious and sustained study. The most significant motivation has undoubtedly been the conceptual shift in our field from rules to a constraints and repair model of sound change. Loanword adaptation is constraints and repairs in "real time". In adapting a loan the speaker tries to remain faithful to the source word while still making the loan conform to the native language (L1) segmental inventory, phonotactic constraints, and prosodic structures. Because inputs of considerable diversity and complexity can be devised, loanword phonology takes on the status of something akin to an "experiment of nature" in allowing us to probe phonological competence. Needless to say, various methodological issues have arisen in this enterprise such as the distinction between on-line vs. integrated loans, the role of orthography, as well as the often-variable nature of the data necessitating statistical generalizations and tendencies rather than categorical rules. Finally, in a significant number of cases adapters converge on a repair strategy that lacks a precedent in the native system and sometimes may even contradict L1 repairs, raising serious learnability puzzles.

A particularly thorny issue is the input to the adaptation process itself and the nature and locus of the repairs. Three positions on this question have emerged in the recent literature. Carole Paradis and her collaborators (LaCharité and Paradis, 2005 and cited references) defend the view that loanword adaptation is largely performed by bilinguals who draw on their native-like competencies in both the donor and recipient languages to discern equivalences between phonological categories and structures that abstract away from the details of their phonetic realization in each grammar (cf. also Jakobs and Gussenhoven, 2000 for a similar view). An opposing position was articulated by Daniel Silverman (1992) and later taken up by Sharon Peperkamp and Emmanuel Dupoux (2003). Impressed by the learnability puzzle, their hypothesis is that the surface form of the foreign loan is mapped to L1 phonological categories and schemata in an extra-grammatical speech perception module on the basis of language-independent acoustic similarity. Finally, an intermediate position has been articulated by such researchers as Broselow (2003), Kang (2003), Kenstowicz (2001/4, 2003), Shinohara (1997, 2000), Steriade (2001), Yip (1993, 2002) and others. On this view the adaptation process can take into account a variety of factors to achieve the best match to the source word including phonetics as well as orthography. The adapter is not a passive recipient of the speech perception module but exercises active control over the native grammar in shaping the loan as well as possibly calling on implicit knowledge of phonetic similarity to fashion adaptations that lack a precedent in the native system.

In this paper we will present some of the results of a study of loanword adaptation in Thai from the perspective of these three approaches. The data come from an 800-word corpus of loans from English assembled by the second author. About 90% of the corpus consists of established loans taken from an English-Thai dictionary (Paopichit 1982); the remaining are recent adaptations used by Thai students in the United States. The properties of Thai grammar that are relevant to the subsequent discussion include the following. Thai has a CRV(V)C syllable template. Main stress is on the final syllable of the word. There is a five-way tonal distinction of High, Mid, Low, Rising, and Falling.

Concerning the phonemic inventory (1), the plosive series is characterized by the well-known three-way aspirated, plain voiceless, and voiced series. Voiced plosives are missing at the palatal and velar points of articulation and there is no voicing contrast in the fricatives. The contrast between the two liquids is unstable.

(1) Thai phonemic system

ph	th	ch	kh		i	ɨ	u
p	t	c	k	ʔ	e	ə	o
b	d				ɛ	a	ɔ
f	s			h			
m	n		ŋ				
	l, r						
w		j					

Our discussion focuses on four topics. First, we examine the context-free adaptation of consonants that lack a direct correspondent in the Thai phonemic inventory. Second, we survey the various contexts in which Thai accommodates the English binary voiceless -voiced opposition. We then turn to the repairs employed in adapting the loan to the Thai CVC syllable template. The final section examines the factors at play in assigning tone to the loanword. It should be noted that all references to Thai in this study concern the standard language based on the Central Thai dialect.

2. Context-Free Mapping of Consonants

English consonants that have a direct counterpart in Thai are regularly mapped as such.

(2)

E	T	E	T	E	T
p^{h}in	**ph**īn	**f**ile	**f**āaj	**l**ink	**l**íŋ
t^{h}one	**th**ōon	**s**olo	**s**ōolôo	**r**um	**r**ām
chip	**ch**íip	**h**and	**h**ɛ̄ɛn	**w**eb	**w**ép
k^{h}itty	**kh**íttî i	**m**ail	**m**ēew	**y**ard	**j**áat
bit	**b**ìt	**n**oise	**n**ɔ́ɔj		
data	**d**āatâa	**f**ishing	**f**ítchîŋ		

English consonants that lack Thai counterparts are shown in (3) with their loanword correspondences.

(3)

g -> k		**ʒ -> c**	
E	T	E	T
goal	**k**ōo	to **j**am	**c**ɛ̄ɛm
green	**k**rīin	**j**oy	**c**ɔ̄ɔj
de**g**ree	dīi**k**rīi	e**j**ect	ī**ic**èk

z -> s		**ʃ -> ch**	
E	T	E	T
zip	**s**ɪ́p	**sh**irt	**ch**áɑt
zulu	**s**ūulūu	**sh**ow	**ch**ōo
bu**s**y	bī**is**ì̂i	fa**sh**ion	fɛ̄ɛ**ch**ân

θ -> t		**v -> w**	
E	T	E	T
thyroid	**th**ājrɔ̄ɔj	le**v**el	lēe**w**êew
thankyou	**t**ɛ́ŋkwî iw	**v**isa	**w**ī isâa
wrea**th**	lii**t** (Panlay 1997) [1]	**v**ote	**w**òot
footpa**th**	futbaa**t**	**v**irus	**w**ājrát
		so**v**iet	sōo**w**iât
		le**v**el	lēe**w**êew

Such correspondences are of course one of the most intriguing aspects of loan phonology since, at least at the onset of language contact, there are no precedents to guide the adaptation process as to which phoneme to select from the native inventory. Obviously some notion of similarity is at play. Paradis (1996) and Paradis and LaCharité (1997) hypothesize that the location of such segments in feature geometry and prosodic structure is the relevant factor. The adapter will search for the minimal change in the space defined by the feature tree and the prosodic hierarchy. Thus, matching for stress may engage radical changes such as syllable and foot truncation (Davidson and Noyer 1996, Fenyvesi and Zsigri 2004, Matondo 2004). Satisfaction of phonotactic constraints can entail addition of a syllable (English *bus*, *film* -> Korean [pəsɨ], [p^{h}illɨm]) while the adaptation of individual segments may involve distributing their distinctive features over successive segments (cf. Paradis and Prunet's 2000 "unpacking" of nasal vowels to VN sequences) or changing a feature's coefficient.

An alternative conception of phonological similarity based on shared features and natural classes has been utilized by Frisch, Pierrehumbert and Broe (2004) in their study of the well-known co-occurrence restrictions on consonants composing the Arabic triliteral root. Similarity is computed by the formula in (4).

(4) $$\text{similarity} = \frac{\text{shared natural classes}}{\text{shared natural classes + unshared natural classes}}$$

On this view the similarity of a pair of phonemes is decreased when one of them gains neighbors in phonological space. For example, at the labial point of articulation the Arabic phonemic inventory comprises /b, f, m, w/. Utilizing the features [sonorant], [continuant], [nasal], and [voice] to define these phonemes, the pair /f, m/ share just two natural classes and have seven unshared classes for a similarity value of 2/9 or 0.22. If /p/ and /v/ were added to the system then while /f/ and /m/ still share just two classes, the number of unshared classes is increased to eleven. The consequence is that the similarity

between /f/ and /m/ decreases to 2/13 or 0.15. So far as we know, this notion of similarity has not been applied to the study of loanword adaptation. It could prove helpful in resolving alternative adaptations that are otherwise phonologically/phonetically equidistant. Similar remarks hold for Clements' (2003) notion of Feature Economy.

Finally, Steriade (2001) sees loanword adaptation as guided by a general model of sound similarity called the P-Map that underlies OT faithfulness as well as judgements of rhyme (cf. also Kenstowicz 2001/4, 2003 for loanword studies from this perspective). On this view similarity is not based on gross feature count but on some more fine-grained distance in auditory space that is highly sensitive to the effects of context and subphonemic (enhancing) properties on the relative salience of speech sounds.

When viewed from the perspective of these three models of phonological/phonetic distance, some of the Thai adaptations in (3) make sense while others remain puzzling. The devoicing of /g/, /ʒ/ is predicted by all models. An alternative change to /b/ or /d/ would preserve voice and manner but at the expense of change in the major articulator. Change in the plus or minus value of the terminal feature [voice] is obviously minimal when compared to a change of the dominating articulator in the feature tree Clements (1984). Frisch, Pierrehumbert and Broe (2004) explicitly weight the sharing of the same major articulator higher than overlap in other natural classes in order to accommodate the fact that the Arabic root co-occurrence constraints are grosso modo based on shared place of articulation. Below in (5) we reproduce the similarity values found by adding in the English segments /g, ʒ, z/ to the existing Thai phonemic inventory one at a time using the shared natural class algorithm as instantiated in the script due to Albright (2004). [2] Adaptations that seek out the most similar member of the Thai phonemic inventory correctly predict devoicing in the *g* -> *k*, *ʒ* -> *c*, and *z* -> *s* cases.

(5)

	g	k	kh	ŋ	
g	1.0	.75	.40	.45	

	ʒ	c	ch	d	
ʒ	1.0	.75	.39	.50	

	z	s	d	r	n
z	1.0	.75	.51	.38	.31

Also in Steriade's P-Map devoicing is viewed as the auditorially minimal change based on results from experimental studies of confusability (confusion matrixes) as well as being the cross-linguistically canonical repair to violations of phonotactic constraints that bar word-final voiced obstruents (final devoicing) or a nasal+voiceless stop sequence (post-nasal voicing).

A more subtle adaptation is the affrication of English /ʃ/ to the Thai aspirated affricate /ch/ rather than fronting to /s/. Here a change of the minor place feature [anterior] (a dependent of the Coronal node in feature geometry) is rejected in favor of a change in continuancy. The location of [continuant] in the feature tree has been a topic of considerable debate (cf. Padgett (1994), Halle (1992)) and so this particular adaptation's implications for the feature-geometric conception of similarity is difficult to assess. But since an affricate preserves the turbulence of the fricative in its delayed release, *ʃ* -> *ch* is

probably best viewed as a repackaging and hence preservation of the essential features of the [ʃ] at the expense of adding the supporting closure. This hypothesis is strengthened by the systematic choice of the aspirated affricate /ch/ over the voiceless unaspirated /c/. This suggests that an equivalence is drawn between aspiration and stridency--properties that contribute to turbulence-- the acoustic signature of a fricative. Aspiration and stridency are not adjacent in the articulator-based feature tree. So the connection would seem to be auditory in nature. Calculation via shared natural classes over distinctive features also fails to choose the aspirated version of the affricate. Indeed it predicts a tie between ʃ -> *s* (change of [anterior]) and ʃ -> *c* (change of [continuant]).

(6)

	ʃ	c	ch	s	h
ʃ	1.0	.49	.32	.49	.30

The mapping of the E inderdentals to stops vs. fricatives is still a major mystery in loanword phonology. See Brannen (2002) and Ahn (2003) for recent discussion of the problem and review of the literature. Thai parts company with Japanese, European French, and German where E /θ/ is adapted as /s/ and joins with Russian, Canadian French and Turkish in choosing /t/ instead. An interesting finding from Brannen's study is that Canadian French speakers who pair /θ/ with /t/ still judge /f/ as a closer sound in a psycholinguistic experiment. If auditory similarity underpins loanword adaptation (as opposed to shared articulation or raw feature count) then we would have to say that the interdental's lack of labial articulation and the possible presence of a dental articulation in the visual modality is enough to overcome the auditory bias to /f/.[3] Interestingly, the algorithm based on shared natural classes makes the correct choice in this case, as shown by the table of values in (7).

(7)

	θ	t	s	f
θ	1.0	.66	.50	.47

The final mystery is the mapping of the voiced English /v/ to the approximant glide /w/ rather than devoicing to the fricative /f/. Given that /z/ devoices to /s/ why does /v/ not follow suit and converge on /f/? This is the expected result in terms of adjacency in the feature tree (change in the terminal feature [voice] as opposed to the root node feature [sonorant]) as well as in terms of calculation via shared natural classes.

(8)

	v	f	b	w
v	1.0	.71	.51	.19

The voiced labio-dental /v/ is the least turbulent of the English fricatives. If sounds are judged in terms of their distance in auditory space then it is conceivable that /v/'s minimal turbulence is sufficient to push it into the sonorant region of the Thai speaker's P-Map and hence make /w/ the closest match. This hypothesis is complicated by the fact that Thai adaptation of E /v/ to /w/ only occurs in the syllable onset. In final position /v/ systematically maps to /p/ even though /w/ is phonotactically valid in the coda (often as a realization of /l/).

(9)		E	T
		creative	khrīɪʔēethìip
		conservative	khɔ̄nsə̄əwēeťiip
		serve	sə́əp
		proof	prúup
		safe	séep
	cf.	shell	chēew
		scale	sʷkēew

Parallel adaptation of E /v/ as /w/ instead of as an obstruent is also reported for Mandarin (Li 2003), Hawaiian (Adler 2004), and Fula (Paradis and LaCharité 1997). This behavior contrasts sharply with Arabic where /v/ maps predominantly to /f/ and occasionally to /b/ but never to /w/. Mahasen Abu-Mansour (p.c.) supplies these examples for Saudi Arabic: *van* -> [fan], *vitamiin* -> [fitamíin], *virus* -> [fayrúus] but *veranda* -> [baránda]. Arabic contrasts voiced and voiceless fricatives at several places of articulation (interdental /θ/ vs. /ð/, alveolar /s/ vs. /z/, dorsal /x/ vs./ɣ/, and pharyngeal /ħ/, /ʕ/). But Thai, Mandarin, Hawaiian, and Fula have relatively impoverished fricative inventories with no contrast in voicing. Thus when being adapted into Arabic, it is possible that E /v/ is attracted to the more densely packed obstruent system overriding the auditory bias towards /w/ seen in these other languages. Obviously, much more systematic study of the role of contrast vs. raw feature count and auditory similarity is called for in order to gain a better understanding of such sound substitutions.

3. Adaptation of Laryngeal Features: Phonological or Phonetic?

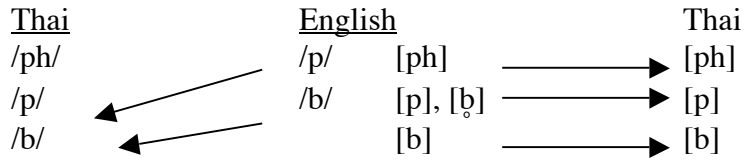
We now turn to one of the best-known properties of Thai--it's three-way /b, p, ph/ laryngeal distinction. Since English has a binary [±voice] phonemic contrast we can ask whether and how this opposition will be expressed in a system with a ternary laryngeal distinction. An interesting complication is presented by the fact that the English voiceless stop has both aspirated and unaspirated allophones depending on context. If adaptation takes place at the phonemic level, then we expect a mapping that abstracts away from these allophonic differences. If the adapter has access to the phonetic representation and strives to achieve the best phonetic match then we expect a correspondence of allophones to the extent possible. In what follows we survey the Thai adaptation of English stops with respect to four contexts in the source word: word-initial, in *sC* clusters, intervocalic, and word-final.

3.1 *Initial Position*

Assuming a simple [±voice] phonemic opposition, mapping at the phonological level predicts that English /p/ will be paired with Thai /p/ and that English /b/ will be paired with Thai /b/. But if loanword adaptation takes place at the phonetic level, then E [ph] should be paired with Thai [ph]. As for the voiced stops, Lisker and Abramson (1964)

find that for the majority of their subjects English initial voiced stops occupy the 0 to 20 VOT region while for Thai the 0-25 VOT region is occupied by [p,t,k]. We might thus expect English [b̥] to map to the Thai voiceless unaspirated [p]. These expectations are diagrammed below.

(10) Phonological Adaptation Phonetic Adaptation



The results from our corpus are that English initial voiceless stops are uniformly adapted as Thai voiceless aspirated stops (11). (There is one qualification to this statement--see 3.4). This looks like strong support for Phonetic Adaptation.

(11)

E	T
pin	**ph**īn
penny	**ph**ēnnīi
parade	**ph**āarèet
test	**th**ées
team	**th**īim
Tibet	**th**íbèet
cone	**kh**ōon
cupid	**kh**īwpît
confirm	**kh**ɔnfəəm

But just as uniformly English word-initial minimally voiced stops are paired with Thai voiced stops.

(12)

E	T
busy	**b**īisî i
bible	**b**āibə̂n
bazaar	**b**āasâa
deuce	**d**īw
dollar	**d**ɔnlâa
domain	**d**ōomēen

Thus, neither a purely phonetic nor a purely phonological account of the adaptation process is straightforward. We might conjecture that when mapping two elements along a three-point scale like VOT, the adapter opts for the extremes in order to maximize a contrast, especially in a salient context like word- or syllable-onset position. This would

imply that the adaptation process is not a piece-meal, word-by-word affair but operates at a more systemic level so that adaptations can be remembered and compared. It thus seems to presuppose bilingualism. The only comparable result we know bearing on this conjecture is Maddieson's (1977) study of tone loans from two-tone Hausa to various three-tone Nigerian languages. In general, Hausa H and L were mapped to H and M or M and L in the other languages rather than to the extremes of the tonal space.

A more relevant factor from the phonetic perspective is that while English word-initial voiced stops typically lack closure voicing, they nevertheless lower the F0 of the following vowel (House and Fairbanks, 1953, Lehiste & Peterson, 1961). Research has shown that the F0 differences are in the range of perceptibility and that they can be used as cues to stop identification by English subjects (Abramson and Lisker, 1985). But if we make the plausible assumption that the majority of English loanwords were adapted into Thai by native Thai (bilinguals) then the question is whether Thai speakers can use the F0 differences as cues to the voicing character of the stop. It so happens that precisely this question was investigated experimentally by Abramson and Erickson (1992). Their perceptual experiments with Thai native speakers found a two-way interaction between voicing category (as measured by VOT) and tone on the following vowel (as measured by F0). As F0 is shifted in 10 Hz steps through a range of 140Hz to 100Hz, the number of /b/ identifications increases systematically as the F0 decreases. They also found a parallel effect in the opposite direction for /p/: higher F0 onsets increases the number of /p/ responses and earlier perceptual crossovers between the /b/ and /p/ categories. Interestingly, there was no comparable effect of F0 on the identification of the aspirated stop /ph/. As we shall see in section 5, Thai adaptations do not in general equate English F0 contours with Thai tonal categories. So F0 variations to which Thais are normally sensitive could be interpreted as relevant to stop identification instead and thus help to push the 0 VOT of English stops into the perceptual space of the Thai voiced stops.

Thus, it is possible that Thai adapters use the lower F0 of the English initial [b̥] loan as a cue that would override the VOT that otherwise places it in the region of Thai /p/. Two qualifications are relevant here. One problem this interpretation faces is the systematicity of the process. In our corpus at least, English initial /b/ and /d/ are always mapped to Thai /b/ and /d/. This suggests a rule or convention that abstracts away from the phonetic gradience. One might grant that for current bilingual speakers the adaptation process is now a phonological rule but still maintain that it was originally phonetically based along the lines proposed above. Another relevant point. Abramson and Lisker (1985) look at the effect of F0 on English speakers' judgements of a /b/ vs. /p/ difference and conclude that VOT is the dominant cue and that F0 has only a "modest effect" on voicing contrasts. The relative salience of the VOT cue presumably underlies the fact that while shifts in VOT can magnify and phonologize F0 differences (tonogenesis) changes in the opposite direction where voicing contrasts arise from tonal neutralizations are much rarer (see Halle, 2003 for a possible example). Further study is obviously required to determine the relative weighting of different cues. (See Kingston and Diehl, 1994 for general discussion).

3.2 *sC Clusters*

English /sC/ clusters contain voiceless unaspirated stops. The cluster is adapted into Thai with the help of a minor syllable containing a reduced, schwa-like vowel for the /s/ followed uniformly by a voiceless unaspirated stop.

(13)	E	T	E	T
	spare	sᵊpēe	screen	sᵊkrīin
	sponsor	sᵊpɔ̄ɔnsə̂ə	scan	sᵊkɛ̄ɛn
	style	sᵊtāaj	plaster	phláatsᵊtə̂ə
	sticker	sᵊtíkkə̂ə	gymnastic	jīmnáatsᵊtìk

This is consistent with phonetically veridical mapping. From the phonological perspective we might follow Stampe (1973) in saying that English speakers phonemicize the stop in an initial *sC* cluster as voiceless /p, t, k/ (rather than the archiphonemes /P,T,K/) and that Thai bilinguals draw on this knowledge. But then it is mysterious why word-initial stops are assigned so consistently to the aspirated category. Since Thai has a three-way VOT contrast there is no reason from the perspective of Thai grammar why word-initial voiceless stops should be aspirated but post-*s* stops unaspirated.

3.3 *Word-Medial Position*

In this section we report word-medial outcomes for the English voiced vs. voiceless stops on the basis of an analysis of the first half of the corpus (c. 400 words). English voiced stops consistently map to voiced stops in Thai (14).

(14)	E	T	E	T
	ca**b**in	khēe**b**în	cre**d**it	khrēe**d**ìt
	fi**b**er	fāj**b**ə̂ə	la**d**y	lēe**d**ìi
	cu**b**ic	khīw**b**ìk	ci**d**er	sāj**d**ə̂ə

The behavior of voiceless stops is more varied but in a way that depends on the nature of the English source. When the following vowel is stressed then the choice between the voiceless unaspirated (15a) and voiceless aspirated (15b) is at chance (ten examples each).

(15)		E	T	E	T
	a.	car**t**oon	kāa**t**ūun	a**p**ache	āa**p**āachêe
		cha**t**eau	chāa**t**ôo	tor**p**edo	tɔ̄ɔ**p**īidōo
	b.	co**c**aine	khōo**kh**ēen	re**q**uest	rīi**kh**wéet
		com**p**ile	khɔ̄m**ph**āaj	sham**p**oo	chɛ̄ɛm**ph**ūu
		con**t**ainer	khɔ̄n**th**ēennə̂ə	con**t**act	khɔ̄n**th**ɛ̀k

But when the following vowel is unaccented in the English source then by a wide margin the voiceless stop is adapted as unaspirated in Thai (41 examples with unaspirated (16a) vs. 5 aspirated (16b).

(16)		E	T	E	T
	a.	mar**k**et	māa**k**êt	chee**t**ah	chīi**t**âa
		a**pp**le	é**pp**ə̂n	chim**p**anzee	chīm**p**ɛ̄ɛnsīi
		au**t**o	ɔ̄ɔ**t**ɔ̂ɔ	cou**p**on	khūu**p**ɔ̄ŋ
		be**t**a	bēe**t**âa	cu**p**id	khīw**p**ît
		cen**t**er	sēn**t**ə̂ə	da**t**a	dāa**t**âa
	b.	cal**c**ulus	khɛ̄ɛw**kh**ūulát	in**t**ro	ī**n**th**r**ōo
		car**p**enter	khāa**ph**ēntə̂ə	i**t**em	āi**th**êem
		crea**t**ive	khrīiēe**th**ìip		

Posttonic position is of course the context where voiceless stops are minimally aspirated in English and the site of various lenitions. It thus appears that here as well Thai speakers are sensitive to the phonetic realization. On the other hand the almost even distribution before a stressed vowel in (15) is puzzling.

3.4 *Final Position*

In the syllable coda Thai stops are unreleased with no contrast in the largyngeal features of voicing or aspiration. As we shall see in 5.1, syllables terminating in a stop can bear H or L tone. A search through the corpus for monosyllabic English loans ending in an obstruent showed a strong tendency to be H if voiceless (76 examples vs. 9 with L)--cf. (17a). If the English source word ends a voiced obstruent (17b) then the loan is still likely to be H but less strongly so (14 H vs. 10 L). This difference is statistically significant (p = .001, 2 tail T-test) and so it appears that the choice of tone is influenced by the voicing of the final obstruent in the English source.

(17)	E	T	E	T
a.	ca**p**	kɛ́p	boo**t**	búut
	co**ck**	khɔ́k	co**k**e	khóok
	bra**k**e	brèek	bi**t**	bìt
b	clu**b**	khlàp	lor**d**	lɔ̀ɔt
	ta**g**	thɛ̀k	gra**d**e	krèet
	co**d**e	khóot	mo**b**	mɔ́p

3.5 *An Emergent Pattern*

Our data also contain an insipient harmony pattern: initial aspiration is often missing from an otherwise expected correspondent to an English initial aspirated stop. We list several of these loans (30 examples in total) in (18). They are almost entirely composed

of cases in which there is a following (covert) unaspirated stop, suggesting a dispreference for Ch…C.

(18)

E	T	E	T
cap	**k**ɛ́p	**p**eg	**p**ék
card	**k**áat	**p**epsi	**p**épsî i
cartoon	**k**āatūun	**p**eter	**p**ī itə̂ə
cocoa	**k**ōokôo	**t**axi	**t**ɛ́ɛksî i
cook	**k**úk	**t**ent	**t**éen
park	**p**áak	**t**ick	**t**ík

However, there are many more cases in which the voiceless aspirated stop appears even if a voiceless unaspirated one follows. For the velar point of articulation we counted 8 loans such as *cap -> kép* where initial aspiration is blocked vs. 24 such as *cupid -> khīwpît* where it surfaces as expected. For the dentals there were 6 loans like *taxi -> **t**ɛ́ɛksî i* where aspiration is blocked vs. 19 such as *technic(al) -> thékník* where aspiration is assigned. For labials the two patterns are more evenly balanced with 16 examples such as *park -> **p**áak* where aspiration is blocked and 16 such as *pack -> phék* where it is not. When we set aside the cases where an unaspirated voiceless stop follows, then the mapping of English word-initial voiceless aspirated stops to Thai aspirated stops is virtually unanimous (*palm -> pāam*, *piano -> piāanōo*, and *ton -> tān* are the only the exceptions in the entire corpus).

3.6 Summary

Stepping back from the details, we find that for the statistically most robust contexts (word-initial, initial sC cluster, and intervocalic post-tonic) the Thai loans faithfully reproduce the English surface allophones of the voiceless stop phoneme. Somewhat paradoxically, English voiced stops are faithfully reproduced word-medially while the partially voiced initial [b̥] [d̥] is overlooked. The latter adaptation strategy seems to hold more generally. We are not aware of any cases in the loanword literature where E initial and medial voiced stops are distinguished as voiceless vs. voiced.[4] From the phonetic point of view we conjecture that this reflects an adaptation strategy in which the percepts taken from more salient and stable environments in the source language set the standard to which more variable ones follow suit. Further study of this conjecture is clearly required.

4. Prosodic Structure

Thai has a CRV(V)C syllable template with neutralization in the coda to unreleased voiceless stops, nasals, and glides. As we have seen in 3.4, when English stops are adapted into Thai they neutralize the voicing distinction in the coda. Final nasals and glides map to their Thai counterparts. Final /r/ deletes while final /l/ is adapted as /n/ in

older loans and as the glide /w/ in more recent ones. The constraint against coda fricatives is being relaxed to allow for /s/ in the speech of Thais familiar with English. A similar finding is reported in Panlay's (1997) study. Two of her six subjects also allowed /f/ in the adaptation of *lift* as [lif] rather than [lip]--a pattern not found in our corpus. Examples illustrating these adaptations to the Thai coda appear in (19).

(19)	E	T	E	T
	do**m**e	dōo**m**	jo**y**	chɔ̄ɔ**j**
	ca**n**	khɛ̄ɛ**n**	co**w**boy	khāa**w**bɔ̄ɔj
	shoppi**ng**	chɔ́ppîŋ		
	bi**ll**	bī**n**	gri**ll**	krī**w**
	bi**ll**iards	bī**n**liât	ge**l**	cē**w**
	fai**r**	fɛ̄ɛ	blu**r**	blāɑ
	proo**f**	prúu**p**	sa**f**e	sée**p**
	bo**ss**	bɔ́ɔ**t**		
	bonu**s**	bōonát	bu**s**	bá**s**
	ga**s**	kéet	di**s**k	dî**s**

As seen in 3.2, English #sC clusters are repaired by mapping the /s/ to a minor CV syllable whose nucleus is a schwa that alternates with /a/. Curiously, loans with a final cluster never employ epenthesis and instead systematically truncate the consonants that are not next to the vowel.

(20)	E	T	E	T
	ac**t**	ʔɛ́k	coi**l**	khɔ̄ɔj
	cam**p**	khɛ́m	new**s**	niw
	clima**x**	khlāimɛ̀k	stri**k**e	sᵊtráj
	mil**k**	mîw	dow**n**	dāaw
	lif**t**	lîp	i**c**e	áj
	physic**s**	fíʔsɨ̀k		

Thai nuclear diphthongs are of the falling sonority variety composed of a high vowel onglide followed by the low central vowel /a/ (Haas, 1964). The offglides in English /aj/ and /aw/ diphthongs are assigned to the Thai coda, bumping off any following consonants: *strike* [strajk] -> *sᵊtráj*, *ice* [ajs] -> *áj*, *down* [dawn] -> *dāaw*. Preservation of the postvocalic element and deletion of the terminal element of the cluster is expected from Côté's (2000) cue-based approach to consonant cluster phonotactics. This would be especially true in Thai where final stops are voiceless and unreleased, leaving VC formant transitions as the only cue to the final stop's place of articulation.

But we can still ask why *strike* is adapted as *sᵊtráj* and not as **sᵊtrajkᵊ* with assignment of the stray consonant to a minor syllable. Why particular languages employ

epenthesis vs. truncation in loanword adaptation is still a major mystery (see Yip, 2002 for discussion). While we cannot provide a general answer to this question, we think there are good reasons why epenthesis is blocked for final clusters in Thai. As shown by Bennett (1994), Thai has a minimal word template that takes the form of an iambic foot. The major stress is on the final syllable, which must be bimoraic--composed of a long vowel or a coda consonant or both. Words of the shape CV and CVCV are systematically avoided. Underlying light syllables are augmented by a glottal stop so that /phrá/ (cf. *phrá.câaw* 'sacred, lord') appears as [phráʔ] 'lord, monk'. The rejection of **sᵊtrajkᵊ* in favor of *sᵊtráj* can thus be described as a familiar case of constraint ranking where the prosodic requirement of terminating in a stressed heavy syllable overrides the preservation of the cluster. (*'v is the constraint from Shinohara 1997 that blocks stress--more generally prominence--on an epenthetic vowel).

(21)

/strajk/	prosody	*'v	Max-C
sᵊtrājkᵊ	*!		
sᵊtrājkāə		*!	
-> sᵊtráj			*

Bennett's (1994) discussion indicates that native Thai grammar augments a syllable by addition of a glottal stop to the coda. We might thus expect this repair to operate in loanwords as well. But in fact glottal stop augmentation is rejected in favor of gemination. As seen in (22) final short vowels of English are adapted with long vowels--never with a glottal stop.

(22)	E	T	E	T
	com**a**	khōom**ə̂ə**	bus**y**	bīis**îi**
	dat**a**	dāatâ**a**	cent**er**	sēntə̂ə
	aut**o**	ʔōotô**o**	lay**er**	lēejə̂ə

We thus appear to have another example of the phonomenon noted by Oh (1996) for Korean: a repair emerges in loanword adaptation that differs from the one employed in the native grammar.[5] Arguably in these cases (cf. Steriade, 2001) the adapter is choosing a strategy that he judges to yield an output that is more faithful to the foreign source: in Korean mapping to a CV syllable headed by the minimal vowel [ɨ] in preference to loss of the consonant or laryngeal feature, and in Thai lengthening the vowel as opposed to adding a glottal stop. Under the view that the adapter exercises control over the native grammar to take account of the foreign source, this can be modeled as an Output-Output constraint (aka "Match constraints" in Yip 2004). In (23) the rejection of [phraa] in favor of [phraʔ] indicates a dispreference for long vowels VV in comparison to the insertion of the glottal stop IO-Dep-C (don't insert a consonant). We model augmentation in terms of Prince's (1990) Weight-to-Stress constraint requiring stressed syllables to be heavy (bimoraic).

(23)

/phra/	W-to-S	*VV	IO-Dep-C
phra	*!		
-> phraʔ			*
phraa		*!	

In (24) Faithfulness to the English source *coma* in the form of the Output-Output constraint Dep-C is ranked above the constraint dispreferring long vowels. This ranking leads to the adaptation [khoomɔɔ].

(24)

/khoomə/	OO-Dep-C	*VV
khooməʔ	*!	
-> khoomɔɔ		*

Another example of this phenomenon occurs in word-medial position. When English loans are rendered in what Surintramont (1973) refers to as the isolative speech style in which each syllable is bimoraic and bears some degree of prominence, if the English source contains a short vowel then the adapter prefers to geminate the following consonant rather than to insert a glottal stop--so long as the outcome is a valid syllable coda. Otherwise the glottal stop is inserted. [6]

(25)

cookie	kúk.kîi	europe	júʔ.ròop
copy	kɔ́p.pîi	gorilla	kɔ̄ɔ.ríʔ.lâa
chassis	chɛ́t.sīi		

Once again, the rejection of the native augmentation option (glottal coda) in favor of gemination makes sense if the adapter is trying to remain as faithful as possible to the English source while still satisfying the syllable canons of native Thai grammar. It can be modeled in the form of an OT Output-Output constraint against the insertion of a consonant (OO-Dep-C).

(26)

/khɔpi/	W-to-S	OO-Dep-C	*gem
kɔpii	*!		
kɔppii			*
-> kɔʔpi		*!	

In the adaptation of *gorilla* the native Thai constraint against liquid codas blocks the perceptually minimal candidate with gemination allowing the candidate that satisfies augmentation via the native strategy of glottal stop insertion to emerge as the winner.

(27)

/gorila/	W-to-S	Coda-Con	OO-Dep-C	*gem
kɔɔ.ri.laa	*!			
kɔɔ.ril.laa		*!		*
->kɔɔ.ri?.laa			*	

We suspect that vowel lengthening--the strategy used word finally to satisfy augmentation--is dispreferred to consonant gemination word medially (*copy -> kɔppii*, **kɔɔpii*) because vowel length is used in part to distinguish among English vowels of different quality--tense vs. lax. Also gemination of a voiceless stop simply prolongs the duration of silence and is presumably less salient than prolonging the vowel. Vowel lengthening must be employed word finally since there is no following consonant to geminate.

In sum, this analysis integrates the loanword adaptation into the native grammar in the form of familiar OT faithfulness constraints with an eye to the foreign source. The leading hypothesis is that the ranking of such Output-Output constraints is guided by some overarching theory of similarity--whether auditorially based or otherwise.

At this point let us consider an alternative interpretation of the truncation of consonant clusters and augmentation of final vowels. Peperkamp and Dupoux (2003) propose that loanword adaptation takes place in an extra-grammatical speech perception module that maps the surface form of the loan into an acoustic signal that is then decoded and matched with an output from the native grammar. Peperkamp (2003) articulates this approach in greater detail. Calling attention to cases in which the repair used in loan adaptation lacks a precedent in the native language or is even contradicted by the native repair, she rejects the hypothesis that loanword adaptation is the product of the native grammar. Instead, loanword adaptations are performed by the same mechanism of phonetic decoding that transforms the acoustic stream into forms that are in accordance with the native phonology. "These perceptual assimilations are completely automatic and apply beyond the listener's awareness. Moreover they are phonetic rather than phonological in nature, and in the cases studied so far they correspond to the transformations that take place in loanword adaptation. " She goes on to state that "language-specific effects in speech perception are entirely due to differences in the surface phonetic structure of individual languages" illustrating with the Dupoux et al (1999) psycholinguistic study of Japanese listeners who perceive [ebzo] as [ebuzo], the phonetically closest legal form in their language.

On this view the adapter matches the loan with the phonetically closest output of the L1 native grammar that is phonotactically valid. From this perspective it is not so clear how to solve the problem of different repair strategies for the same violation such as epenthesis vs. truncation for the adaptation of illegal consonant clusters or adaptation of the English interdentals as a stop vs. fricative. If adaptation is modeled in terms of

Output-Output constraints then there is more flexibility in ways to achieve a match. This implies a greater range of variation in loanword adaptation than does Peperkamp's hypothesis, but one that we believe is empirically justified. Given the hypothesis that these Output-Output constraints are grounded in perception (e.g. Steriade's P-Map) then they implicate a hierarchy of preferences that can be (dis)confirmed and compared with other sound changes. Another relevant point of comparison between the two models is that loanword adaptations may sometimes override native constraints and give rise to an output that is otherwise not found in the native system. As noted earlier this appears to be happening in Thai where speakers with greater exposure to English now allow /s/ in the coda. This phenomenon can eventuate in a stratified lexicon with different sectors having different phonotactic constraints. (cf. Itô and Mester's (1995) discussion of Japanese **nt* which is overridden in the loan vocabulary not by a sound change but by remaining faithful to the source.) If the phonetic decoder automatically matches the acoustic input to a phonotactically valid string of the native grammar, it is not clear how to model such importations, which violate the native constraint system and hence would not be present in the pool of phonotactically valid outputs.

5. Tone

Every syllable in Thai must be assigned one of five possible tones. There are restrictions on which tones can combine with which syllable structures in Thai grammar. While tone is lexically contrastive in Thai, F0 in English is assigned at the level of the intonational phrase. Given the distinct functions that F0 serves in the two languages, it is not obvious that loanword adaptation will drawn any equivalences between the two.

In this section we survey the tonal assignments found in our corpus and speculate as to their basis. First, we review the phonotactic restrictions and the prior literature. We then turn to our findings and an experiment that corroborates one of them in more depth.

As in many other Asian languages, syllables closed by an obstruent restrict the range of tonal contrasts. Traditional Thai grammar distinguishes between "live" and "dead" syllables. The latter terminate in an obstruent ([p, t, k] and glottal stop) while the former do not. CVV as well as CVVR and CVR syllables may take all five tones: H (*náa* 'aunt'), M (*nāa* 'rice field', L (*nàa* 'custard apple'), R (*nǎa* 'thick'), F (*nâa* 'face'). Dead syllables containing a long vowel (CVVT) are restricted to L and F while dead syllables with a short vowel nucleus (CVT) take either H or L. (See Morén and Zsiga, 2004 for a recent analysis).

In a short paper on the rules for assigning tone to English loanwords in Thai, Gandour (1979) discovered the gross generalizations that allow the tone of the loan to be predicted with a fair degree of accuracy. Our more extensive corpus largely confirms his findings. Gandour noted some significant discrepancies (tabulated in (28)) between the tonal inventory of native Thai words and English loans. Final live syllables in loans are restricted to M and F. Long dead syllables in loans lack the F and have a H not found in the native vocabulary. And in short dead syllables the native inventory of H and L expands to include a F.

(28)

Syll type	Thai	E loan

CVV(R), CVR	H,M,L,R,F	M,F
CVVT	L, F	H, L
CVT	H,L	H, L, F

It turns out that this table is not very informative because the tonal outcomes are also determined by the number of syllables and the location of stress in the English source. In our exposition, we follow Gandour in distinguishing between monosyllablic and polysyllabic loans.

5.1 Monosyllables

The tone of a monosyllable is largely predictable from its syllable shape. Syllables terminating in a sonorant (vowel or consonant) are almost without exception M.

(29)	E	T	E	T
	bill	bīn	cone	khōon
	claim	khlēem	fair	fɛ̄ɛ
	coil	khɔ̄ɔj	fan	fɛ̄ɛn

Syllables terminating in an obstruent contain both H and L tones and thus conform to the native Thai inventory for dead syllables. But the native vowel length restriction is overlooked. We find virtually no F in monosyllabic dead syllables even if the nucleus is long; and we also find a predominance of H even when the nucleus is long. Specifically, our corpus contains 97 dead monosyllables with H (30a) vs. 21 with L (30b). Among the 21 ten have a voiced obstruent in the source.

(30)		E	T	E	T
	a.	big	bík	boot	búut
		bird	bə́ət	boss	bɔ́ɔt
		block	blɔ́k	Bob	bɔ́p
	b.	grade	krèet	lab	lèp
		bit	bìt	brake	brèek

Gandour also noted the existence of the monosyllables in (31) which terminate in a sonorant and hence should be M but instead take a H. They originate from English words with a final obstruent that has been clipped to satisfy Thai syllable structure constraints. Gandour suggests an ordering of the adaptation rules to assign tone before simplification of the consonant clusters. The underlying obstruent will place these words in the class of (30) that take H. We will refer to this class of words as containing a "covert" obstruent.

(31)	E	T
	bank	bɛ́ŋ

pump	pám
tent	tén
belt	bén
tank	théŋ

We list (32) all additional words in our corpus terminating in a deleted obstruent as well as a few cited elsewhere in the literature.

(32)

English	Thai: H	English	Thai: M
camp	khém	blond	blɔ̄n
champ	chéɛm	brand	brɛ̄ɛn
Frank	fréŋ	bronze	brɔ̄ɔn
link	líŋ	deuce	dī̄w
malt	móɔw	field	fī̄w
mink	míŋ	fuse	fī̄w
mouse	máaw	jaws	cɔ̄ɔ
noise	nóɔj	Jones	cɔ̄ɔn
punch	phán	pence	pɛ̄n
site	sáj	land	lɛ̄ɛn
slide	saláj		
sphinx	safíŋ		
Sprite	sapráj		
tank	théŋ		
volt	wóow		
waltz	wóow		

There are 21 items in the covert class that are assigned a H tone and ten that take a M. The vast majority of items taking H end in a voiceless obstruent in English (*noise* and *slide* are the exceptions) while the majority of items taking M terminate in a voiced obstruent (*deuce* and *pence* are the exceptions). In a study of the truncation of final clusters in a number of loan corpora, Shinohara (this volume) finds a significantly greater tendency to truncate clusters ending in voiced obstruents. For example, in the adaptation of English loans CV Fijian maps consonants not followed by a vowel to an epenthetic syllable. Final *nt* clusters assign both elements to a prenasalized stop plus vowel (e.g. *parliament* > [palime^{n}di]) while in final *nd* clusters the *d* is typically missing (*band* > [bani]). Shinohara (this volume) and Kenstowicz (2003) suggest that the acoustic cues to the voiced obstruent in *nd* are diminished to the point where either it is not perceived or its presence in an epenthetic syllable would represent such an auditory disparity with the original that deletion proves a better match. If the same asymmetry is operative in Thai and the final obstruent is not perceived, then only two cases remain in (32) where a word from the covert obstruent class takes a mid: *deuce* > [dī̄w] and *pence* > [pɛ̄n]. We

conclude that Gandour's observation of CVNT -> CVN with a H tone is a valid generalization. (See also Bickner 1986).

The loans with covert obstruents are obviously of some significance since if Gandour's interpretation is taken literally they represent a challenge to the position that loanword adaptation consists in finding the closest match between a loan and a phonotactically permissible output. The final obstruent cannot be included in a legitimate coda and is elided. But yet it still controls the tone. This phenomenon bears a strong resemblance to derivational opacity, which is modeled well by grammatical input-output mappings. These data raise two questions. First, is the generalization psychologically real? Second, if it is, on what basis is the H tone assigned? Does tone assignment refer to the deleted obstruent or to some other property of the English syllable (e.g. duration)? Before addressing these questions we will review our findings for the remainder of the corpus.

5.2 *Polysyllables*

In multisyllable loans, the tone assigned to nonfinal (unstressed) syllables is again a function of the syllable structure: it is H if the coda is an obstruent and M otherwise. This assignment has no exceptions and is identical to rules operating on monosyllables (29, 30)-- putting aside the small number of monosyllables in L. It is in the tone of the final (stressed) syllable of the multi-syllabic loan that we find intriguing differences. Gandour (1979) noted that a final live syllable tends to show a fall if the stress in the English source is penultimate (more generally nonfinal). Our findings confirm this trend.

First of all, smooth syllables that correspond to English oxytones (final stress) overwhelmingly have mid tone (29 examples with M vs. 6 with F).

(33)

E	T	E	T
domain	dōomēen	bazaar	bāasâa
canoe	khēɛnnūu	café	khāafê̌e
cartoon	kāatūun	chateau	chāatôo
compile	khɔ̄mpāaj	cigar	sî?kâa
chimpanzee	chīmpēɛnsīi	guitar	kīitâa
chlorine	khlōorīin	buffet	búpfê̌e
cocaine	khōokhēen		

Second nonfinal stress in the English source disproportionally correlates with a F on the final syllable of the Thai loan terminating in a live syllable. Our corpus contains 222 items with this tonal correspondence; the remaining 85 take M. This difference is statistically significant (2-tail: 2.57).

(34)

E	T	E	T
apple	ɛ́ppə̂n	alloy	ānlɔ̄ɔj
agency	ēecēnsî̌i	baron	bāarɔ̄n
action	ɛ́kchân	barrel	bāarēw

arrow	ɛ̄ɛrôo	capsule	khɛ́psūun
auto	ɔ̄ɔtôo		
bible	bāibɛ̂n		
brewery	brīwwə̄ərî̌i		
broker	bróokkə̂ə		

We follow Gandour in assuming that the stressed syllable of English is associated with an F0 peak (in citation pronunciations) followed by a fall to a L boundary tone, as sketched below.

(35) English '□ □ □
| |
H L
\ |
Thai □ □ '□

In Thai loanword adaptation the peak is shifted to the final (stressed) syllable. The examples with M tone such as *baron* > [bāarə̄n] represent cases where the peak is not shifted (presumably because the English F0 was not perceived or given a tonal interpretation) and thus follow the default M assignment for a live syllable. Stressed syllables and F0 peaks have a natural affinity both in loanword adaptation (Kenstowicz 2004) and of course in synchronic phonology (see de Lacy (2002) as well as Li (2003) for recent discussion, the latter based on examples from several Asian languages). Thus phonologically speaking the shift of the peak depicted in (35) has ample precedent.[7]

Turning to polysyllables terminating in an obstruent, we find three tonal outcomes for the final syllable. In order of frequency they are L (75), H (24), and F (15).

(36)

	E	T
a.	booklet	búklèt
	trumpet	thrāmpèt
	tulip	thīwlì̀p
	united	jūunājtèt
	pilot	phājlɔ̀t
b.	tennis	thēnní̀t
	donut	dōonát
	bonus	bōonát
	calculus	khɛ̄ɛwkhūulát
c.	billiards	bīnliât
	make up	méekʔâp

The examples with a final fall (36c) presumably reflect the shift of the peak sketched in (35) above. Curiously in many of these cases the vowel nucleus is short and thus the

native Thai phonotactic constraint banning F on a short dead syllable is not obeyed. Presumably it is for this reason these adaptations are in the minority. The cases in (36b) represent the situation in which the F0 contour of the original is either not perceived or not equated with a Thai tone, leaving the default rule to step in and assign a H to the final dead syllable. Alternatively, they can be analyzed as cases where the peak H is parsed at the expense of the terminal L. The words with final L (36a) represent examples in which the terminal portion of the F0 contour of the English source is parsed but the shift of the peak is blocked--presumably to avoid a F on a dead syllable with a short vowel nucleus.

The adaptations in (36) can be modeled in terms of constraints that ban the F0 peak on a syllable with weaker stress (Peak-to-Stress) and the interplay of Max-H and Max-L which demand preservation of the two tones comprising the English F0 contour in the Thai output with the constraint of Thai grammar that bans a F on a short dead syllable. We illustrate with the evaluations assigned to a generic penultimately stressed English word of the shape *CaaCat* (37). We assume all candidates satisfy the undominated Peak-to-Stress. Depending on the ranking (statistically determined) one of the three candidates depicted emerges as the output.

(37)

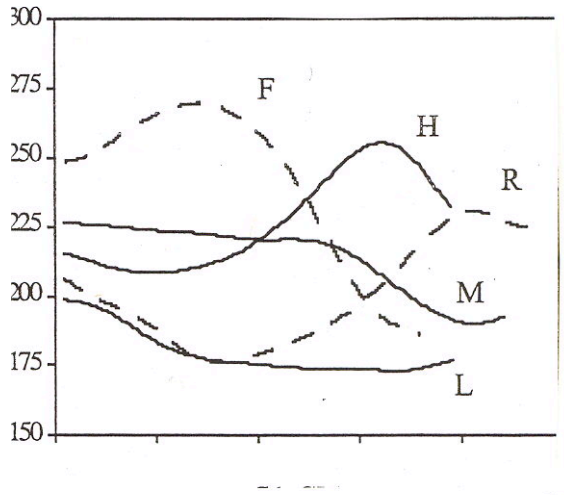
/CáaCàt/	*CVˆC	Max-H	Max-L
CaaCât	*		
CaaCát			*
CaaCàt		*	

5.3 *Interpretation*

Stepping back from the details, one of our most striking findings is that F is not found on monosyllables. Evidently to the Thai ear the falling F0 contour on the E word *team* lacks the scooped rise plus fall that characterizes the Thai falling tone in citation form. The recent study of Morén and Zsiga (2004) reports that the Thai F actually rises or stays H until beginning of second mora when it sharply descends. This finding accords with the previous literature. The Thai M has a much more gradual decline that starts at the beginning of the first mora. Representative pitch tracks from one of Morén and Zsiga's subjects are reproduced below.

(38)

(38)



Exemplar pitch contours for five contrastive tones in citation form (Morén and Zsiga, 2004)

The F0 contour on the citation form of an English CV(R) monosyllable such as *team* typically lacks the initial rise and sharp fall that characterize the Thai F and so it is perhaps not too surprising that this contour is not equated with the Thai F. What is less clear is whether the gradual descent of the Thai M is singled out as a positive match (correspondent) for the English contour or rather is selected as a default given that the English contour does not sufficiently approximate any Thai tonal category but yet every Thai syllable must be assigned some tone. We are inclined to the latter interpretation but experimentation is required to determine the similarity in the F0 contours of the two languages and their perceptual correlates.

The emergence of default accent patterns in the face of a failure to identify English F0 contours with native accents has been documented before. Shinohara (1997, 2000) showed that the default antepenultimate accent of Japanese is assigned to French loans. See also Kubozono (2004). Kenstowicz and Sohn (2001) document a default penultimate accent in Northern Kyungsang Korean loans from English.

The loanword evidence thus suggests that the equations live syllable = mid tone and dead syllable = high tone are default patterns for Thai. We are not aware of any evidence internal to Thai tonology that would suggest such a connection though Haas (1956:26) and Peyasantiwong (1986:220) call attention to a fast speech rule whereby an unstressed syllable loses its glottal stop with the result that underlying H and L tones turn to mid: [thaʔlēe] ≈ [thālēe] 'sea', [bùʔřii] ≈ [būřii] 'cigar, cigarette, [kùʔlàap] ≈ [kùlàap] 'rose', [pháʔnān] ≈ [phānān] 'gamble'. However, this is a fast speech rule and so its connection to the rule operative in loans is not so clear.

Putting aside the question of the origin of the live syllable = mid tone and dead syllable = high tone equations with respect to Thai grammar, we can ask whether these

tonal assignments have a natural phonetic basis. One possibly relevant factor is the observation by Henderson (1962) that the final unexploded stops of Thai are accompanied by secondary closure at the glottis to ensure no perceptible off-glide when the oral stop is released. She also notes that both the high tone and the falling tone are accompanied by glottal constriction before pause. More importantly, "the mid tone is not accompanied by a glottal constriction of any kind at the end" (p. 416). It is well known that laryngealization on consonants can affect the F0 contour of adjacent vowels and give rise to tonal distinctions. For example, Kingston (2003) proposes that the H vs. L reflex of a Proto-Athabaskan glottalized coda reflects two different phonetic realizations of the glottalization--a stiffening vs. a slackening of the vocal folds. Noting that coda obstruents are accompanied by a glottal closure in Thai, Morén and Zsiga (2004) postulate a constraint requiring the coda of a dead syllable to project a L tone. This constraint bars a default M from being inserted and helps to account for the otherwise puzzling absence of the default M on dead syllables in native Thai grammar. If this analysis is correct and if the default H on dead syllables in loans is still properly connected to glottalization in the Thai coda then the laryngealization in loans would have to be [+stiff vf] while that in native grammar [-stiff vf]. We noted earlier that the final syllable of loans is augmented by vowel lengthening rather than by glottalization--the native language repair. It is thus at least possible that the adaptation of a word-final obstruent could also differ from the native grammar in terms of the type of laryngealization that is imposed. Phonetic testing will be required to (dis)confirm this hypothesis.

The literature on Thai phonology contains another observation on the connection between the high tone of dead syllables and laryngealization. Haas (1952) describes a taboo governing the speech of Thai students studying in the United States (in the 1940's and 1950's) in which they avoided using Thai words that bear a phonetic resemblance to English obscene words. Among the words she cited are *fàk* 'sheath, (bean-)pod', *fák* 'to hatch', and *phrík* 'chili pepper'. Of particular relevance here is Haas' discussion of the tabooed *khán* 'to crush, squeeze out'. She notes that there are other words with the same phonemic sequence but different tones that are not taboo: *khān* 'to itch', and *khǎn* 'to be funny'. "But it is only the word having the high tone that bears, to the Thai ear, a strong resemblance to the English tabooed word" [p. 359]. Haas goes on to offer an explanation that English words ending in a stop are borrowed into Thai with a H and notes that H on a syllable lacking a final stop is accompanied by glottal stricture prepausally. "The Thai ear equates the final stop of the English word with the glottal stricture of the Thai word; hence the English word, as pronounced in English, sounds like the Thai word *khán*, whereas *khān* and *khǎn* do not". While one may question the assertion of a direct connection between the English final stop and Thai glottal stricture, the example clearly points to the correlation observed earlier between the covert obstruent class and H tone.

6. A Tonal Experiment

In order to test whether the connection between the covert obstruent and the H tone noted by Haas (1952), Gandour (1979, and by our data in (30) represents a linguistically significant one in the mind of the Thai speaker we conducted an experiment. A battery of CVN and CVNT nonsense syllables were recorded by a native English speaker. [8] Each such English nonsense syllable was paired with a Thai "loan" adapted by the second

author in accord with the sound correspondences found in our corpus. The Thai loan took the form CVN but systematically differed as to M vs. H tone. These nonsense syllables were combined into an A-X-B stimulus where X is the English "word" and A and B are the Thai "loans" with M or H tone. For example, English [bæm] was paired with Thai [bám] and [bām]. Stimuli were chosen to avoid overlap with existing Thai words. The stimuli were counterbalanced for H and M tone in the A and B positions and presented aurally over head-phones to ten native Thai subjects who were required to choose between the A vs. B Thai loan in terms of which sounded closest to the English word.[9] The subjects responded by clicking a box labeled A or B on the computer screen. They were permitted to replay the stimuli. But once a choice was made they were passed on to the next stimulus. The English stimuli consisted of syllables formed from the four short English vowels [i], [u], [ɛ] and [æ] followed by [m], [n], [ŋ] codas for the "live" syllable category and corresponding CVNT (T = [p], [t], or [k]) for the "dead" syllable category. Onset consonants were drawn from the set [b, d, f, g, h, k, l, s, ʃ, t, w]. (See Appendix for the complete list of English stimuli). There were a total of 36 CVN and 36 matching CVNT syllables. These 72 items were intermingled and presented to each subject in randomized order in two blocks with a short break in between. Four subjects completed the two blocks once for 144 responses. Five subjects completed the two blocks twice for 288 responses each. And one subject completed a single block just once for 72 responses. The overall results are presented in the following table. The differences between the two variables H vs. M tone and CVN vs. CVNT syllables type is highly significant by the Fisher's Exact Test.

(39)

	H	M
CVN	202	842
CVNT	593	451

It is thus clear that Thai subjects discern a difference between the CVN vs. CVNT English words and correlate it with the tone of the Thai correspondences in a fashion that replicates the tonal assignments found in the loans in our corpus as well as in the previous literature.

The next question is what could be the basis of the distinction? In deciding between a M and a H tone do Thai speakers refer to the presence or absence of the stop directly or could they be attending to differences in the VN portion of syllable rhyme of the English stimulus that reflect the English stop in terms of rules of English phonology/phonetics presumably unknown to the Thai speaker? One obvious correlate is rhyme duration. The voiced portion of the English syllable rhyme is significantly longer in the CVN than in the CVNT syllables. So one reasonable hypothesis is that the shorter rime in the English CVNT syllables correlates with a difference in the F0 contours of these nonsense syllables that Thai speaker attends to in deciding whether to categorize the stimulus as H or M. Some reasonable differences could be the height of the peak (higher in CVNT stimuli) or the extent of the fall between the peak and the F0 terminus (smaller in the short rhyme CVNT syllables and hence more likely to be categorized as H than M). A third possibility is that there was a difference in the location of the peak

within the syllable rime. Remembering that the Thai M exhibits a gradual decline while the H peak is delayed in (38), might there be a correlation between the subjects' H vs. M response and the relative location of the peak in the E stimulus?

An analysis of the data found no correlation between the amount of pitch drop in the English stimulus and the Thai subjects' H vs. M response. Nor was there any correlation between the maximum pitch attained in the stimulus and the H vs. M response. Finally, for both the CVN and CVNT syllables the maximum F0 value was at the very beginning of the syllable rhyme.

It thus appears that the H vs. M categorization is not dependent on any obvious differences in the F0 contour in the English stimuli. The only significant difference we found was within the class of CVNT stimuli. The number of H responses for CVŋk stimuli was significantly higher than for CVmp ones. When we looked at an estimate of the burst energy for the stop within the entire CVNT class we found a good fit with the number of H responses: the greater the burst energy the larger the number of H responses. This finding suggests that Thai speaker decides between the H vs. M tone on the basis of whether or not the stimulus is perceived to terminate in a stop, the salience of the burst being the major cue. This in turn looks like solid support for the tonal assignment based on the rule dead syllable = high tone originally proposed by Gandour (1979).

Another point worth mentioning is that our subjects were much more confident in assigning CVN stimuli to the M class than they were in assigning CVNT stimuli to the H class. This is apparent in the ratios of tonal response: 80% vs. 20% M for the CVN syllables in comparison to 60% vs. 40% H for the CVNT syllables. It also shows up in the number replays of the A-X-B stimulus the subjects made before deciding their answer: CVNT vs. CVN were replayed on a 3 to 2 ratio. In terms of the experimental task there were two competing representations that could serve as the basis for tonal assignment in the CVNT stimuli: the input English stimuli with a final stop that calls for the H response (dead syllable) and the output CVN (live syllable) which calls for a M response. The CVN stimuli had a consistent shape at both levels of representation. This difference can be modeled directly in an OT grammar on the basis of faithfulness to the English source or to the surface Thai output. But if adaptation proceeds on the basis of an automatic parse of the stimulus in terms of the Thai CVC syllable template then it is unclear how to account for the tonal difference.

7. Summary and Conclusion

This paper reported some of the major results from an analysis of an 800-word corpus of loanwords from English into Thai and their bearing on models of loanword adaptation in the current theoretical literature. The first section reviewed the adaptation of consonants lacking a counterpart in the Thai phonemic inventory. Adaptations such as ʃ -> *ch* and *v* -> *w* made more sense when viewed from the perspective of auditory similarity rather than proximity in articulator-based feature geometry or shared natural classes. On the other hand, the adaptation of the interdentals as dental rather than the auditorily more similar labio-dental seemed to be based on articulatory grounds. It was speculated that visual information may override auditory factors.

The next section reviewed the mapping of English voiceless-voiced stops to the Thai three-way aspirated, voiceless, voiced series. The consistent assignment of English

word-initial voiceless stops to the aspirate category suggests that the Thai adapter is trying to achieve a match with English surface phonetics and hence that the details of phonetic realization play a role in adaptation. But the fact that certain details are overlooked (e.g. partially voiced stops in initial position) indicates that some abstraction over the surface phonetics also occurs. It was speculated that salient contexts in which phonetic distinctions are more reliable in the source set the standard for normalization.

The next section discussed adaptation to Thai prosodic structure in which the final syllable of the citation form bears a major stress and is required to be a heavy syllable. Well-established alignment constraints and avoidance of prominence on weak vowels implied truncation rather than epenthesis as the appropriate repair. It was also noted that loanword adaptation invoked a novel repair of vowel lengthening as opposed to glottalization found in the native grammar. We suggested that a modeling in terms of OT Output-Output Correspondence constraints provides an adequate interpretation.

The final topic was the assignment of a tone to the loanwords. Our corpus allowed us to confirm the tonal assignments discovered by Gandour (1979). The data suggest that no direct correspondence is drawn between English F0 contours and Thai tonal categories. For the most part tone is assigned in terms of two default rules: syllables terminating in a sonorant take M and syllables terminating in an obstruent take H. It was shown that the latter rule is sensitive to a covert obstruent that is not realized in the loan. A phonetic experiment in which listeners were required to choose between M vs. H tonal assignments for CVN and CVNT corroborated the reality of these rules.

Footnotes

*This paper was read at the 12 Manchester Phonology Conference, Manchester University, May 2004. We are grateful to our reviewers Curtis Rice and Moira Yip as well as to Arthur Abramson, François Dell, and Jackson Gandour for comments and criticisms.

[1] These loans are cited without tone marks by Panlay (1997:85). The second author of this paper assigns *líit* and *fútbàat*.

[2] Thanks to Andrew Nevins for help in running these calculations.

[3] See Yip (this volume) for similar observations on the relevance of the visual modality. However, she reports (based on Hung and Man 2004 and p.c.) that English /θ/ is loaned as /f/ in Cantonese as in *thin* -> [fɪn].

[4] Shin and Davis (2003) report cases of English loans into Korean where the initial voiced stop is realized as tense in the face of intervocalic lax (phonetically voiced) adaptations such as *dollar* -> [t'alla], *bar* -> [p'a]. However, as they show this is paralleled by a more general shift of word-initial lax stops to tense that affects the Korean lexicon as a whole--both native and loans.

[5] In Korean native vocabulary the ban against release features in the syllable coda is repaired by suppression of the release node (leading to massive neutralization) while in loans release features are preserved by epenthesis: cf. [nac^h-ɨl] 'face' acc. but [nat] 'face' citation form vs. E *coach* > [k^{h}oc^{h}i]. The same asymmetry holds for clusters. Underlying /talk/ 'chicken' (cf. [talk-ɨl] acc.) is realized as [tak] citation form while English *belt* is adapted with epenthesis as [peltɨ].

[6] A similar phenomenon occurs in Cantonese loans from English. Yip (1993:274) cites *copy* -> $k^{h}ap^{55}p^{h}i^{35}$ and *letter* -> $let^{55}tha^{35}$. When consonant gemination would lead to an illicit coda such as [s] then vowel lengthening occurs instead: *commission* -> $k^{h}am^{35}mi{:}^{55}sön^{35}$.
[7] There is nothing abnormal about a H-L tonal sequence in native Thai vocabulary (cf. *náampàa* 'forest flood'). The shift of the peak only occurs in loanword adaptation--a retreat to the unmarked in the sense of Kenstowicz (2005); see Steriade (2004) for other examples of emergence of the unmarked in loanword adaptation. Since tone in English loanwords has minimal value as a lexical contrast, it is not surprising that markedness factors like alignment of the F0 peak with metrical prominence step in to shape the loan.
[8] Thanks to Seth Cable for help in constructing these stimuli.
[9] Before the experiment began the subjects were given some examples of English loanwords into Thai and told that the study was designed to test their reactions to English loans in connection with choosing brand names for new products on the Thai market.

Appendix

Stimuli for experiment

CVN	CVNT
bæm	bæmp
bɛŋ	bɛŋk
bim	bimp
dɛm	dɛmp
fɛŋ	fɛŋk
fim	fimp
fum	fump
gɛm	gɛmp
gɛn	gɛnt
giŋ	giŋk
hæn	hænt
hɛn	hɛnt
hiŋ	hiŋk
kæŋ	kæŋk
kuŋ	kuŋk
læn	lænt
lun	lunt
meŋ	mɛŋk
min	mint
næm	næmp
næn	nænt
nɛm	nɛmp

nɛŋ	nɛŋk
nim	nimp
nuŋ	nuŋk
sæn	sænt
sɛm	sɛmp
ʃæn	ʃænt
ʃɛn	ʃɛnt
sim	simp
sin	sint
tæm	tæmp
tɛŋ	tɛŋk
wæn	wænt
wæŋ	wæŋk
wɛŋ	wɛŋk

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