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Interlanguage coda production of Hmong second language learners of English

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INTERLANGUAGE CODA PRODUCTION OF HMONG SECOND LANGUAGE LEARNERS OF ENGLISH

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This thesis, submitted by Renae L. Caneday in partial fulfillment of the requirements for the Degree of Master of Arts from the University of North Dakota, has been read by the Faculty Advisory Committee under whom work has been done and is hereby approved.

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This thesis meets the standards for appearance, conforms to the style and format requirements of the Graduate School of the University of North Dakota, and is hereby approved.

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To my Grandmother
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ABSTRACT

This paper reports on Hmong speakers' acquisition of English in children ages 9 and 12 on final voiced and voiceless consonants and consonant clusters, none of which occur in Hmong codas except /ŋ/. The learners' production patterns were considered using an Optimality Theory account to understand the conflict between the learner's first language constraints and the learner's target language constraints. The main findings of this study are that the Hmong language and the English language constraints interacted in an ordered fashion allowing predictable patterns in production. The final consonants and consonant clusters were often deleted or changed by the intermediate Hmong speakers of English, because they have not completely resolved the conflict of what they know in their native language with what they are learning in the English language. This experiment observes the stages of coda development in the production of the intermediate Hmong speakers of English as a second language.

CHAPTER 1

INTRODUCTION

One of the issues in second language acquisition is how learners acquire the phonology (sound system) of the target language in light of the differences between languages. These differences include what sounds there are and how sounds can cluster. It has been observed that target language clusters are often simplified by second language learners. While consonant cluster reduction has been well researched (Bernhardt and Stemberger 1998; Gnanadesikan 1996; Ingram 1989, etc.), previous studies have mainly focused on reduction in word-initial position. Few studies have explored the phenomenon of reduction in word-final position. Furthermore, research that was conducted in the early 1990's and before used non-linear theoretic frameworks that did not allow for the full range of variant productions observed in L2 learners. Therefore, the purpose of this paper is to define and understand the production of syllable final consonants and clusters by Hmong children (ages 9 and 12) learning English using a constraint-based theory.

In the Hmong language, the only final coda allowed is the nasal /ŋ/. It is reasonable to assume that Hmong speakers learning English will have difficulty producing coda consonants and consonant clusters in English. A Hmong speaker may completely delete the coda or substitute one coda with another. For example, the voiced stop /d/ in syllable-final position in the word *bad* [bæd] may be completely deleted resulting in [bæ], or it

may be substituted with a voiceless stop /t/, resulting in [bæt]. Alternatively, Hmong speakers learning English may insert a vowel (usually a schwa) at the end of word, producing [bædə] with no closed syllables. These three changes that may occur during the production of English (substitution, deletion, and insertion) show that the learners still prefer the syllable structure of their first language.

According to Avery and Ehrlich (1992), this should not be surprising when you consider that English speakers deal with many final clusters in the same way. For example, consider the italicized words (1) and (2).

1) *Last one* out please close the window. Phonetically: [læs wʌn…]

2) The sweater was *hand-made*. Phonetically: […hæn mejd]

The words in italics contain final clusters which are usually simplified by native English speakers (Avery and Ehrlich 1992:59). Hmong learners of English may simplify both final consonants and final consonant clusters more extensively, leading to misunderstanding or incomprehensibility.

Citing many researchers, White (2003:19) asserts that research in the late 1960's and 1970's "pointed out that the language of second language (L2) learners is systematic and that learner errors are not random mistakes but evidence of rule-governed behavior" (Adjemian 1976; Corder 1967; Nemser 1971; Selinker 1972). This claim led to the idea that L2 learners have an internalized mental grammar or "interlanguage." The term "interlanguage" was first proposed by Selinker in 1972. An interlanguage is a system of rules said to develop in the mind of someone learning a foreign language (L2), which is intermediate between L1 and L2 (Selinker 1972).

1.1 Contrastive Analysis

Traditionally, applied linguists have compared the first language with the target language by doing a contrastive analysis of the two languages. A contrastive analysis is a detailed structure-by-structure comparison of the phonological, morphological, syntactic and cultural systems of two languages for the purpose of discovering similarities and differences. One goal is to predict what will be easy or difficult for the learner and then to exploit this prediction for the purpose of curriculum development/pedagogy (Lado 1957). The data from a contrastive analysis can also help in the process of anticipation of possible error production for the L2 learner.

Knoebel (1986:2) made predictions regarding Hmong production of word-final obstruents in English on the basis of a contrastive analysis completed by Smalley (1976) and Jarkey (1985). For example, the voiced obstruents /b/, /g/, /z/, and /ʤ/ occur in Hmong but only as allophones (variants of phonemes). Because of this, Hmong learners may not be consistent in their pronunciation of such English phonemes (Knoebel 1986:4). Another example based on the contrastive analysis is that all the Hmong consonant phonemes, except /ŋ/, only occur in word-initial position, so it is predicted that Hmong learners of English will have difficulty in producing the closed syllable since it does not occur in Hmong, except /ŋ/. CA also predicts that deletion of the final consonant is more likely to occur than is syllable-final vowel epenthesis, since multisyllabic words are uncommon in the Hmong language (Knoebel 1986:3).

Many of the errors in Knoebel's data, however, were not accounted for by any one hypothesis or clear-cut hierarchy (Knoebel 1986:44). For example, the Final-Weakening Hypothesis did not hold up well in Knoebel's study because when weakening or deletion

occurred, it occurred not because the segment was strong or weak, but rather because it was less optimal for some other reason. The Final-Weakening Hypothesis (Hyman 1975) claims that there is a kind of weakening process found in final position which includes devoicing, change from labial to dental position, change from dental to velar, velar to glottal, and total deletion. Final weakening in Knoebel's study was realized as general deletions of final consonants, which Knoebel (1986:44) states "could be due to language transfer or, attention paid to speech paradigm, to a more universal tendency toward syllable simplification." As previously stated, in Knoebel's study, no one hierarchy or process was proven to be the primary influence on the production of codas by Hmong learners of English. Since the focus of the contrastive analysis hypothesis is on the differences between the first language (L1) and the target language (L2), it has been less helpful for studies done on interlanguage phonology (Carlisle 1994).

1.2 Optimality Theory

Recent studies (e.g. Hancin-Bhatt and Bhatt 1997, 2000; Broselow et al., 1998) have "demonstrated the utility of using [Optimality Theory] OT for understanding interlanguage grammar development, especially in accounting for areas of L2 phonological acquisition that were impervious to earlier theoretical accounts" (Hancin-Bhatt 2000:202). OT is a linguistic theory that was first developed in the early 1990s (McCarthy and Prince 1994, 1995; Prince and Smolensky 1993). The theory has been extremely influential in the area of phonology and more recently has been used to account for acquisition facts. OT does not appeal to rules or processes like other linguistic theories; instead it appeals to interactions between constraints to explain

language patterns. The two main sets of interacting constraints are markedness constraints and faithfulness constraints. Faithfulness constraints require that the input and output representations are identical. Markedness constraints require that the output representation be unmarked in structure. Markedness generally refers to the complexity of a representation; unmarked features are the more basic representations. One example of this in English would be the form [kæts] 'cats,' which comes from the input /kætz/. Faithfulness constraints would require the output to be [kætz], since that is identical to the input. Opposed to this, there is a markedness constraint which would require that [z] cannot follow [t]. In English, the markedness constraint is more important than faithfulness. Therefore, the output is [kæts], not [kætz].

In OT, all constraints are universal giving language learners full access to all constraints. The constraints are ranked relative to each other within a particular language. Each language reflects a different set of constraint rankings. Although all languages have the same set of constraints, the higher ranking constraints play a more important role in the language. According to Hancin-Bhatt (2000:202), recent OT-L2 phonology studies have been able to account not only for accuracy/error rates, but also error types in syllable structure, as well as learners' asymmetric behavior with complex onsets versus complex codas.

The basic syllable structure of the Hmong language is C(C)V(V)(ŋ), which allows for the syllables CV, CCV, CVV, CCVV and CVŋ. Sequences such as VC, CVCC, etc., never occur in the Hmong language, unlike in the English language. In other words, both languages have markedness constraints restricting codas, but these constraints are more important in Hmong than they are in English. This markedness constraint is called

NOCODA, that is, syllables must not have codas. Because NOCODA is low-ranking in English, many codas are allowed in English. In Hmong, on the other hand, NOCODA is high ranking, allowing only the coda /ŋ/[1]. Hmong learners of English need to learn to violate this high-ranking constraint found in their first language in order to become fluent speakers of English.

A study conducted by Barbara Hancin-Bhatt (2000:228) was able to account for the entire range of codas produced by Thai learners of English using an Optimality Theory framework. The study used eleven Thai learners of English. When the Thai learners of English encountered non-Thai simple codas, the subjects were more likely to substitute the unfamiliar sound with a known sound than to delete it or add a vowel to take the segment out of coda position. The substitutions were not erratic, but systematic. The data reflected the native Thai constraint rankings because of the fact that incorrect simplifications of complex codas were often produced. The findings using the data from Hancin-Bhatt's study show that markedness constraints against single codas are violated sooner than markedness constraints against clusters, that is, single codas are allowed before clusters are allowed. The important finding "is that OT provides for an explicit definition of the stages of L2 phonological development" (Hancin-Bhatt, 2000:229). Hancin-Bhatt, citing Broselow (1998), states that the constraint rankings within an interlanguage grammar consists of the following: the native language ranking, which account for 'erroneous' productions due to full transfer; a hypothesized target language

[1] There must be an even more highly ranked constraint NO DELETE /ŋ/ to account for the fact that /ŋ/ codas are allowed.

ranking, which accounts for accurate productions; as well as re-rankings between the native and target rankings, which account for 'erroneous' productions that do not have an obvious link to the native or target grammar.

1.2.1 Input Representations

In addition to the issues of constraint ranking, it is also necessary to determine what the input forms are for each word. It is not easy to define what the 'input' or the underlying representation is for L2 words. In second language studies it is impossible to know exactly what the subjects used as input because of perceptual factors. It is difficult to know whether an error produced is due to perception or production.

Hancin-Bhatt (2000) claims one reason why the liquids were more likely to be deleted was because they were not 'heard' in the input. A coda identification task was used to determine whether or not Thai speakers do, in fact, have difficulty hearing liquids in coda position. The results indicated that subjects did not hear the liquid in the coda position in a significant number of items.

In spite of the fact that sometimes errors may be due to perceptual factors, there is good evidence that errors mainly occur because of production problems, that is, that the input does indeed have the coda segments that are frequently deleted.

As the ELL (English Language Learner) teacher of the Hmong students who took part in this study, I have three arguments that their mental representations are the same as the English forms. First, if the students were given a picture related to the word *hot* and a picture related to the word *hop*, the students are able to recognize the difference between the two words when heard and can point to the correct picture, even if they pronounce both as [hɑ]. This indicates their mental representations of the two words are not the

same. Second, in this study when a word ending with /p/ was to be repeated by the students the /p/ was usually produced. This also indicates their mental representation includes a /p/ in the coda. Finally, if the students produce the word *hopping*, the /p/ would not be deleted because the /p/ would syllabify as the onset of the second syllable. This also shows that their mental representation has a /p/. In this study, then, I assume that the input forms contain codas identical to the English surface forms unless there is clear evidence to the contrary. In some cases I will indicate that an error could be accounted for in terms of perceptual problems, but I will also show, whenever possible, how it could be accounted for as a production error using Optimality Theory.

1.2.2 Intra-speaker Variability

Optimality Theory assumes a dynamic constraint ranking during acquisition which explains why accurate and inaccurate responses can be produced by the same speaker. OT does not assume discrete categories of interlanguage stages. Rather, it allows us to define the interlanguage states in terms of constraint rankings and to show that those states are dynamic: learners can and do move back and forth, depending in part on the complexity of the task at hand (Hancin-Bhatt 1997).

According to Barlow and Gierut (1999), one way to account for situations in which a learner produces a given word in different ways is to organize the constraints into strata in which they are equally, rather than hierarchically ranked (Demuth 1997; Tesar and Smolensky 1998). This allows different outputs as different constraints are applied to the same input. That is, on one occasion one constraint is applied in the production of a target word while on another occasion, an alternate co-ranked constraint may be crucial to the same word. This then yields different outputs. According to Demuth (1997),

"Multiple optimal outputs are not random articulatory events but are principled phonologically constrained forms, each of which is optimal given a certain ranking of constraints."

1.3 Sonority Hierarchy

One constraint which has been proposed as a significant factor in the interlanguage development of the learners is based on the Sonority Hierarchy. Crosslinguistic research on syllable structure shows that higher sonority consonants are preferred in coda position (Clements 1990).

3) Sonority Hierarchy (Ladefoged 1982)

-sonorant +sonorant

Stops > Affricates > Fricatives > Nasals > Liquids > Glides

According to Ohala (1999), children learning different languages tend to reduce the same types of clusters to the same type of singleton consonant. For example, a final /sk/ cluster as in *tusk* should be reduced to [s] and not [k] because fricatives are more sonorous than stops and will provide a minimal sonority descent (Ohala 1999:403). Other researchers have also reported that the nature of omission is usually independent of the native language spoken by the child (e.g. Ingram 1989; Locke 1983). This suggests that typical error patterns regarding syllable coda production are not solely based on the learner's first language. In recent studies, other factors have been able to account for the development of phonological patterning. The Sonority Principle (Clements 1990; Steriade 1983) meets the qualifications for explaining why children particularly omit one particular type of consonant and not another.

Ohala (1999) conducted two studies on consonant cluster reduction in children with normal language development and based her hypothesis on the Sonority Principle. Predictions were made that clusters would be reduced "to whichever consonant would result in the least complex syllable as defined by sonority." More specifically relating to this study, Ohala predicted that final clusters would be reduced to whichever consonant produced a minimal sonority descent. The Sonority Principle is mainly concerned with simplicity of the syllable in which the cluster is contained. Both of Ohala's studies supported the Sonority Principle on consonant reduction. More evidence was given to the claim that the SP can be applied on a cluster-to-cluster basis. Most critical to this study, according to Ohala (1999), is that the "SP predicts differential production of the same consonant depending on the type of cluster within which the consonant is contained." For example, the fricative /s/ should in one case be omitted and in another case be retained, depending on whether it occurs in an initial fricative-stop cluster (omitted) or in an initial fricative-nasal cluster (retained) (Ohala 1999:402). Ohala also highlights the relationship between cross-linguistically attested patterns in adult language and early child data. Her studies demonstrate that both children's cluster reduction and adult patterns mirror cross-linguistically preferred syllable shapes as defined by the Sonority Principle.

1.4 Basic consonant differences between Hmong and English

The following is a table of English and Hmong consonants. The consonants that are italicized are found in syllable initial position in the Hmong language.

Table 1: Hmong and English consonants

	Bilabial	Labio-dental	Dental	Alveolar	Post-alveolar	Retroflex	Palatal	Velar	Glottal
stop	*p*, b			*t, d*				*k*, g	
nasal	*m*			*n*				*ŋ*	
fricative		*f, v*	θ, ð	*s, z*	*ʃ, ʒ*				*h*
approximant	w					ɹ	j	(w)	
lateral app.				*l*					
affricate					ʧ, ʤ				

Some of the consonant sounds in Hmong are very similar to those found in English. For example, the consonants /p/, /m/, /f/, /h/, and /l/ in Hmong sound very much like their English equivalents. Other sounds are somewhat different. For example, Hmong has a /t/ that to an English speaker sounds sometimes like a /t/ and sometimes like a /d/. Other consonants in Hmong have no equivalent in English, an example is /n̥/ as in *hnab*[2] 'bag'. The many consonants in Hmong that do not resemble any consonants in English were not placed in the table above. The Hmong language, however, does not have these phonemes /b/, /g/, /θ/, /ð/, /ɹ/, /j/, /w/, /ʧ/, or /ʤ/ anywhere in the language, so it is expected that these phonemes would be difficult for a learner to produce.

Problems with coda production are not due to the fact that Hmong speakers cannot produce the English consonants, since Hmong speakers can produce many of the consonants in the onset. There are other factors that attribute to the production of codas. In particular, a child acquiring the phonology of English (or any other language) must learn items of the lexicon and also the relative rankings of universal constraints as pertains to that language (Prince and Smolensky 1993; Seidenberg 1997). The Hmong

[2] The Hmong word is written in Hmong orthography. The sequence *hn* represents a voiceless nasal, and the final *b* represents the tone.

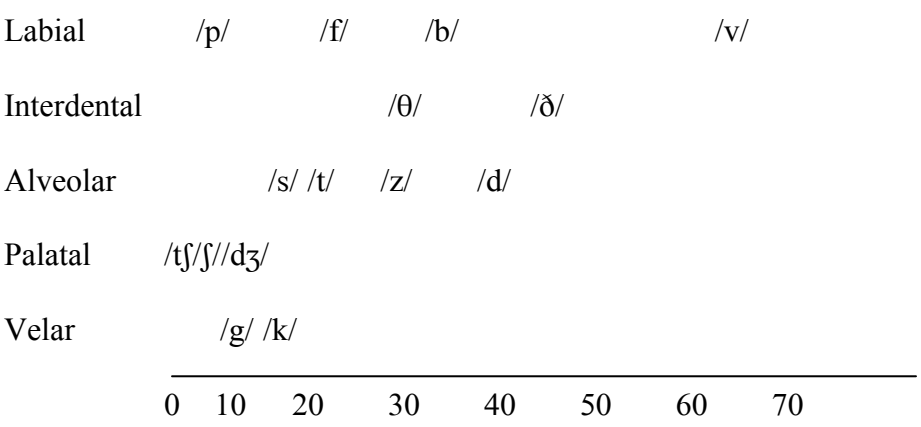
speakers need to learn the coda constraints that pertain to English.

1.5 Knoebel's study on Hmong coda production in English

In this section, a report on work by Knoebel (1986) concerning Hmong adult productions of English codas will be described. Knoebel examined ten Hmong adult learners of English as a second language. The adult learners ranged from twenty-four years of age to fifty-five years of age. The learners were considered to be at a low level of proficiency in spoken English, having an average of two years of English studies. The learners individually completed three tasks in which they produced word-final obstruents in English. The focal point of Knoebel's (1986:31) analysis and discussion was on one of these tasks. The results of this task will be discussed.

Through a contrastive analysis of the Hmong and English phonemes, Knoebel chose to examine these final obstruents: /b/, /p/, /d/, /t/, /g/, /k/, /v/, /f/, /ð/, /θ/, /z/, /s/, /ʃ/, /ʤ/, and /ʧ/. She also examined the following final clusters containing nasals and sibilants: /nd/, /nt/, nts/, /ŋk/, /kst/, /ks/, /ts/, /st/, and /ðz/. The common error patterns shown in the analysis of Knoebel's study are categorized according to deletion, change in place and/or manner of articulation, voicing change, consonant insertion, vowel insertion, and nasalized vowel. Deletion occurred in twenty-one percent of all production attempts. The diagram below, showing these deletions, is taken from Knoebel (1986:63).

Deletions in Knoebel's Study



Voiced final obstruents were deleted twice as many times as voiceless final obstruents. The voiced labiodental fricative /v/ was deleted sixty-three percent of the time and was deleted more often than any other final segment. The voiceless labiodental fricative /f/ was deleted only twenty percent during the tasks. The voiced bilabial stop /b/ was deleted in thirty-four percent of all cases and the voiceless bilabial stop /p/ was only deleted five percent of the time. The voiced bilabial stop /b/ was deleted more than the voiced velar stop /g/. If the voiced velar stop /g/ was not deleted, it usually underwent devoicing.

Voicing changes were the least noticeable difference between the final obstruents; however, if voice change took place, devoicing of voiced obstruents occurred more than voicing of voiceless obstruents. Forty-six percent of all voiced segments were devoiced and only three percent of voiceless segments became voiced.

Forty-two percent of all production attempts resulted in manner of articulation change. Nine percent of the changes were in labiodentals and fifteen percent of the changes were in alveolar fricatives. The manner changes usually resulted in stops, not

fricatives. The result of stops over fricatives was mainly due to tested interdental fricatives. When stops changed in manner of articulation, the change usually resulted in a fricative (seventy-four percent into a sibilant) more often than in an affricate, so there seemed to be a preference for fricatives over stops. Voiced palatal affricates were rarely deleted but often changed in manner or place of articulation.

Place of articulation changes resulted primarily in alveolars, glottals and labials. Fifty percent of all interdentals, which caused the most difficulty, were substituted with an alveolar or labial. Labial fricatives changed thirteen percent of the time and alveolars changed fourteen percent of the time. Place changes occurred most frequently with alveolars, then glottals, then labials, then velars, palatals, and dentals. Knoebel (1986:34) states that it is quite possible that some dentals may have been incorrectly perceived as alveolars during transcription.

Consonant insertion was rare in the production of closed syllables, but when consonant insertion occurred, the inserted consonants seemed to usually be alveolars. According to the data, this was not statistically significant (Knoebel 1986). When open syllables were produced as closed syllables, alveolar stops and fricatives were the result.

Alveolar fricatives and palatals had a higher percentage of accurate productions than other final segments. This was consistent across all ten subjects.

Table 2: Correct production of phonemes

Target Phoneme	b	p	d	t	g	k	v	f	ð	θ	z	s	ʃ	ʤ	tʃ
# of Target Responses	44	60	60	60	60	60	60	60	16	60	60	60	60	36	60
% Correct	2	72	10	58	23	57	10	58	0	7	8	65	93	3	100

The voiceless labiodental fricative /f/ was correct fifty-eight percent of the time and the voiceless alveolar sibilant /s/ was correct sixty-five percent of the time. The voiceless interdental fricative /θ/ was only accurately produced in seven percent of all occurrences.

The consonant clusters used in Knoebel's study contained either a sibilant or a nasal. They formed part of either two-segment consonant clusters or three-segment clusters. The sibilants were usually bound morpheme suffixes attached to already closed-syllable words. When deletion occurred within a consonant cluster containing a sibilant, the sibilant always remained. However, when the cluster consisted of a nasal and a sibilant, the nasal was always preserved. Partial deletion of consonant clusters occurred ninety-one percent of the time overall as shown in Table 3.

Table 3: Consonants remaining after partial deletion of clusters (#)

Consonant Clusters Affected	z	s	st	n	ŋ
nd	—	—	—	2	—
nts	—	1	—	6	—
ŋk	—	—	—	—	1
kst	—	1	7	—	—
ks	—	3	—	—	—
ts	—	9	—	—	—
st	—	4	—	—	—
ðz	1	—	—	—	—

Knoebel (1986:37) asserts, "When subject groups are compared, it can be seen that the number of correct responses given by those subjects who had studied English the longest

was significantly greater than the number of segments correctly produced by the subject who had studied English for only one year and had only been in the United States for eighteen months."

1.6 Summary and hypothesis for testing

The hypothesis being tested in this study is that errors produced by 9-12 year old Hmong children who speak English at an intermediate level can be accounted for by differences in the importance of the constraints related to coda production in English and Hmong. That is, this study will give insights using OT as a theoretical framework for understanding L2 interlanguage development of Hmong speakers regarding L2 syllable coda production.

The methodology of the study will be presented in Chapter 2. The results of the study will be shown in Chapter 3. The discussion of the data collected will be revealed in Chapter 4 followed by a conclusion in Chapter 5.

CHAPTER 2

METHODOLOGY

The research I undertook involved looking at the production of coda consonants and coda consonant clusters produced by 9-12 year old Hmong children who speak English at the intermediate level to see if the speech innovations that occurred could be explained using Optimality Theory. In section 2.1, the targeted coda consonants and consonant clusters are listed. In section 2.2, the tasks that were used for this study are explained. Section 2.3 gives a profile of the subjects chosen for this study. The final section 2.4, gives detail on the transcriptions that were made.

2.1 Target coda consonants

The words targeted in this study contain both words ending in consonant clusters and words ending in a single consonant. The targeted codas were chosen to find error patterns in the complex coda production and the simple coda production.

2.1.1 Singleton Consonants

The singleton consonants consisted of liquids, stops, fricatives, nasals, and sibilants to correspond with elements of the final clusters. The following segments are found in the Hmong language but only in word-initial position. I specifically listened for the final consonant phoneme.

Phoneme	Targeted words used in the study	
p	‘mop’	‘top’
d	‘mad’	‘glad’
f	‘cliff’	‘sniff’
v	‘five’	‘dive’
m	‘lamb’	‘ham’
n	‘run’	‘men’
l	‘roll’	‘tall’

The next set of segments in English also occur in the Hmong language. However, the phonemes /b/, /t/, and /z/ are only used as allophones.

b	‘cob’	‘job’
t	‘sit’	‘hit’
z	‘size’	‘prize’

In the following two words, I listened for the final /w/. The /w/ sound is found in Hmong as a vowel making a sound similar to the off-glide in *houses* (Smalley, 1990)

w	‘cow’	‘wow’

The phones in the last set of simple codas are not used in the Hmong language.

s	‘class’	‘gas’
r	‘more’	‘sore’

2.1.2 Target consonant clusters of two consonants beginning with a liquid

Seven words chosen for this study contain final consonant clusters beginning with a liquid. Since consonant clusters in Hmong never occur with an initial liquid, so all of the clusters given below are not found anywhere in the Hmong language. The Hmong /r/ is a

stop rather than a liquid and may sound like the English /t/, while unaspirated /r/ may sound like the English /d/. The liquid may not be a prominent sound to the listener in coda position because of the phonological constraints in Hmong. I specifically listened for the final consonant clusters in the words listed below.

Liquid + stop (3)

lp	'help'	'pulp'
lt	'melt'	'built'
rp	'harp'	'tarp'

Liquid + fricative (4)

lf	'elf'	'shelf'
lv	'shelve'	'twelve'
rf	'scarf'	'turf'
rs	'force'	'horse'

Liquid + liquid (1)

rl	'girl'	'curl'

2.1.3 Target Consonant Clusters of Three Consonants Beginning with a Liquid

This second set of final clusters beginning with a liquid consisted of final consonant clusters of three consonants. These words were chosen specifically because the liquid is not an allowable coda in Hmong.

Liquid + stop + fricative (1)

lts	'malts'

Liquid + fricative + stop (1)

rst	'first'	'worst'

Liquid + liquid + stop (1)

rld	‘world’	‘curled’

2.1.4 Target Consonant Clusters Beginning with a Stop

The next three final consonant clusters begin with a stop. The first and second clusters of two consonants begin with a stop and end with a sibilant. The third cluster begins with a stop, followed by a fricative and ending with a stop. All three of these clusters are not found anywhere in the Hmong language.

Stop + fricative (2)

ps	‘maps’	‘taps’
ts	‘cats’	

Stop + fricative+ stop (1)

kst	‘next’	‘text’

2.1.5 Other target consonant clusters of two consonants

For this study, I also chose three clusters beginning with a nasal and two beginning with a fricative. The consonant clusters /nt/ and /nd/ do occur in Hmong but only as prenasalized stops. These two sounds only occur in onset position in Hmong. I listened for the nasal-initial final consonant clusters in the six words given below.

Nasal + stop (3)

nt	‘pant’	‘rent’
nd	‘hand’	‘lend’
mp	‘jump’	‘bump’

The last consonant clusters have initial fricatives. These clusters were chosen since there are no clusters or segments similar to them in the Hmong language. I listened for

the final consonant clusters in the words given below.

Fricative + stop (2)

ft	'lift'	'gift'
sp	'gasp'	'wasp'

2.2 Tasks

The eleven subjects performed two tasks. The first task was used to measure what codas the subjects could produce using English words in a set framework. The second task was also used to measure what codas the subjects could produce using natural sentences in English. In task 1, the students listened to the target word in the set frame 'Say____now,' and in task 2, the students listened to the target word in a natural English sentence. The students then repeated the utterance that they heard. The students' responses were recorded. Both tasks were given to each student individually in a quiet testing room to reduce background noise. The two tasks took approximately 15 -20 minutes to complete and were given in the order mentioned above.

2.2.1 Task #1: Word Production Exercise

The Word Production Exercise consists of thirty-one monosyllabic words that the students listened to in the framework of 'Say___now.' The students then repeated what they heard. The thirty-one words in frames were repeated twice giving a total of sixty-two responses. Of the thirty-one words, each word had a different word ending. Three of the words ended in a consonant cluster of three segments, fifteen of the words ended in a consonant cluster of two segments, and thirteen of the words ended with a simple coda. The exercise was divided into five groups with each group having a cross-section of coda

syllables. Each group of words was repeated in a random order. The first set consisted of these seven words. The two columns show the two different orders given for production.

Say *lend* now.	Say *mop* now.
Say *mop* now.	Say *lift* now.
Say *pant* now.	Say *lend* now.
Say *wow* now.	Say *pant* now.
Say *melt* now.	Say *five* now.
Say *roll* now.	Say *roll* now.
Say *five* now.	Say *melt* now.

The second set consisted of these seven words.

Say *cob* now.	Say *curl* now.
Say *more* now.	Say *elf* now.
Say *elf* now.	Say *sniff* now.
Say *curl* now.	Say *run* now.
Say *maps* now.	Say *cob* now.
Say *run* now.	Say *maps* now.
Say *sniff* now.	Say *more* now.

The third group consisted of these eight words.

Say *sit* now.	Say *class* now.
Say *ham* now.	Say *size* now.
Say *class* now.	Say *mad* now.
Say *gasp* now.	Say *help* now.

Say *cats* now. Say *gasp* now.

Say *help* now. Say *ham* now.

Say *mad* now. Say *sit* now.

Say *size* now. Say *cats* now.

The fourth group consisted of these four words.

Say *force* now. Say *harp* now.

Say *harp* now. Say *force* now.

Say *jump* now. Say *first* now.

Say *first* now. Say *jump* now.

The fifth group consisted of these four words.

Say *shelve* now. Say *next* now.

Say *turf* now. Say *shelve* now.

Say *next* now. Say *curled* now.

Say *curled* now. Say *turf* now.

The complete list of words used in the Word Production Exercise can be found in Appendix A.

2.2.2 Task #2: Sentence Production Exercise

The Sentence Production Exercise includes a total of thirty-one sentences. The targeted words used in the sentences are not the same words as in the Word Production Exercise. The targeted words in the sentences do, however, contain the same simple and complex codas. The targeted words were placed in the middle of the sentence to ensure an accurate pronunciation. Also, the word following the target word always began with a consonant to ensure clear pronunciation. In this task, the sentences are only said once,

not repeated twice as in the Word Production Exercise. The list of sentences used in the Sentence Production Exercise is shown below in the order in which they were presented to the students.

I had two *malts* for lunch.

Don't *bump* your head.

Jim is a *tall* man.

I have a *gift* for you.

I have a *sore* knee.

I *hit* the ball.

He will *dive* from the side.

The *wasp* flew away.

He *taps* his pencil.

The *horse* ran fast.

The *world* looks big.

I have the *worst* cold.

The *men* sat down.

The *cow* made noise.

The *lamb* stood still.

The *scarf* matches your coat.

The *girl* walked home.

I have *twelve* sisters.

He *built* model cars.

I am *glad* he is here.

The *shelf* fell over.

The *text* looks long.

You can win the *prize* box.

The *gas* made us sick.

The *pulp* tastes bad.

We need the *tarp* now.

She *ran* to the top floor.

The *cliff* looks steep.

My *job* makes me happy.

I pay *rent* next month.

Your *hand* looks small.

2.2.3 Recording

A female speaker of Midwestern American English recorded both sets of stimuli onto a Sony ICD-P17 digital voice recorder. The recorded stimuli were then copied to an audio compact disc with five second pauses between the set frames in Task 1 and seven second pauses between each sentence in Task 2. The two tasks were piloted by a native English speaker prior to the actual testing of the eleven subjects. Many of the targeted words that contained the segment /s/ were difficult to distinguish due to the limited sound recording ability of the Sony ICD-P17 digital recorder. A modification was made to fix this problem. This modification also recorded the students' responses in the same way as in Task 1 and 2 as mentioned above. At the end of Task 1, the words containing the segment /s/ were then said orally by the researcher in the same set framework of 'Say___now'. A list of the following words that were repeated after each exercise is as

follows:

WORD PRODUCTION

Say *maps* now.	Say *maps* now.
Say *class* now.	Say *class* now.
Say *gasp* now.	Say *gasp* now.
Say *cats* now.	Say *cats* now.
Say *size* now.	Say *size* now.
Say *force* now.	Say *force* now.

Similarly, the same modification was used in Task 2 for the following sentences.

SENTENCE PRODUCTION

I had two *malts* for lunch.

The *wasp* flew away.

He *taps* his pencil.

The *text* looks long.

The *gas* made us sick.

The *cliff* looks steep.[3]

After performing these two tasks, subjects answered a few background questions regarding learning English as their second language, and soliciting information on what languages are spoken at home and how the subjects feel about learning English. The subjects' responses were also recorded onto the Sony ICD-P17 digital recorder.

[3] This sentence was included because the native speaker had difficulty understanding the word *steep*. In fact, this potential problem never affected the production of the target word; the target word was always produced correctly.

2.3 Subjects

The subjects chosen for this study were eleven native speakers of Hmong at a public elementary school in the Minneapolis, Minnesota area. The students were born in the United States of America and have been in a public elementary school since kindergarten. The students were currently enrolled in ELL (English Language Learning) classes for the academic school year 2003-2004. I chose eleven subjects who are speaking at a proficiency level of three or four. The English speaking levels 1-5 are used in the school district to measure a student's English speaking ability, where 1 represents no English speaking skills, 2 represents beginning English speaking skills, 3 represents intermediate English speaking skills, 4 represents high-intermediate English speaking skills, and 5 represents advanced native-like English speaking skills. Second language learners who are at a level one or two proficiency level can easily move to an intermediate level. Intermediate and high-intermediate speakers have a difficult task before them, before becoming advanced English speakers. One way to address this challenge is to have an understanding of the phonological constraints that affect the second language learning process. Second language learners need to be taught how to go against these constraints in order to become fluent speakers of English.

I chose to test 6 third grade students, age nine, and 5 sixth grade students, age twelve, to allow for a wider range of data. I chose these students to see if their age would be a factor in their production of codas. A profile of the Hmong speakers' and their English language learning experience can be found in Table 4.

Table 4: Profile of subjects

Subject	Sex	Age	Time in US	Begin English Service[4]	English Level	ELL Hours/ Day	Extra Tutoring	Special Services
1	Female	12	Born	1/18/2001	3	30 min.	None	None
2	Male	9	Born	1/18/2001	3	1 hour	20 min.	None
3	Female	9	Born	9/5/2000	4	1 hour	None	None
4	Female	9	Born	10/1/2003	4	1 hour	20 min.	None
5	Female	9	Born	9/1/2000	3	1 hour	None	None
6	Male	9	Born	10/1/2003	3	1 hour	20 min.	None
7	Male	12	Born	1/13/2003	3	30 min.	None	None
8	Female	12	Born	9/23/2003	3	30 min.	None	None
9	Male	12	Born	9/23/2003	4	30 min.	None	None
10	Female	12	Born	12/21/1999	4	30 min.	None	None
11	Female	9	Born	11/26/2001	3	1 hour	20 min.	None

2.4 Transcriptions

Four independent transcriptions were made of the subjects' recorded responses in Task 1 and Task 2. The first transcription involved note-taking while the subjects were being recorded during the exercises. The second and third transcriptions were done using a digital audio player on the computer that was hooked up to a Sony stereo system. The transcriptions were made while listening to the Sony stereo speakers. A second transcriber was consulted to ensure accurate results. For the final transcription headphones were used instead of stereo speakers. Results were then coded into six categories: Accurate, Substitution, Deletion, Metathesis, Nonreleased, and Epenthesis.

Each of the six error types was listened for in word-final position only. If the targeted word was *mop* [mɑp^{h}] and a subject produced *cop* [kɑp^{h}], then the word was

[4] The dates of the students' English service begin at the starting date of the students' qualification of ELL (English Language Learning) classes in the school district in which they are currently enrolled. There are no records of other English services that the students may have received prior to the current school's records of ELL classes.

counted as accurate. However, if the subject produced [mɑt^{h}], then the error would be accounted for as substitution of /t/ for /p/.

Deletions included when a subject would delete one final consonant, one final consonant in a cluster, or the entire final consonant cluster, for example [mɑp^{h}] said as [mɑ] or [lɪft^{h}] said as [lɪf] or [lɪt^{h}].

Metathesis included when a subject would produce a consonant cluster out of order such as [gæsp^{h}] said as [gæps].

Another error listened for were final voiceless consonant phonemes that were not released. Released voiceless consonants are marked by aspiration following the final consonant. In the transcription and analysis, the (native-like) release is normally not transcribed, only the lack of release is transcribed. A phoneme was considered nonreleased if a subject did not release the final phoneme. An example of this is: [mɑp^{h}] said as [mɑp̚].

If a consonant was added to a targeted word either in between a consonant cluster, before a single phoneme or cluster, or at the end of the final cluster or phoneme, it was considered a case of epenthesis, for example [gæsp^{h}] said as [gæsps]. If a vowel (usually a schwa) was added to the end of a final cluster or phoneme, it was also considered epenthesis, for example [mɑp^{h}] said as [mɑp^{h}ə].

Multiple errors were also listened for during the production of words. A multiple error could consist of a number of combinations such as substitution, deletion, and a consonant that is not released. An example of this would be [mɑlts] produced as [mɑo̰ʊ̯t̚].

CHAPTER 3

RESULTS

In this chapter, the results of the final singleton consonants and the final consonant clusters are reported. In section 3.1, the final singleton consonants are presented according to manner of articulation beginning with stops and ending with approximants. Then, in section 3.2, the final consonant clusters of two consonants beginning with a liquid are noted followed by section 3.3 on final clusters of three consonants beginning with a liquid. In section 3.4, final clusters of two and three consonants beginning with a stop are presented. The final section 3.5 gives an account for various other consonant clusters of two consonants. Three of the final clusters begin with a nasal and end with a stop, one cluster begins with a flat fricative and ends with a stop, and the final cluster begins with a sibilant and ends with a stop. There were no significant differences in the production of codas between the nine and twelve year old students. Therefore, I will be presenting the results for the subjects as a whole rather than by age group.

3.1 Final Singleton Consonants

In this section, I will summarize the results of the subjects' production of final singleton consonants. The final singleton consonants include /p/, /b/, /d/, /t/, /f/, /v/, /s/, /z/, /m/, /n/, /l/, /ɹ/, and /w/ and will be presented according to place and manner of articulation. The first part of the section will give the results for the bilabial stops /p/ and

/b/. Secondly, the results for the alveolar stops /d/ and /t/ will be displayed. Next, the labiodental fricative /v/, and then the alveolar sibilants /s/ and /z/ will be shown. The final labiodental fricative /f/ was produced 100% accurately and therefore will not be discussed. Also, the final sonorants /n/, /ɹ/, and /w/ were produced 100% accurately and therefore, the only sonorants discussed will be the bilabial nasal /m/ and the lateral approximant /l/.

The production of the final bilabial stop /p/ resulted in two different error patterns which are shown in the two tables below. If both responses made by a subject were identical, then a single entry is made such as 'p' as shown in Table 5 below. If the responses were not identical, two entries are listed, separated by '/' such as 'p/ps' as shown in Table 6 below.

Nine of the eleven subjects made the error of not releasing the final voiceless bilabial stop /p/ for one or both of the test cases as shown in Table 5.

Table 5: Realization of /p/: Nonrelease

Word	Subject 1	Subject 4	Subject 5	Subject 6	Subject 7	Subject 8	Subject 9	Subject 10	Subject 11
mop	p	p	p̚	p	p̚	p̚	p̚	p	p
top	p̚	p̚	p̚	p̚	p̚	p̚	p̚	p	p

As shown in Table 6, one of the subjects substituted a voiceless velar stop /k/ for the voiceless bilabial stop /p/. Another subject added a voiceless alveolar sibilant /s/ in absolute final position.

Table 6: Realization of /p/: Substitution and epenthesis

Word	Subject 2	Subject 3
mop	k^h	p/ps
top	p	p

The word *top* was produced accurately by both subjects.

Production of the bilabial stop /b/ resulted in three kinds of error patterns: releasing into a schwa, deletion, or not releasing the final stop /b/. The three tables below show which subjects made each error pattern. Table 7 gives the error patterns of Subjects 2, 3, 10 and 11.

Table 7: Realization of /b/: Release into a schwa

Word	Subject 2	Subject 3	Subject 10	Subject 11
cob	bᵊ	bᵊ	bᵊ	bᵊ
job	b	b	b	b

The final voiced bilabial stop /b/ was released into a schwa by four of the subjects. This only occurred in the targeted word *cob* which was used in the Word Production Task.

Table 8 shows the deletion errors made by Subjects 6 and 7 along with Subject 6 releasing into a schwa and Subject 7 not releasing the final /b/.

Table 8: Realization of /b/: Deletion, nonrelease, and release into a schwa

Word	Subject 6	Subject 7
cob	bᵊ	b̚
job	Ø	Ø

Subject 6 deleted the final voiced bilabial stop /b/ in the word *job*, but released the final /b/ into a schwa in both occurrences of the word *cob*. Subject 7 also deleted the final /b/ in the word *job*, but did not release the final /b/ at the end of the word *cob* in either occurrence.

The other five subjects either produced the final voiced bilabial stop /b/ accurately

or did not release the final stop /b/ as shown in Table 9 below.

Table 9: Realization of /b/: Nonrelease

Word	Subject 1	Subject 4	Subject 5	Subject 8	Subject 9
cob	b̚	b̚	b̚	b	b̚
job	b̚/b	b̚	b	b̚	b̚

Next, I will discuss the production of the voiced alveolar stop /d/ which resulted in the same error patterns as the final bilabial stop /b/: releasing into a schwa, deletion, and not releasing the final /d/. The tables are grouped according to the subjects' production patterns. Table 10 shows accurate productions made by Subjects 1, 2, 3, and 8. The other three subjects did not release the final /d/.

Table 10: Realization of /d/: Nonrelease

Word	Subject 1	Subject 2	Subject 3	Subject 4	Subject 6	Subject 8	Subject 9
mad	d	d	d	d̚	d	d	d̚
glad	d	d	d	d̚	d̚	d	d̚

Two of the subjects deleted the final voiced alveolar stop /d/ in one of the tasks and produced the final /d/ accurately in the other task.

Table 11: Realization of /d/: Deletion

Word	Subject 5	Subject 7
mad	d	Ø
glad	Ø	d

Table 12 shows accurate productions of the final /d/ and also shows the production of releasing into a schwa.

Table 12: Realization of /d/: Release into a schwa

Word	Subject 10	Subject 11
mad	dᵊ	dᵊ
glad	d	d

The last two subjects released the final voiced alveolar stop /d/ into a schwa during the

word production task.

The final voiceless alveolar stop /t/ which will be shown next, was either substituted with another consonant or was not fully released. Therefore, there are two tables to display the two error patterns made by the subjects. In Table 13, accurate productions of the final /t/ along with non-releases of the final /t/ are given.

Table 13: Realization of /t/: Nonrelease

Word	Subject 1	Subject 2	Subject 5	Subject 6	Subject 7	Subject 8	Subject 9	Subject 10	Subject 11
sit hit	t t̚	t t	t/t̚ t̚	t t	t̚ t̚	t t	t̚ t̚	t t̚	t t

The final voiceless alveolar stop /t/ was produced accurately by four of the subjects and was not released by five of the subjects.

Table 14 below shows two substitution errors.

Table 14: Realization of /t/: Substitution

Word	Subject 3	Subject 4
sit hit	tʃ t	ks t

The other two subjects substituted the voiceless alveolar stop /t/ with another final obstruent in the case of *sit*. Subject 3 substituted the voiceless stop /t/ with the voiceless palatal-alveolar sibilant /tʃ/. Subject 4 substituted the voiceless stop /t/ with the consonant cluster /ks/.

The final voiced labiodental fricative /v/ was accurately produced by nine out of eleven subjects. Two of the subjects deleted the final voiced fricative /v/ as shown in the table below.

Table 15: Realization of /v/: Deletion

Word	Subject 7	Subject 9
five	Ø	v
dive	Ø	Ø

Subject 9 accurately produced the final /v/ during the word production task but deleted the final /v/ during the sentence production task. Subject 7 deleted the final /v/ in both test cases.

The final alveolar sibilant /s/ will be presented next. Shown below are two errors made by only two of the subjects regarding the final sibilant /s/. The errors made were substitution and addition shown in Table 16.

Table 16: Realization of /s/: Substitution and epenthesis

Word	Subject 2	Subject 6
class	st	f
gas	s	s

One of the subjects inserted a voiceless alveolar stop /t/ in absolute final position. Another subject substituted the voiceless alveolar sibilant /s/ with the voiceless labiodental fricative /f/. The other nine subjects produced the final /s/ accurately.

The alveolar sibilant /z/, presented next, was produced accurately by nearly all of the subjects. Table 17 shows a deletion error made by one of the subjects.

Table 17: Realization of /z/: Deletion

Word	Subject 7
size	Ø
prize	z

Subject 7 deleted the final voiced sibilant /z/ in *size* during the word production task.

The next part of this section on final singleton consonants deals with the final sonorant consonants. The most common production problem for the bilabial nasal /m/

was releasing into a schwa shown in Table 18.

Table 18: Realization of /m/: Release into a schwa

Word	Subject 1	Subject 3	Subject 8	Subject 9	Subject 10
ham	mᵊ	mᵊ	m	m	mᵊ
lamb	m	m	m	m	m

The voiced bilabial nasal /m/ was accurately produced by Subjects 8 and 9 and was released into a schwa or produced accurately by Subjects 1, 3, and 10 as shown above.

The production of the bilabial nasal /m/ also resulted in a number of other errors as shown in table 19.

Table 19: Realization of /m/: Substitution, epenthesis, and release into a schwa

Word	Subject2	Subject 4	Subject 5	Subject 6	Subject 7	Subject 10
ham	mᵊ	n	m	m	m	m
lamb	n	mp	nd	n	nd	mp

Six of the subjects made other errors such as substituting a voiced alveolar nasal /n/ for the voiced bilabial nasal /m/ or inserting a consonant in absolute final position following the nasal /m/. Subjects 2, 4 and 6 all substituted the voiced alveolar nasal /n/ for the voiced bilabial nasal /m/. Subjects 4 and 10 inserted a voiceless bilabial stop /p/ in absolute final position. Subjects 5 and 7 inserted a voiced alveolar stop /d/ in absolute final position and also substituted the voiced nasal /m/ with the voiced nasal /n/.

The last sonorant shown in the results is the voiced alveolar velarized lateral approximant /l/ shown in Table 20. The lateral approximant /l/ was either substituted with the glided vowel /oʊ̯/ or was completely deleted.

Table 20: Realization of /l/: Substitution and deletion

Word	Sbj 1	Sbj 3	Sbj 4	Sbj 5	Sbj 6	Sbj 7	Sbj 8	Sbj 9	Sb 10	Sb 11
roll	o͡u	o͡u	o͡u	o͡u	o͡u	o͡u	o͡u	o͡u	o͡u	o͡u
tall	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø

Ten out of the eleven subjects made the same errors of substitution or deletion.

One of the subjects made a different substitution error shown in Table 21.

Table 21: Realization of /l/: Substitution and deletion

Word	Subject 2
roll	d/o͡u
tall	Ø

In one occurrence, Subject 2 substituted the /l/ with the voiced alveolar stop /d/ in final position. Subject 2's results are given in the table above.

3.2 Final Consonant Clusters of Two Consonants Beginning with a Liquid

In this section, the results of the subjects' production of consonant clusters beginning with a liquid are presented. The final consonant clusters are organized into two groups. The first group of final liquid clusters begins with the lateral approximant /l/ followed by either a stop or a fricative (/lp/, /lt/, /lf/, /lv/). Also in this first group of liquids is the final liquid cluster /ɹl/. The second group of liquid clusters begins with the alveolar approximant /ɹ/ followed by either a stop or a fricative (/ɹp/, /ɹf/, /ɹs/).

I will begin this section with the first group mentioned above, that is, final consonant clusters including the lateral approximant /l/. The main findings with regard to these clusters have to do with substitutions by glided vowels as shown in the table below.

Table 22: Realization of final clusters containing /l/: Substitution

CC	Word	Subject 3	Subject 8	Subject 10
/lp/	help/pulp	o͡up	o͡up	o͡up
/lt/	melt/built	o͡ut	o͡ut	o͡ut
/lf/	shelf/elf	o͡uf	o͡uf	o͡uf
/lv/	twelve/shelve	o͡uv	o͡uv	o͡uv
/ɹl/	curl/girl	ɹo͡u	ɹo͡u	ɹo͡u

Substitution of the final approximant /l/ with the glided vowel /o͡u/ is the preferred repair for the final consonant clusters consisting of the lateral approximant /l/. Subjects 3, 8, and 10 all produced this common error pattern. These threes subjects also made this substitution in their other productions of final clusters containing /l/.

Other subjects produced forms that included substitution of the voiced alveolar velarized lateral approximant /l/ with the glided /o͡u/ along with non-released stops of the consonant in absolute final position.

Table 23: Realization of final clusters containing /l/: Nonrelease and Substitution

CC	Word	Subject 1	Subject 4	Subject 5	Subject 6	Subject 9
/lp/	help pulp	o͡up o͡up̚	o͡up o͡up̚	o͡up̚ o͡up	o͡up o͡up̚	o͡up̚ o͡up̚
/lt/	melt built	o͡uk o͡ut̚	o͡ut o͡ut	o͡ut̚ o͡ut	o͡ut̚ o͡ut̚	o͡ut̚ o͡ut̚
/lf/	shelf/elf	o͡uf	o͡uf	o͡uf	o͡uf	o͡uf
/lv/	twelve/shelve	o͡uv	o͡uv	o͡uv	o͡uv	o͡uv
/ɹl/	curl/girl	ɹo͡u	ɹo͡u	ɹo͡u	ɹo͡u	ɹo͡u

Subjects 1, 4, 5, 6, and 9 frequently produced non-released stops that follow the liquid /l/. Subject 9 did not release any of the stops following a liquid. Subject 6 usually did not release stops following the liquid /l/. Subject 4 usually released stops following a liquid. However, in the production of simple consonants, Subject 4 only released one of the final stops. Subjects 1 and 5 were inconsistent with releases of final stops following liquids. Subject one also substituted the final voiceless bilabial stop /p/ with the final voiceless

velar stop /k/.

Finally, three of the subjects occasionally deleted the /l/ in final clusters of LIQUID + STOP, and LIQUID + LIQUID. The majority of the errors produced were still the preferred error of substitution with an occasional non-released stop.

Table 24: Realization of final clusters containing /l/: Nonrelease, substitution and deletion

CC	Word	Subject 2	Subject 7	Subject 11
/lp/	help pulp	o͡up Øp	o͡up̚ Øp̚	o͡up̚ Øp
/lt/	melt built	o͡ut o͡ut̚	o͡ut o͡ut̚	o͡ut o͡ut
/lf/	shelf/elf	o͡uf	o͡uf	o͡uf
/lv/	twelve/shelve	o͡uv	o͡uv	o͡uv
/ɹl/	curl/girl	ɹo͡u	ɹo͡u	ɹØ

The production of consonant clusters beginning with a liquid for Subjects 2, 7, and 11 are show above. Subject 7 tended to not release final stops, while Subjects 2 and 11 usually did release the final stops. Subject 11 deleted the approximant /l/ in the final cluster /ɹl/. The three subjects above deleted the /l/ in the final cluster /lp/.

The final part of this section will present the results of consonant clusters beginning with the voiced alveolar approximant /ɹ/ followed by a stop, a fricative, or a sibilant. These final clusters do not include the lateral approximant /l/. Many of the productions of these consonant clusters were accurate as shown in Table 25.

Table 25: Realization of final clusters beginning with /ɹ/: Substitution

CC	Word	Subject 4	Subject 5	Subject 6	Subject 11
/ɹp/	harp/tarp	ɹp	ɹp	ɹp	ɹp
/ɹf/	scarf/turf	ɹf	ɹf	ɹf	ɹf
/ɹs/	force horse	ɹθ ɹs	ɹθ/ɹs ɹs	ɹθ ɹs	ɹθ ɹs

Four of the subjects produced all of the consonant clusters beginning with /ɹ/ accurately

except in the word *force*. These subjects substituted the voiceless interdental fricative/θ/ for the voiceless alveolar sibilant /s/, producing the word *fourth*. In the simple final consonant production, all four pronounced the final /s/ in *class* accurately. However, in one production of the word *class*, Subject 6 said *claf*, substituting the fricative /f/ for /s/.

The next four subjects rarely made any errors during the liquid coda production tasks. Table 26 shows the few errors of deletion, addition, and a non-released stop.

Table 26: Realization of final clusters beginning with /ɹ/: Deletion, epenthesis, and nonrelease

CC	Word	Subject 3	Subject 8	Subject 9	Subject 10
/ɹp/	harp	ɹp	ɹp	ɹp	ɹp
	tarp	ɹp	ɹp	ɹp˺	ɹp
/ɹf/	scarf	ɹf	ɹØ	ɹf	ɹf
	turf	ɹf	ɹf	ɹf	ɹf/ɹft
/ɹs/	force/horse	ɹs	ɹs	ɹs	ɹs

Subject 3 said everything accurately. The other 3 subjects only made one error during the test cases shown in Table 6. Subject 10 made an unusual error of adding the voiceless alveolar stop /t/ to the consonant cluster /ɹf/ producing /ɹft/. Subject 8 accurately produced most of the final consonant clusters but in one response deleted the final voiceless labiodental fricative /f/ in *scarf*.

The last three subjects made more than one error during the productions of consonant clusters beginning with the voiced alveolar approximant /ɹ/.

Table 27: Realization of final clusters beginning with /ɹ/: Deletion, substitution, epenthesis and nonrelease

CC	Word	Subject 1	Subject 2	Subject 7
/ɹp/	harp	ɹp	ɹp	ɹpˀ
	tarp	ɹpˀ	ɹp	ɹpˀ
/ɹf/	scarf	ɹf	ɹf	ɹf
	turf	ɹf	ɹf/ɹp	ɹf
/ɹs/	force	ɹs	ɹst/ ɹs	ɹs
	horse	ɹs	ɹs	ɹs

Two of the subjects made the common error of not releasing the final voiceless bilabial stop /p/. Subject 2 added the voiceless alveolar stop /t/ to *force* – producing *forst*. This subject also substituted the voiceless bilabial stop /p/ for the voiceless labiodental fricative /f/ in *turf* – producing *turp*.

Looking at the results of consonant clusters beginning with a liquid, overall nearly all of the subjects substituted the vowel glide /o̯u̯/ for the approximant /l/. The clusters including the voiced alveolar approximant /ɹ/ were mostly produced accurately, exhibiting only a few other uncommon errors.

3.3 Final Consonant Clusters of Three Consonants Beginning with a Liquid

In this section, the final consonant clusters of three consonants beginning with a liquid will be presented. The three cluster combinations are as follows:

- liquid + fricative + stop (/ɹst/)
- liquid + stop + fricative (/lts)
- liquid + liquid + stop (/ɹld/)

The final cluster /ɹst/ will be discussed first due to the few errors that were made. Then, the final clusters /lts/ and /ɹld/ will be presented together.

Almost half of the subjects produced the final consonant cluster /ɹst/ accurately.

The subjects' accurate responses are shown in the table below.

Table 28: Realization of /ɹst/: Accurate

Word	Subject 1	Subject 3	Subject 4	Subject 5	Subject 11
first/worst	ɹst	ɹst	ɹst	ɹst	ɹst

The other half of the subjects tended to delete the final voiceless alveolar stop /t/ in the word *worst* shown in Table 29.

Table 29: Realization of /ɹst/: Deletion

Word	Subject 2	Subject 6	Subject 7	Subject 8	Subject 9	Subject 10
first	ɹst	ɹst	ɹsØ	ɹst	ɹst	ɹst
worst	ɹsØ	ɹsØ	ɹsØ	ɹsØ	ɹsØ	ɹsØ

These subjects had no difficulty producing the beginning liquid or sibilant in the cluster /ɹst/. Subject 7 deleted the final /t/ in both production tasks. Subjects 2, 6, 8, 9, and 10 had no problem producing the word *first* accurately.

The next three tables give the errors for the final consonant clusters /lts/ and /ɹld/. The majority of the errors involved deleting the final voiced alveolar stop /d/ and substituting /o͡ʊ̯/ for /l/ as shown in Table 30.

Table 30: Realization of /lts/ and /ɹld/: Deletion and substitution

CCC	Word	Subject 2	Subject 3	Subject 4	Subject 10	Subject 11
/lts/	malts	o͡ʊ̯ts	o͡ʊ̯ts	o͡ʊ̯ts	o͡ʊ̯ts	o͡ʊ̯tØ
/ɹld/	world	ɹo͡ʊ̯Ø	ɹo͡ʊ̯d	ɹo͡ʊ̯Ø	ɹo͡ʊ̯Ø	ɹØ Ø
	curled	ɹo͡ʊ̯d	ɹo͡ʊ̯d	ɹo͡ʊ̯d	ɹo͡ʊ̯d	ɹØ Ø

Most of the subjects produced the voiced alveolar stop /d/ in the word *curled* but not in the word *world*. Subject 11 deleted the final voiceless alveolar sibilant /s/ in the cluster /lts/ and also deleted both the voiced alveolar velarized lateral approximant /l/ and the voiced alveolar stop /d/ in all responses of the cluster /ɹld/.

The subjects presented in Table 31 frequently deleted the final voiceless alveolar

sibilant /s/ and at the same time did not release the voiceless alveolar stop /t/ in the cluster /lts/.

Table 31: Realization of /lts/ and /ɹld/: Deletion, substitution, and nonrelease

CCC	Word	Subject 5	Subject 6	Subject 7	Subject 8	Subject 9
/lts/	malts	oʊ̯ɾ̚Ø	oʊ̯ɾ̚Ø	oʊ̯ɾ̚Ø	oʊ̯ɾ̚Ø	oʊ̯ɾ̚Ø
/ɹld/	world	ɹoʊ̯Ø	ɹoʊ̯Ø	ɹoʊ̯Ø	ɹoʊ̯Ø	ɹoʊ̯Ø
	curled	ɹoʊ̯Ø	ɹoʊ̯Ø	ɹoʊ̯Ø	ɹoʊ̯d	ɹoʊ̯d

These subjects also deleted the final voiced alveolar stop /d/ in the cluster /ɹld/ in at least one form. Subjects 8 and 9 however, produced the final stop /d/ in the word *curled*.

During the production of the codas /lts/ and /ɹld/, Subject 1 made multiple errors. These errors are shown in Table 32.

Table 32: Realization of /lts/ and /ɹld/: Deletion and substitution

CCC	Word	Subject 1
/lts/	malts	oʊ̯k^{h}Ø
/ɹld/	world	ɹoʊ̯Ø
	curled	ɹoʊ̯Ø

Subject 1 substituted a voiceless velar stop /k/ for the voiceless alveolar stop /t/ in the cluster /lts/ and also made the common error of substituting the glided vowel /oʊ̯/ for the voiced alveolar velarized lateral approximant /l/ in addition to deleting the final voiced alveolar stop /d/ in *world* and *curled*.

3.4 Final Consonant Clusters Beginning with a Stop

This section deals with the production of final consonant clusters beginning with a stop. Two of the clusters begin with a stop and end with a sibilant (/ps/ and /ts/) and one of the clusters is a cluster of three consonants beginning with a stop (/kst/). The two clusters beginning with a stop and ending with a sibilant will be presented first.

The majority of the subjects either produced the final cluster accurately or deleted the final voiceless alveolar sibilant /s/ segment in the words *maps*, *taps*, and *cats*. Table 33 gives the accurate production of /ps/ and /ts/.

Table 33: Realization of /ps/ and /ts/: Accurate

CC	Word	Subject 2	Subject 4	Subject 8	Subject 10
/ps/	maps/taps	ps	ps	ps	ps
/ts/	cats	ts	ts	ts	ts

These subjects made no errors on their production of final clusters beginning with voiceless stops /p/ and /t/ and ending with /s/.

Deletions of the final /s/ in the coda clusters /ps/ and /ts/ are shown in Table 34. Two of the subjects consistently deleted the final consonants during the production exercises.

Table 34: Realization of /ps/ and /ts/: Deletion

CC	Word	Subject 7	Subject 11
/ps/	maps/taps	pØ	pØ
/ts/	cats	tØ	tØ

The table above shows that Subjects 7 and 11 deleted the final voiceless alveolar sibilant /s/ in all of the productions of clusters of /ps/ and /ts/. Deletion is a common error for these two subjects in many of their productions of complex codas. Subject 7 also deleted many final consonant phonemes (/b/, /d/, /v/, /z/, and /l/) in responses to simplex codas.

The next three subjects were very inconsistent in their production of the sibilant /s/ when following a stop. Table 35 shows accurate productions of /ps/ and /ts/ and also shows deletion errors of the final /s/.

Table 35: Realization of /ps/ and /ts/: Deletion

CC	Word	Subject 3	Subject 6	Subject 9
/ps/	maps taps	pØ ps	ps pØ	ps pØ
/ts/	cats	ts	ts	ts

Subjects 6 and 9 both made the same error of deleting the final sibilant /s/ in *taps*. The targeted word *taps* was used in the Sentence Production Exercise which could be the cause for deletion. However, Subject 3 only deleted the final sibilant /s/ in *maps* which was given in the Word Production Exercise.

The last two subjects made a variety of different errors including substitution, deletion, and insertion. Both subjects were inconsistent in their production of the final sibilant /s/ shown in Table 36 below.

Table 36: Realization of /ps/ and /ts/: Deletion, substitution, and release into a schwa

CC	Word	Subject 1	Subject 5
/ps/	maps taps	pØ^{ə} pØ	ps pØ
/ts/	cats	ts	tØ

Subject 1 deleted the final /s/ in *maps* and also inserted a schwa producing [mæp^{ə}]. Subject 5 deleted the final sibilant /s/ in *taps* and *cats* producing [tæp] and [kæt]. Overall, the subjects either completely deleted the final sibilant /s/ in the consonant clusters beginning with a stop or produced the full consonant cluster accurately.

The last part of this section gives the results of the final cluster /kst/. A number of different errors were produced by the subjects. The errors are presented in three individual tables. The first table, Table 37, shows the deletions of the final /t/.

Table 37: Realization of /kst/: Deletion of /t/

Word	Subject 2	Subject 3	Subject 7	Subject 9	Subject 11
next	kst/ksØ	kst	ksØ	kst	ksØ
text	kst	kst	ksØ	ksØ	ksØ

The first group of subjects either responded accurately in their production of the final cluster /kst/, or they only deleted one of the consonants in the cluster.

This next table shows more than one consonant deletion in the cluster.

Table 38: Realization of /kst/: Deletion of /s/ and /t/

Word	Subject 1	Subject 4	Subject 5	Subject 6	Subject 8	Subject 10
next	kst/kØØ	ksØ/kØØ	kst/kØØ	kØØ/ksØ	kst/kØØ	kØØ/kst
text	ksØ	kst	kst	kst	kst	ksØ

These subjects tended to delete two of the consonants in the cluster /kst/. All six subjects deleted both the voiceless alveolar sibilant /s/ and the voiceless alveolar stop /t/ in one out of the two responses of the word *next*.

3.5 Other Consonant Clusters of Two Consonants

In this final section of the chapter, consonant clusters beginning with a nasal and ending with a stop will be given first (/mp/, /nt/, and /nd/) follwed by a presentation of two clusters beginning with a fricative and ending with a stop (/ft/, /sp/).

The results of the subjects' production of consonant clusters beginning with a nasal will be displayed in the following three tables following. The consistent errors made during the production of the clusters beginning with a nasal were deletion of the final stop or not releasing the final stop in the cluster.

Table 39: Realization of /mp/, /nt/, and /nd/: Deletion and nonrelease

CC	Word	Subj. 4	Subj. 5	Subj. 7	Subj. 8	Subj. 9	Subj. 10	Subj. 11
/mp/	jump	mp	mp	mp̚	mp	mp	mp	mp
	bump	Øp̚	mp̚	mp̚	mp	Øp̚	mp	Øp̚
/nt/	pant	nt	nt̚	nØ	nt	nØ	nt̚	nt
	rent	nt	nt	nØ	nt	nØ	nt	nt
/nd/	lend	nØ	nØ/nd	nØ	nd	nØ	nd	nd
	hand	nd	nØ	nØ	nØ	nØ	nØ	nØ

Subjects 4, 9 and 11 deleted the /m/ in the word *bump* but not in the word *jump*.

Table 40 below shows only the error of deleting the final stop in the cluster.

Table 40: Realization of /mp/, /nt/, and /nd/: Deletion

CC	Word	Subject 1	Subject 6
/mp/	jump	mp	mp
	bump	mp	mp
/nt/	pant	nt	nt
	rent	nØ	nt
/nd/	lend	nd	nØ/nd
	hand	nØ	nØ

Two of the subjects released all of the final stops, only producing the error of deletion. However, both of the subjects made deletions inconsistently.

The final two subjects, as shown in Table 41, produced all the consonant clusters beginning with a nasal and ending with a stop accurately.

Table 41: Realization of /mp/, /nt/, and /nd/: Accurate

CC	Word	Subject 2	Subject 3
/mp/	jump/bump	mp	mp
/nt/	pant/rent	nt	nt
/nd/	lend/hand	nd	nd

The last portion of this section is divided into two parts. The first part gives the results of the cluster /ft/ and the second part gives the results of the cluster /sp/. The cluster /ft/ followed by the cluster /sp/ will be shown in the next three tables.

Deletion is a common error for stops following a fricative. This is shown in Table

42.

Table 42: Realization of /ft/: Deletion

Word	Subject 1	Subject 4	Subject 6	Subject 7	Subject 9
lift/gift	fØ	fØ	fØ	fØ	fØ

These five subjects deleted the final voiceless alveolar stop /t/ in all productions of the targeted words *lift* and *gift*. Most of these subjects did not delete the final stops during the production of simple consonants.

In Table 43, the following three subjects substituted another two-consonant cluster for the final cluster /ft/.

Table 43: Realization of /ft/: Deletion and substitution

Word	Subject 2	Subject 3	Subject 11
lift	ft/st	st	st
gift	fØ	ft	fØ

Subjects 2, 3, and 11 substituted /st/ for /ft/ in the word *lift*, but not in the word *gift*. Subjects 2 and 11 however, deleted the final stop /t/ in the word *gift*.

The last three subjects shown in Table 21 did not make any substitution errors, only deletion errors were made.

Table 44: Realization of /ft/: Deletion

Word	Subject 5	Subject 8	Subject 10
lift	ft	ft	ft
gift	fØ	ft	fØ

Most responses were produced accurately except for two, deleting the final voiceless alveolar stop /t/ in *gift*.

Lastly, the results for the cluster /sp/ are displayed in three separate tables showing accuracy, substitution, deletion, and metathesis. Three subjects produced the final

consonant cluster /sp/ accurately on all attempts as shown in Table 45.

Table 45: Realization of /sp/: Accurate

Word	Subject 3	Subject 6	Subject 11
gasp/wasp	sp	sp	sp

The next three subjects often deleted either the sibilant /s/ or the stop /p/ in the cluster /sp/. These deletions are shown in Table 46.

Table 46: Realization of /sp/: Deletion and nonrelease

Word	Subject 1	Subject 4	Subject 8
gasp wasp	sp/Øp Øp	sp sØ	sp̚ Øp̚

Subject 8 consistently did not release the final /p/ in all responses.

The last table shows a variety of errors that were uncommon among the subjects in the production of the final cluster /sp/.

Table 47: Realization of /sp/: Deletion, epenthesis, substitution, metathesis, and nonrelease

Word	Subject 2	Subject 5	Subject 7	Subject 9	Subject 10
gasp wasp	sps/spt sp	sp fØ	Øp fØ	sp̚ fØ	ps tØ

Interestingly, Subjects 5, 7, and 9 deleted the final voiceless bilabial stop /p/ in the word *wasp* and also substituted the voiceless alveolar sibilant /s/ with the voiceless labiodental fricative /f/. Subject 10 made a similar error but substituted the sibilant /s/ with the voiceless alveolar stop /t/. Subjects 10 metathesized the consonant cluster/sp/ in the word *gasp*, changing it to *gaps*. Subject 2 inserted the sibilant /s/ after the cluster /sp/ in one occurrence and inserted the stop /t/ after the cluster /sp/ in another occurrence.

CHAPTER 4

DISCUSSION

In this chapter, I will present an analysis of the final consonant codas produced by Hmong children learning English as a second language. In section 4.1, the final voiced segments are discussed, followed by section 4.2 which discusses the final voiceless segments. Final segments /m/ and /n/ are presented in section 4.3 followed by section 4.4 which discusses the final singleton /l/. The next two sections 4.5 and 4.6, give an analysis of the final clusters of two and three consonants beginning with a liquid. In section 4.7, the final clusters of two and three consonants beginning with a stop are discussed. In section 4.8, an account is given of various other two-consonant clusters. Finally, in section 4.9 a short summary of the analysis is given.

4.1 Voiced Segment /b/, /d/, /v/, and /z/

The voiced labiodental fricative /v/ was deleted in 6 out of 33 responses. Deletion of the voiceless bilabial stop /b/ occurred 4 times out of 33 responses, and the deletion of /d/ occurred 3 times out of 33 responses. The voiced alveolar sibilant /z/ was deleted only once. It is notable that all of these segments are voiced segments. When deletion occurred, it only occurred with voiced segments; voiceless segments, which will be discussed later, were not deleted, but changed in manner or place of articulation. Broselow and Xu (2004) state that learners whose native language has no obstruents in

coda position are often more successful in producing voiceless obstruent codas in the target language, even though both structures are equally new to the learner. Voiced stops seem to be the most difficult for the learners to produce as a coda.

One explanation for the deletion of voiced segments is due to the highly ranked constraint in the Hmong language that does not allow codas. We can call this constraint NOCODA.[5] Both English and Hmong contain the constraint NOCODA, but in English it is less important than a faithfulness constraint NO DELETION which blocks the deletion of codas. In Hmong, on the other hand, it is more important than NO DELETION. Therefore, Hmong speakers will delete a coda in order to satisfy the constraint against codas. The symbol > means 'more important than.'

1) NOCODA > NO DELETION

Deletion of the voiced segments, as in [ʤɑ] for *job*, reflects the constraint rankings in the Hmong language being applied in the interlanguage because the constraint NO DELETION was violated.

The voiced bilabial stops /b/ and /m/, and to a lesser degree the voiced alveolar stop /d/ were frequently released into a schwa. The release into a schwa was only common in task 1, where the target word appeared in the frame 'Say ___ now.' For example, *cob* was sometimes produced as [kʰɑbᵊ]. This is probably due to the fact that there is an intonation break after the target word, which results in a favorable environment for a release. Even the speaker on the CD, to whom the students were copying, released into a

[5] The constraints that will be discussed have been proposed by others, with more formal names, but I will use nonformal names to help readers who are not familiar with Optimality Theory literature.

schwa. However, in the sentence task there is no intonation break after the target words, so it is less likely that a schwa would be inserted. Instead, other changes were more likely to occur. In Hmong, NOCODA is more important than either NO DELETION or NO EPENTHESIS as shown in (2).

2) NOCODA > NO EPENTHESIS, NO DELETION

In English, on the other hand, both NO EPENTHESIS and NO DELETION are more important than NOCODA in careful speech, resulting in [k^hɑb]. When a Hmong learner pronounces *cob* as [k^hɑ] the Hmong order NOCODA > NO DELETION is being applied in the interlanguage; when a Hmong learner pronounces it as [k^hɑb^ə], the Hmong order NOCODA > NO EPENTHESIS is being applied in the interlanguage. There is no evidence in Hmong for the relative ranking of NO EPENTHESIS and NO DELETION, since no input in Hmong ends in any consonant other than /ŋ/. Because of this, when Hmong speakers encounter an English word like [k^hɑb], they have two options. One is to rank NO EPENTHESIS higher than NO DELETION and delete the [b]. The other is to rank NO DELETION higher than NO EPENTHESIS and release into a schwa. Even a given speaker can switch between the two strategies, resulting in different types of errors.

4.2 Voiceless segments /p/, /t/, /s/, and /f/

In both Knoebel's investigation and in this study, learners make far fewer errors with voiceless obstruents than with voiced obstruents. This can be accounted for if the learners have a constraint NO DELETE VOICELESS that is ranked higher than the NOCODA constraint in the interlanguage. The presence of NO DELETE VOICELESS means that the original constraint NO DELETION was too general. Instead, it is made

up of two constraints: NO DELETE VOICELESS and NO DELETE VOICED. In the Hmong language, NOCODA is higher than both NO DELETE VOICED and NO DELETE VOICELESS. So the ranking in Hmong is NOCODA > NO DELETE VOICELESS, NO EPENTHESIS, NO DELETE VOICED. Since NOCODA always disallows most codas, we cannot tell the ranking between the lower-ranked contstraints. In English, on the other hand, the ranking is NO DELETE VOICELESS, NO EPENTHESIS, NO DELETE VOICED > NOCODA. That is, it is most important to keep the underlying coda. In the interlanguage, speakers have learned to re-rank the constraint NO DELETE VOICELESS as more important than NOCODA, but vary the ranking between NO DELETE VOICED and NOCODA. Given the order NO DELETE VOICELESS > NOCODA > NO DELETE VOICED, we get no deletion of voiceless codas and deletion of voiced codas; given the order NO DELETE VOICELESS, NO DELETE VOICED > NOCODA, neither coda deletes. The variability of responses indicates a variability of ranking among constraints. Voiceless obstruents in the coda are universally less marked than voiced obstruents in the coda. That is, there seem to be markedness constraints that favor voiceless codas. If the constraint NO DELETE VOICELESS is universally more important than NO DELETE VOICED, we can explain why these students never deleted the voiceless codas, but sometimes deleted the voiced codas.

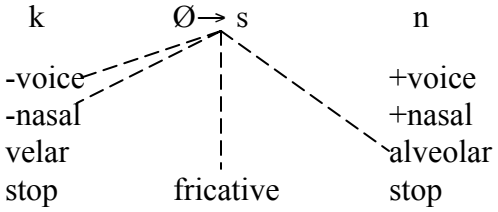
The changes that were made by substitution or epenthesis usually resulted in a reduction of markedness at the coda. There are six changes that will be discussed in this section. The first two changes that will be discussed are the substitutions of the voiceless velar /k/ for the voiceless bilabial /p/ and for the voiceless alveolar /t/. Of the 33

responses given where the final targeted phoneme /p/ occurred, only two of the responses changed in place of articulation. The two changes were made by Subject 2. The word *mop* was produced as [mɑk^{h}] in the frame 'Say *mop* now.' The learner said 'Say mo[k^{h} n]ow.' Phonemes /p/ and /k/ are often perceptually confused (Cooper et. al. 1952). This student might have a markedness constraint that says NO NONVELAR CODA that is more highly ranked than the faithfulness constraint that says be FAITHFUL TO POINT. The constraint rankings for this particular learner can be shown as follows:

3) NO NONVELAR CODA > FAITHFUL TO POINT

In a similar change, subject 4 produced *sit* as [sɪks], indicating no change in voicing, but resulting in a consonant cluster in the coda. The frame with word 'Say *sit* now' was produced as 'Say si[ks n]ow.' In this response, the voiceless alveolar /t/ was changed to the voiceless velar /k/ and then an alveolar /s/ was added. The inserted [s] takes its voicing and nonnsality from the preceding [k], and its point of articulation from the following [n]. In addition, it is a fricative, unlike the stops before and after it. This is shown in the following formulation.

4)



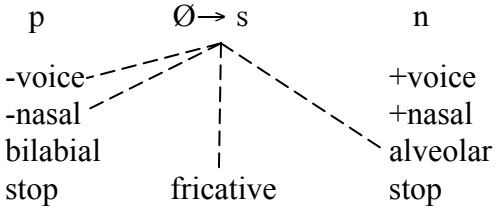
When the velar [k] is produced, the tongue back is raised to the velum which completely impedes the airstream. While switching to [s], the tongue back lowers and the tongue tip rises to the alveolar ridge. This time, the tongue only greatly impedes the airstream. The air is flowing over the center of the tongue making a grooved fricative. Finally, when [n]

is produced, the tongue stays in the same position (at the alveolar ridge) but completely impedes the airstream once again. Meanwhile, the vocal folds begin to vibrate to make the voiced sound and the velum lowers to let all air pass through the nasal passage.

The function of [s] shown in formulation (4) is to be a transition between the [k] and the [n]. We will call this constraint MINIMAL ARTICULATORY DIFFERENCE. In the production of 'Say si[ks n]ow,' made by Subject 4, the constraint MINIMAL ARTICULATORY DIFFERENCE is ranked higher than the constraint NO EPENTHESIS, while in the production on 'Say mo[k n]ow,' made by Subject 2, the constraint MINIMAL ARTICULATORY DIFFERENCE is ranked lower than the constraint NO EPENTHESIS. In both productions, the constraint NO NONVELAR CODA is more important than the faithfulness constraint FAITHFUL TO POINT. This difference in rankings in the interlanguage accounts for the difference in errors.

The next error to be discussed also exhibited an insertion of the alveolar /s/. Subject 3 produced 'Say mo[ps n]ow.' The voiceless alveolar sibilant /s/ was inserted between the voiceless bilabial stop /p/ and the voiced alveolar stop /n/. This student may have perceived the word *mop* to be the plural form *mops*. It is also possible that the learner epenthesized the /s/ as shown below. This diagram is almost identical to (4) above.

5)



When the voiceless bilabial [p] was produced, the tongue is in neutral position in the

mouth; the lips are closed, completely impeding the airstream, while the vocal folds are stationary (voiceless). Then the tongue tip rises to the alveolar ridge and the lips open. The air is flowing over the center of the tongue making the grooved fricative [s]. Then [n] is produced and the tongue tip stays in the same position but completely impedes the airstream. The vocal folds begin to vibrate to make the voiced sound and the velum lowers to let all air pass through the nasal passage.

The epenthesis shows that the learner ranks the NO EPENTHESIS constraint below MINIMAL ARTICULATORY DIFFERENCE. The order of Subject 3's constraint rankings are given below in (6):

6a) FAITHFUL TO POINT > NO NONVELAR CODA

b) MINIMAL ARTICULATORY DIFFERENCE > NO EPENTHESIS

Another substitution that occurred when the voiceless alveolar /t/ was in final position was the replacement [t] by a voiceless palatal-alveolar affricate /tʃ/ in the frame 'Say *sit* now.' Subject 3 may have palatalized the [t] because it follows the high front vowel [ɪ] in the target word *sit*. This can be accounted for by a highly ranked constraint that says NO ALVEOLARS AFTER HIGH FRONT VOWELS which is more important than the faithfulness constraint FAITHFUL TO POINT. This production also shows that MINIMAL ARTICULATORY DIFFERENCE is ranked higher or is more important than the NO EPENTHESIS constraint.

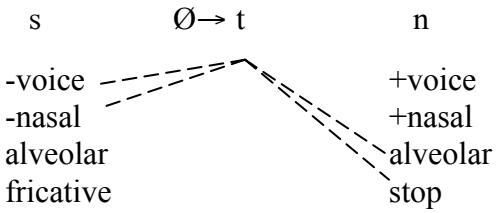
7a) NO ALVEOLARS AFTER HIGH FRONT VOWELS > FAITHFUL TO POINT

b) MINIMAL ARTICULATORY DIFFERENCE > NO EPENTHESIS

The next two innovations occurred with the voiceless alveolar /s/ in coda position. The first innovation that I will discuss here is the insertion of the voiceless alveolar stop

between the alveolars /s/ and /n/ in the frame 'Say *class* now.' Subject 2 produced 'Say cla[st n]ow.' Most likely, epenthesis of the alveolar /t/ was a result of partial assimilation of the oral stop to the place of articulation of the nasal as shown below.

8)



When the alveolar [s] is produced, the tongue tip is on the alveolar ridge greatly impeding the airstream. Then the tongue tip closes onto the alveolar ridge to completely impede the airstream to make a [t]. Finally, the vocal folds begin to vibrate and the velum lowers to produce the nasal [n]. This is another instance of MINIMAL ARTICULUTORY DIFFERENCE. The epenthesis above shows that the learner ranks the NO EPENTHESIS constraint below MINIMAL ARTICULATORY DIFFERENCE. The order of Subject 2's constraint rankings are given below:

9a) FAITHFUL TO POINT > NO NONVELAR CODA

b) MINIMAL ARTICULATORY DIFFERENCE > NO EPENTHESIS

The order of the constraints are the same as that of Subject 3's in the production of 'Say *mop* now,' becoming 'Say mo[ps n]ow.'

The final change to be discussed in this section is the substitution of a voiceless alveolar fricative /s/ for the voiceless labiodental fricative /f/. The target word *class* was produced as [k^hlæf] in the frame 'Say *class* now.' Since the word *claf* is not an English word, it is unlikely the error is due to perceptual problems. Within OT, the change cannot be accounted for by a faithfulness constraint, since the output is different than the

input. Also, the students never made errors with syllable-final /f/, but they did with syllable-final /s/.

The voiceless segment /f/ was always produced 100% accurately among the learners. This shows that the students have learned the constraint rankings in English which result in the voiceless /f/ in coda position, and it also suggests that /f/ is universally less marked. The consonant /f/ seems to be more natural and easier to pronounce, so there must be some kind of constraint. However, we do not know what it is.

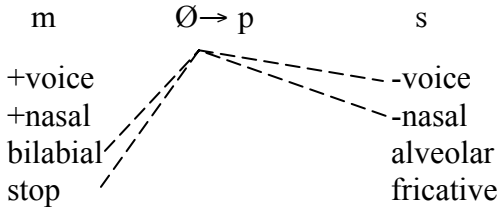
4.3 Final segments /m/ and /n/

The voiced bilabial nasal /m/ was frequently released into a schwa by the subjects during the Word Production task, but not during the Sentence Production task. This may be due to the fact that *ham* was released into a schwa on the original recording that students were trying to copy. This is because an open transition was needed to distinguish the final /m/ from the following /n/. This phenomenon could also be due to the fact that there is a greater possibility of having an open release when there is a pause after the target word in the frame 'Say ___ now' than with a word produced in a natural English sentence.

A number of errors happened with the target word *lamb* used in the sentence 'The *lamb* stood still.' One error that occurred was the insertion of a voiceless bilabial stop /p/ following the /m/. It is possible that Subjects 4 and 11 may have lexically perceived the word to be *lamp* instead of *lamb*. Another possibility is that the /p/ was epenthesized as a transition between the velic opening and velic closure producing 'The la[mp s]tood still.' This transitional [p] takes features from the preceding and following segments as shown

below.

10)



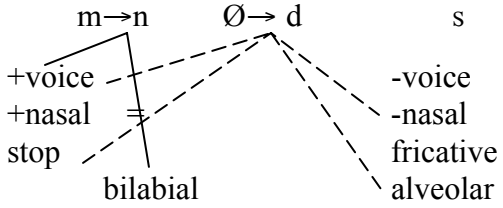
This is once again expressed in OT by the constraint MINIMAL ARTICULATORY DIFFERENCES, which is ranked higher than NO EPENTHESIS. When [m] is produced, both lips are closed which completely impedes the airflow through the mouth, and the velum is lowered to allow the air to pass through the nasal passage. While this is happening, the vocal chords are vibrating. Then, the vocal chords stop vibrating resulting in a voiceless sound, and the velum rises to produce the [p]. Finally, the lips open and the tongue tip rises to the alveolar ridge while only greatly impeding the airstream to produce the fricative [s]. The epenthesis of /p/ between the /m/ and /s/ shows that this learner ordered the constraints in the same way as both Subjects 2 and 3 when producing 'Say cla[st n]ow' and 'Say mo[ps n]ow.' The ordering of the relevant constraints is as follows:

11) MINIMAL ARTICULATORY DIFFERENCE > NO EPENTHESIS

Lexical confusion may also have occurred when the word *land* was produced instead of the target word *lamb*. However, this seems unlikely given the context of the sentence 'The *lamb* stood still.' This occurred 4 times out of 22 responses. Another option for analysis could be that partial regressive assimilation has occurred causing the segments to be produced at the same place of articulation. The phonemes /n/ and /s/ are both alveolars, which would allow for ease of production. In addition, the epenthesis of

/d/ between /n/ and /s/ in *la*[nd s]*tood* would also allow for ease of production. This is shown in the following diagram.

12)



In the production of *la*[nd s]*tood*, the highly ranked markedness constraint MINIMAL ARTICULATORY DIFFERENCE is more important than the faithfulness constraint FAITHFUL TO POINT. This allows the /m/ to be pronounced as [n]. At the same time, the constraint MINIMAL ARTICULATORY DIFFERENCE is also more important than the NO EPENTHESIS constraint, allowing the [d] to be inserted.

13) MINIMAL ARTICULATORY DIFFERENCE > FAITHFUL TO POINT, NO EPENTHESIS

Many students also produced [læn] instead of *lamb* and [hæn] instead of *ham*. This can be accounted for as another case of partial regressive assimilation. But there is no epenthesis in, for example, the production of *la*[n s]*tood*. In these instances, the constraint NO EPENTHESIS is more important than the constraint MINIMAL ARTICULATORY DIFFERENCE, and therefore no consonant is inserted between the [n] and [s]. But, the constraint MINIMAL ARTICULATORY DIFFERENCE is more important than FAITHFUL TO POINT. The rankings are as follows:

14) NO EPENTHESIS > MINIMAL ARTICULATORY DIFFERENCES > FAITHFUL TO POINT

The voiced alveolar stop /n/ was accurately produced during each production across

all subjects. The target word *run* in the frame 'Say *run* now,' and the target word *men* in the sentence 'The *men* sat down,' already have a minimal articulatory difference between the target /n/ and the following /n/ in the word *now* and the /s/ in the word *sat*. Therefore, there is no need to change the final /n/ according to these constraints.

4.4 Final segment /l/

The voiced alveolar velarized lateral approximant /l/ following front unrounded vowels such as /ɛ/, /ɪ/ or the back rounded /o/, is often changed into the glide [oʊ̯]. This substitution was consistent among all of the subjects. An example of this substitution is that *roll* was produced as [ɹoʊ̯] in the frame 'Say *roll* now.'

Ladefoged (1993:65) states,

> "In most forms of American English, all examples of /l/ are comparatively velarized except, perhaps, those that are syllable initial and between high front vowels, as in '*freely'*. In British English /l/ is usually not velarized when it is before a vowel, as in '*lamb*, *swelling'* but it is velarized when word final or before a consonant, as in '*ball*, *filled'*. …In my own speech, the whole body of the tongue is drawn up and back in the mouth so that the tip of the tongue no longer makes contact with the alveolar ridge. Strictly speaking, therefore, this sound is not an alveolar consonant but more like some kind of back vowel in the speech of some English speakers."

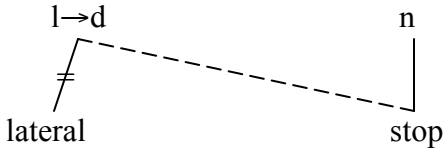
The Hmong learners of English show that vocalizing the coda is better preferred to having a lateral /l/ in the coda. The constraints NO DELETION and NOCODA seem to be more important than the constraint FAITHFUL TO CONSONANT /l/, since /l/ is

substituted with a glided vowel. It is impossible to know the relative ranking between NOCODA and NO DELETION. When /l/ exists in initial position the constraint FAITHFUL TO CONSONANT /l/ causes speakers to pronounce /l/. However, in final position, it is less important than both NO DELETION and NOCODA. To obey NOCODA, speakers need to get rid of the coda /l/, but they cannot delete it since NO DELETION is also important. If FAITHFUL TO CONSONANT /l/ is violated, there is no deletion, and there is no coda consonant.

15) NO DELETION, NOCODA > FAITHFUL TO CONSONANT /l/

Another error, made by Subject 2, was the appearance of an alveolar /d/ instead of the approximant /l/. This student may have lexically perceived the word to be *road* instead of *roll*. Another option to look at in this analysis is the delinking of the feature lateral and spreading of the resultant alveolar stop shown in the diagram below.

16)



This would be another case of MINIMAL ARTICULATORY DIFFERENCE being higher ranked than FAITHFUL TO CONSONANT /l/.

17) MINIMAL ARTICULATORY DIFFERENCE > FAITHFUL TO CONSONANT /l/

When the targeted word ending with a voiced alveolar velarized lateral approximant /l/ was placed within a natural sentence, the /l/ was completely deleted by all of the students instead of the glide [oʊ̯] being substituted in its place. For instance, in the sentence 'Jim is a *tall* man,' the subjects consistently deleted the final /l/ in all

responses. One explanation for this difference is that after low unrounded vowels the /l/ is deleted and after round vowels the /l/ becomes vocalized. This may be sonority driven or, more likely, the deletion may be due to the markedness of the final /l/. In Hancin-Bhatt's (2000) study on Codas in Thai ESL, the Thai speakers were using their L1 constraint ranking within the faithfulness constraints to parse their L2. The only caveat to that finding was that liquid codas had just as many deletions as substitutions. As shown in this study and in Hancin-Batt's study, it seems that liquid codas are somehow different from other types of codas because they are the only ones that behave in this way (Hancin-Bhatt, 2000). In the innovations resulting in deletion of the final /l/, the NOCODA constraint is more important than the constraint that says FAITHFUL TO CONSONANT /l/.

4.5 Final clusters of two consonants beginning with a liquid

In this section, the final consonant clusters beginning with a voiced alveolar velarized lateral approximant will be discussed first (/lp/, /lt/, /lf/, /lv/) followed by the cluster containing both the alveolar lateral and the alveolar central approximant (/ɹl/). Then the final clusters beginning with a voiced alveolar central approximant will be explained (/ɹp/, /ɹf/, /ɹs/).

The most straightforward clusters are the two segment clusters beginning with a voiced alveolar velarized lateral approximant /l/ followed by the voiced labiodental fricative /v/ (/lv/) or the voiceless labiodental fricative /f/ (/lf/). The only error produced in these two coda clusters was the substitution of the glide [o̯u̯] for the lateral approximant, resulting in [o̯u̯v] and [o̯u̯f], respectively. The constraint NOCODA will

not help here, since there is a coda consonant. However, the coda sequence has been simplified. There seems to be another constraint here, NOCODA CLUSTERS, which forbids clusters in the coda. If NOCODA CLUSTERS is ranked higher than NOCODA, this will account why it is possible to delete only one of the two consonants in the cluster but still leave a coda. The markedness constraint FAITHFUL TO CONSONANT /l/ is ranked lower than the constraints NO DELETION and NOCODA CLUSTERS in the interlanguage of the Hmong learners of English.[6] In the resulting forms, [oʊ̯v] and [oʊ̯f], faithfulness to the /l/ is violated in order to avoid coda clusters while at the same time not deleting any segment.

In the coda clusters /lt/ and /lp/ only four errors were made. Three out of the four errors were deletion of the lateral approximant /l/ in the coda cluster /lp/. For these three errors in which /l/ was deleted, NO DELETION was ranked lower than NOCODA CLUSTER. We do not know why this ranking only occurred with stops. Given a large enough sample, some students may have deleted the /l/ before /v/ and /f/. The important constraints here are NOCODA CLUSTER and NO DELETION. Normally, NO DELETION is highly ranked, but in these three cases, it is less highly ranked. With the coda cluster /lp/, the /l/ was deleted in 'The *pulp* tastes bad.' In the frame 'Say *help* now,' the /l/ was never deleted, but always changed to /oʊ̯/. Once again, the difference may be due to the difference in the vowels in the target words.

In the coda cluster /lt/, Subject 1 changed the voiceless alveolar /t/ to a velar /k/. In the frame 'Say *melt* now,' the subject produced 'Say me[oʊ̯k^{h} n]ow.' This is similar to

[6] Universally it is more likely to delete laterals than to delete nonlaterals.

the errors mentioned above with the final segments /t/ and /p/ changing to the velar /k/. This student may have lexically perceived the word to be *milk* instead of *melt*. This would be another case of NO NONVELAR CODA being more highly ranked than FAITHFUL TO POINT.

18) NO NONVELAR CODA > FAITHFUL TO POINT

In the target cluster /ɹl/, the lateral approximant /l/ was completely deleted by Subject 11. The other 10 subjects always changed the final /l/ to the glided [oʊ̯]. For Subject 11, NOCODA CLUSTER is more important than NO DELETION. For the other errors, NO DELETION and NOCODA CLUSTER are higher than FAITHFUL TO CONSONANT /l/. So the only way to avoid a coda cluster without deleting it is to change the /l/ to the glided [oʊ̯].

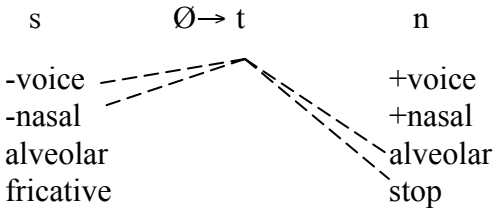
The final part of this section will discuss the coda clusters beginning with the alveolar central approximant /ɹ/ (/ɹp/, /ɹs/, and /ɹf/). No errors were made during the production of the final cluster /ɹp/, which is not surprising because it ends with the voiceless bilabial /p/. In these forms, NO DELETE VOICELESS is ranked more highly than NOCODA CLUSTER.

The final cluster beginning with the liquid /ɹ/ and ending with an alveolar sibilant /s/ often changed in manner and place of articulation. In the frame 'Say *force* now,' the fricative remained voiceless and the alveolar /s/ changed to the interdental /θ/ producing 'Say fo[ɹθ n]ow.' The change in manner was from a sibilant to a flat fricative, and the change in place was from an alveolar to an interdental. In English, /s/ is a less marked fricative than /θ/, so it would be difficult to account for this change by a naturalness constraint. However, the word *horse* in the sentence 'The *horse* ran fast,' was never

changed to *horth*. The change from /s/ to /θ/ does not seem to result from markedness constraints. Therefore, it is possible this change does result from problems in perception. The word *fourth* is an actual English word. Furthermore, there is no context to show that *fourth* does not fit. There is, however, no word *horth* and the students know that a *horse* runs fast. Therefore, we would not expect a problem in perception in 'The *horse* ran fast.' Optimality Theory cannot account for this error, therefore it is most likely that Subjects 4, 5, 6, and 11 made this error due to problems in perception.

Subject 2 added a voiceless alveoar stop to /ɹs/ creating the complex cluster /ɹst/. This student may have epenthesized an alveolar /t/ between the alveolars /s/ and /n/ as a transitional segment. This is very similar to the error previously mentioned, which was also made by Subject 2, in the phrase 'Say cla[st n]ow.'

19)



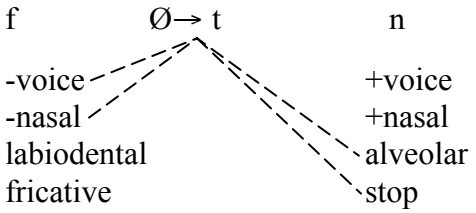
For the coda cluster /ɹs/, this student has ranked the constraint FAITHFUL TO POINT higher than NO NONVELAR CODA so there is no change in point. Both of these constraints rank higher than MINIMAL ARTICULATORY DIFFERENCE which is more important than NO EPENTHESIS, so that the transitional [t] can be inserted. Ranked below these is the constraint on NOCODA CLUSTERS, so no part of the coda cluster is deleted.[7]

Similar to the error mentioned above, Subject 10 epenthesized an alveolar /t/

[7] Another possibility is that this student perceived the past-tense form of the word *force*.

between the labiodental /f/ and the alveolar /n/ in the frame 'Say *turf* now.' The subject produced 'Say tu[ɹft n]ow,' inserting a transitional stop between the fricative and the stop as shown below.

20)



When producing [f], the vocal chords are stationary, and the tongue tip is in neutral position. The upper teeth and the lower lip are brought together resulting in great impedance of the airstream. When [t] is produced, the vocal chords are stationary. The tongue tip is raised to the alveolar ridge to completely impede the airstream. Finally, the vocal folds begin to vibrate and the velum lowers to produce [n]. For Subject 10, the FAITHFUL TO POINT constraint is more important than the markedness constraint NO NONVELAR CODA. These two constraints are ranked higher than MINIMAL ARTICULATORY DIFFERENCES, which, in turn, is higher than NO EPENTHESIS, thus allowing the insertion of the transitional [t].

Also in the frame 'Say *turf* now,' Subject 2 responded with 'Say tu[rp n]ow.' Again, this shows a preference for the voiceless bilabial stop in coda position. Bilabial stops are less marked than interdental fricatives. NO VOICELESS LABIAL STOPS is ranked higher than FAITH MANNER, MINIMAL ARTICULATORY DIFFERENCES and NO EPENTHESIS. NOCODA CLUSTER is ranked even lower than the four constraints mentioned above.

The last innovation to be discussed is the deletion of the labiodental /f/ in the

sequence /ɹf/. This deletion reduced the final cluster to /ɹØ/ exhibiting a minimal sonority descent at the coda. In this response, the constraints NOCODA CLUSTER and MINIMAL SONORITY CODA DESCENT are more important than NO DELETION constraint.

21) NOCODA CLUSTER, MINIMAL SONORITY CODA DESCENT > NO DELETION

4.6 Final clusters of three consonants beginning with a liquid

This section will discuss the innovations made in the final consonant clusters beginning with a liquid which include /ɹst/, /lts/, and /ɹld/.

Three-segment clusters were typically reduced to either one or two consonants by the majority of the intermediate level speakers. There were 42 total reductions out of 88 possible attempts. Only 3 out of the 88 total cluster reductions resulted in only one consonant remaining. The consonant that remained was always the one immediately following the nucleus. In the case of the three final clusters listed above, the /ɹ/ was always preserved. The reductions support the preference for a minimal sonority descent in the coda. Deletion of the absolute final consonant was observed in 39 out of the 88 cluster reductions. For the subjects who made these deletions, the constraints NOCODA CLUSTER and MINIMAL SONORITY CODA DESCENT are ranked very high. These constraints are shown to be more important than the NO DELETION constraint. It is impossible to determine the ranking of NOCODA CLUSTER and MINIMAL SONORITY CODA DESCENT because both constraints preserve the /ɹ/.

One innovation occurred during the production of the targeted cluster /lts/ which

resulted in both substitution and deletion. Subject 1 changed *malts* to *ma*[oʊ̯k^{h}] using the same vowel as in *malts*. This is the same student who changed *melt* to *me*[oʊ̯k^{h}]. There are a number of constraints involved in this particular production. It is not possible to determine all of the rankings involved. Changing /t/ to /k/ shows that the constraint FAITHFUL TO POINT is less important than the markedness constraint NO NONVELAR CODA. The /l/ changing to the glide [oʊ̯] shows that NO DELETION is more important than FAITHFUL TO CONSONANT /l/. Lastly, deleting the final /s/ between /k/ and /f/ in *ma*[oʊ̯k^{h} f]*or* shows that NOCODA CLUSTER is more important than NO DELETION.

4.7 Final consonant clusters beginning with a stop

In this section, final clusters of two and three consonants beginning with a stop are discussed. Two of the clusters begin with a stop and end with a fricative (/ps/ and /ts/) and one begins with a stop, followed by a fricative and ending with a second stop (/kst/). The final /s/ was deleted 17 times out of a total of 55 attempts in the clusters /ts/ and /ps/. That is, /mæps/ *maps* was produced as [mæp^{h}], and /kæts/ *cats* was produced as [k^{h}æt^{h}]. The final /s/ in the words *cats*, *maps*, and *taps* may have been thought of as a suffix, so the error of deleting the final /s/ may have been made in order to preserve the root of the word. That is, students might have deleted a consonant to satisfy the important NOCODA CLUSTER; the fact that they deleted the final /s/ could have been due to a constraint that root segments should not be deleted. Another analysis would be that deleting the final /s/ in the frame 'Say *cats* now,' shows that Subjects 7 and 11 rank the constraint MINIMAL ARTICULATORY DIFFERENCES as more important than the

constraint NO DELETION. This is because the sequence *ca*[ts n]*ow* changes from the voiceless nonnasal fricative [s] to the voiced nasal stop [n] (three changes), while the sequence *ca*[t n]*ow* only changes from the voiceless nonnasal stop [t] to the voiced nasal stop [n] (only two changes).

In the other final cluster, /kst/, the voiceless velar stop /k/ was always preserved. Reductions of both the fricative /s/ and the stop /t/ were seen in 5 out of 33 productions of the word *next*. Subjects 1, 4, 5, 8, and 10 deleted both the sibilant and the stop in final position which shows that the learners rank the constraint NOCODA CLUSTERS higher than NO DELETION.

In the sentence production task, the natural sentence used was 'The *text* looks long.' One segment deletion, however, did occur in 11 out of 33 productions.[8] In these productions, the stop /t/ was deleted in both the words *next* and *text*. When [nɛkst^{h}] became [nɛks] in 'Say *next* now,' the alveolar /s/ syllabified with the /n/ which eliminates the final cluster. Also, when [tɛkst^{h}] became [tɛks] in the sentence 'The *text* looks long,' the alveolar /s/ syllabified with the /l/. In view of that, Subjects 1, 2, 4, 6, 7, 9, 10 and 11 have the constraint NOCODA CLUSTER as shown to be more important than the constraint NO DELETION. This phenomenon is not uncommon among second language learners. It is found that when producing English words in both Mandarin and Cantonese, the learners tend to apply deletion to modify English syllable structure. For

[8] When there is a three consonant cluster and only one consonant gets deleted, the markedness constraint NOCODA CLUSTER is violated worse than if two consonants were to be deleted. If two consonants are deleted in a three segment cluster, then the faithfulness constraint NO DELETION is violated worse than NOCODA CLUSTER. It is not clear in Optimality Theory on how to deal with the severity of violations or whether NOCODA CLUSTER should be split.

instance, they also simplify /kst/ in the word *text* into /ks/ (Eckman 1987; Edge 1991).

4.8 Other final clusters of two consonants

This section of the chapter will discuss the results of other final consonant clusters of two consonants. Three of the final clusters begin with a nasal and end with a stop (/mp/, /nt/, and /nd/). The other two final clusters begin with a fricative and end with a stop (/ft/, /sp/).

The nasal – stop clusters caused difficulty for many of the intermediate speakers. There were 23 reductions out of 66 possible attempts. The voiced alveolar nasal /n/ always remained when there was a stop in absolute final position. There were 16 deletions of the voiced alveolar stop /d/ and only 7 deletions of the voiceless alveolar stop /t/. It is not surprising that the voiced alveolar stop /d/ would be deleted more frequently than the voiceless alveolar stop /t/. As shown in the production of the final singleton segments /d/ and /t/, the voiced /d/ was frequently deleted, and the voiceless /t/ always remained voiceless but changed in place of articulation. In the deletions of /d/, NO DELETE VOICELESS is more important than NOCODA CLUSTERS, which, in turn, is more important than NO DELETE VOICED. This is shown in (24):

24) NO DELETE VOICELESS > NOCODA CLUSTER > NO DELETE VOICED

The deletions of the final /t/ show NOCODA CLUSTER to be more important than the constraint NO DELETE VOICELESS which, in turn, is more important than NO DELETE VOICED.

During the Sentence Production task, Subjects 4, 9, and 10 deleted the voiced bilabial nasal /m/ that preceded the voiceless bilabial stop /p/ in the coda cluster /mp/. In

the coda cluster /mp/, the /m/ was deleted by three of the subjects in the sentence 'Don't *bump* your head,' but not in the frame 'Say *jump* now.' The sequence /pju/ is a possible sequence in English words such as *pure*. It is possible, then, that the /p/ in *bu*[mpj]*our* might have syllabified with the following word. This would have put the /p/ in the onset, so that it could not delete. Instead, the /m/ would be in the coda and could delete. This would not be possible in the sequence *ju*[mp n]*ow*, however. Therefore, the /p/ could delete in this form. The subjects may have perceived a nasalized vowel in *bump* and therefore deleted the nasal /m/. Most likely, the learners were simplifying the coda cluster by deleting one segment. The learners rank the constraint NOCODA CLUSTER as less important than NO DELETE VOICELESS.

Moving on to the next final cluster, beginning with a voiceless labiodental fricative /f/ followed by a voiceless alveolar stop /t/, the productions frequently resulted in the deletion of the voiceless stop. This occurred 19 times out of 33 production attempts. Deletion of the final alveolar /t/ could be due to a sonority constraint, or it may simply be that alveolar stops are more difficult for the learners to produce word-finally than the fricative /f/. For all of the students, except for Subjects 3 and 8, the constraints NOCODA CLUSTER and MINIMAL SONORITY CODA DESCENT are evidently more important than NO DELETION. Therefore, the deletion of the /t/ results in a syllable with no coda cluster, and with a minimal drop in sonority in the coda.

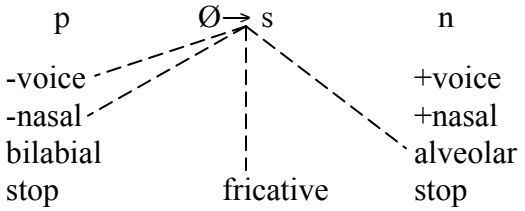
There were six responses where the voiceless labiodental fricative /f/ changed in place and manner of articulation to a voiceless alveolar sibilant /s/. The word *lift* was produced as the word *list*. The subjects may have perceived the targeted word as *list* due to the recording; therefore, the learners remained faithful to what they heard. The change

may also be due to the fact that /st/ in the coda is less marked than /ft/. This suggests a constraint NO LABIAL CODA that is more important than the constraint FAITHFUL TO POINT for Subjects 2, 3 and 10.

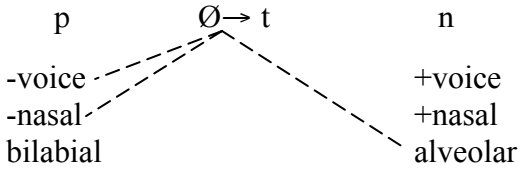
A number of errors occurred in the productions of the final cluster /sp/. One error that occurred was the deletion of the sibilant /s/ in the target word *gasp,* which resulted in [gæp^{h}]. This also shows that there is a preference for bilabial stops in the coda that can be captured by a constraint NO DELETE STOPS. NOCODA CLUSTERS and NO DELETE STOPS are ranked higher than NO DELETION for Subjects 1, 7, and 8.

Subject 2 inserted a voiceless alveolar sibilant /s/ in absolute final position in the first response of the word *gasp* producing [gæsps] and during the second response inserted a voiceless alveolar stop /t/ in absolute final position producing [gæspt^{h}]. This subject may have lexically perceived a plural and a past-tense form of the word, respectively. Alternatively, epenthesizing either a /s/ or a /t/ between a bilabial /p/ and an alveolar /n/ makes an easier transition. These two epenthesis formulations are shown below.

25) 'Say *gasp* now' became 'Say ga[sps n]ow'



26) 'Say *gasp* now' became 'Say ga[spt n]ow'



During both responses, the constraint FAITHFUL TO POINT was ranked higher than NO NONVELAR CODA. These constraints, in turn, are ranked higher than MINIMAL ARTICULATORY DIFFERENCES which is also shown to be more important than the constraint NO EPENTHESIS. Thus, the student inserts a transitional consonant to minimize the differences between adjacent segments.

One other subject metathesized the two segment cluster of a voiceless alveolar sibilant /s/ followed by a voiceless bilabial stop /p/ producing [gæps]. This student may have perceived the targeted word as *gaps*, which is another English word. Kirk and Demuth (2000), however, showed that metathesis errors turned the lower frequency /s/, /z/, + stop clusters (e.g. *wasp*) into higher frequency stop + /s/, /z/ clusters (e.g. *waps*). Many elementary age learners are not yet able to discriminate final segments or organize certain sound patterns consistently into their appropriate coda cluster (Hazan & Barrett 2000). This is the same phenomenon that occurs when *ask* is changed to *aks* in some varieties of African American Vernacular English (AAVE).

Substitution was another error commonly made in the final cluster /sp/. However, substitution was only made during the sentence production task when the students did not know which word was being targeted. The word *wasp* was used in the sentence 'The *wasp* flew away.' The word *wasp* was probably not known among the second language learners since *waf* and *wat* were commonly produced with hesitation, indicating confusion.

4.9 Summary

In this chapter I have shown that different rankings of a small number of constraints that are common to both Hmong and English phonology (as well as all other languages of the world) can account for both the correct and incorrect responses of students when faced with final codas. The problem is that the relative rankings are different in Hmong and English. In the interlanguage, the constraints do not have a fixed ranking. Errors result when the ranking used for a particular attempt do not follow the ranking of English.

CHAPTER 5

CONCLUSION

It has been hypothesized that coda consonant and consonant clusters would be difficult for Hmong second language learners of English to produce. The hypothesis was based on the assumption that the Hmong learners were still using the ranking of constraints form their first language in their English coda production. The analysis of this study shows that the constraint rankings in the learners L1 interact with the constraint rankings in their L2 in a specific way as shown by the common error patterns produced. This experiment revealed that in the production of these English words each learner re-ordered constraints in different ways resulting in different errors. The production actually resulted in fewer errors for the single final obstruents and sonorants but resulted in more frequent errors in the targeted complex clusters. This shows that even for the intermediate level speakers of English the development of their interlanguage phonology is a longterm, ongoing process. The errors that were made were not erratic, but rather systematic, reflecting their native language constraints in coda position. The insights from OT given in chapter 4 are just the beginning of the issues that can be addressed using such a rich framework. OT is able to account for common error patterns and also individual differences. This allows for a look into some of the specific stages of interlanguage development as evidenced by constraint re-rankings.

All of the phenomena that have been described (deletion, epenthesis, metathesis, substitution) affect the intelligibility of Hmong speakers of English. Pedagogically speaking, these phenomena do not need to be explicitly presented to the learners using theoretical detail, however, providing some awareness of the errors should be available to the learners. Swain (1995) claims the importance of three levels of awareness (1) noticing, (2) hypothesis testing, and (3) metalinguistic awareness, are all beneficial for accurate language development. Further examination of cross-linguistic differences between Hmong second language learners of English may provide additional insight.

APPENDICES

APPENDIX A

WORD PRODUCTION EXERCISE

Say *lend* now.

Say *mop* now.

Say *pant* now.

Say *lift* now.

Say *wow* now.

Say *melt* now.

Say *roll* now.

Say *five* now.

Say *mop* now.

Say *lift* now.

Say *lend* now.

Say *pant* now.

Say *five* now.

Say *roll* now.

Say *melt* now.

Say *wow* now.

Say *cob* now.

Say *more* now.

Say *elf* now.

Say *curl* now.

Say *maps* now.

Say *run* now.

Say *sniff* now.

Say *curl* now.

Say *elf* now.

Say *sniff* now.

Say *run* now.

Say *cob* now.

Say *maps* now.

Say *more* now.

Say *sit* now.

Say *ham* now.

Say *class* now.

Say *gasp* now.

Say *cats* now.

Say *help* now.

Say *mad* now.

Say *size* now.

Say *class* now.

Say *size* now.

Say *mad* now.

Say *help* now.

Say *gasp* now.

Say *ham* now.

Say *sit* now.

Say *cats* now.

Say *force* now.

Say *harp* now.

Say *jump* now.

Say *first* now.

Say *harp* now.

Say *force* now.

Say *first* now.

Say *jump* now.

Say *shelve* now.

Say *turf* now.

Say *next* now.

Say *curled* now.

Say *next* now.

Say *shelve* now.

Say *curled* now.

Say *turf* now.

Forms repeated during testing

Say *maps* now.

Say *class* now.

Say *gasp* now.

Say *cats* now.

Say *size* now.

Say *force* now.

Say *maps* now.

Say *class* now.

Say *gasp* now.

Say *cats* now.

Say *size* now.

Say *force* now.

APPENDIX B

SENTENCE PRODUCTION EXERCISE

1. I had two *malts* for lunch.
2. Don't *bump* your head.
3. Jim is a *tall* man.
4. I have a *gift* for you.
5. I have a *sore* knee.
6. I hit the *ball*.
7. He will *dive* from the side.
8. The *wasp* flew away.
9. He *taps* his pencil.
10. The *horse* ran fast.
11. The *world* looks big.
12. I have the *worst* cold.
13. The *men* sat down.
14. The *cow* made noise.
15. The *lamb* stood still.
16. The *scarf* matches your coat.
17. The *girl* walked home.
18. I have *twelve* sisters.
19. He *built* model cars.

20. I am *glad* he is here.

21. The *shelf* fell over.

22. The *text* looks long.

23. You can win the *prize* box.

24. The *gas* made us sick.

25. The *pulp* tastes bad.

26. We need the *tarp* now.

27. She *ran* to the top floor.

28. The *cliff* looks steep.

29. My *job* makes me happy.

30. I pay *rent* next month.

31. Your *hand* looks small.

Forms repeated during testing

32. I had two *malts* for lunch.

33. The *wasp* flew away.

34. He *taps* his pencil.

35. The *text* looks long.

36. The *gas* made us sick.

37. The *cliff* looks steep.

APPENDIX C

Hmong Rankings:

NO NONVELAR CODA, NO ORAL CODA, NO DELETE /ŋ/ >

NOCODA >

NOCODA CLUSTER, MINIMAL SONORITY CODA DESCENT >

NO DELETE VOICELESS, NO DELETE VOICED, NO DELETE STOPS, NO EPENTHESIS, MINIMAL ARTICULATORY DIFFERENCES, NO ALVEOLARS AFTER HIGH FRONT VOWELS >

FAITHFUL TO POINT, FAITHFUL TO MANNER, FAITHFUL TO CONSONANT /l/.

English Rankings:

FAITHFUL TO POINT, FAITHFUL TO MANNER, FAITHFUL TO CONSONANT /l/, NO DELETE VOICELESS, NO DELETE VOICED, NO DELETE /ŋ/, NO EPENTHESIS >

MINIMAL ARTICULATORY DIFFERENCES, NO NONVELAR CODAS, NO ORAL CODA, NO ALVEOLAR AFTER HIGH FRONT VOWELS, NOCODA, NOCODA CLUSTER, MINIMAL SONORITY CODA DESCENT

Interlanguage Rankings:

Page 53	NOCODA > NO EPENTHESIS	*[kɑbə] instead of [kɑb] *[hæmə] instead of [hæm] *[mædə] instead of [mæd]
Page 54	NO DELETE VOICELESS > NOCODA > NO DELETE VOICED	*[ʤɑ] instead of [ʤɑb] *[mæ] instead of [mæd] *[glæ] instead of [glæd] *[daɪ̯] instead of [daɪ̯v] *[faɪ̯] instead of [faɪ̯v] *[saɪ̯] instead of [saɪ̯z]
Page 55	NO NONVELAR CODA > FAITHFUL TO POINT	*[mak^{h}] instead of [map]
Page 56	MINIMAL ARTICULATORY DIFFERENCES > NO EPENTHESIS, NO NONVELAR CODA > FAITHFUL TO POINT	*[sɪks nɑʊ̯] instead of [sɪt nɑʊ̯]
Pages 56-58	FAITHFUL TO POINT > NO NONVELAR CODA, MINIMAL ARTICULATORY DIFFERENCES > NO EPENTHESIS	*[mɑps nɑʊ̯] instead of [mɑp nɑʊ̯] *[klæst nɑʊ̯] instead of [klæs nɑʊ̯]
Page 57	NO ALVEOLARS AFTER HIGH FRONT VOWELS > FAITHFUL TO POINT, MINIMAL ARTICULATORY DIFFERECES > NO EPENTHESIS	*[sɪʧ nɑʊ̯] instead of [sɪt nɑʊ̯]
Page 61	MINIMAL ARTICULATORY DIFFERENCES > FAITHFUL TO POINT, NO EPENTHESIS	*[lænd stood] instead of [læm stood]
Page 61	NO EPENTHESIS > MINIMAL ARTICULATORY DIFFERENCES > FAITHFUL TO POINT	*[læn stʊd] instead of [læm stʊd] *[hæn nɑʊ̯] instead of [hæm nɑʊ̯]
Page 60	MINIMAL ARTICULATORY DIFFERENCES > NO EPENTHESIS	*[læmp stʊd] instead of [læm stʊd]
Page 63	NO DELETION, NOCODA > FAITHFUL TO CONSONANT /l/	*[roʊ̯] instead of [rol]
Page 63	MINIMAL ARTICULATORY DIFFERENCES > FAITHFUL TO CONSONANT /l/	*[rod nɑʊ̯] instead of [rol nɑʊ̯]

Page 64	NOCODA > NO DELETE VOICED	*[tɑ] instead of [tɑl]
Page 65	NO DELETION, NOCODA CLUSTER > FAITHFUL TO CONSONANT /l/	*[ɛoʊ̯f] instead of [ɛlf] *[ʃɛoʊ̯f] instead of [ʃɛlf] *[mɛoʊ̯t] instead of [mɛlt] *[bɪoʊ̯t] instead of [bɪlt]
Page 65	NOCODA CLUSTER > NO DELETION	*[pup] instead of [pulp] *[gər] instead of [gərl] *[kər] instead of [kərl]
Page 66	NO NONVELAR CODA, NO DELETION > FAITHFUL TO POINT, FAITHFUL TO CONSONANT /l/	*[mɛoʊ̯k^{h}] instead of [mɛlt]
Page 67	NO DELETION, NOCODA CLUSTER > FAITHFUL TO CONSONANT /l/	*[gəroʊ̯] instead of [gərl] *[kəroʊ̯] instead of [kərl]
Pages 67-68 74-75	FAITHFUL TO POINT > NO NONVELAR CODA > MINIMAL ARTICULATORY DIFFERENCES > NO EPENTHESIS	*[forst nɑʊ̯] instead of [fors nɑʊ̯] *[tərft nɑʊ̯] instead of [tərf nɑʊ̯] *[gæsps nɑʊ̯] instead of [gæsp nɑʊ̯] *[gæspt nɑʊ̯] instead of [gæsp nɑʊ̯]
Pages 68-69	NO VOICELESS LABIAL STOPS > FAITH MANNER, MINIMAL ARTICULATORY DIFFERENCES, NO EPENTHESIS > NOCODA CLUSTER	*[tərp nɑʊ̯] instead of [tərf nɑʊ̯]
Page 69	NOCODA CLUSTER, MINIMAL SONORITY CODA DESCENT > NO DELETION	*[skɑr] instead of [skɑrf]
Pages 69-70	NOCODA CLUSTER, MINIMAL SONORITY CODA DESCENT > NO DELETION	*[wərs] instead of [wərst] *[fərs] instead of [fərst] *[wəroʊ̯] instead of [wərld] *[kəroʊ̯] instead of [kərld] *[mɑoʊ̯t] instead of [mɑlts]
Page 70	NO NONVELAR CODA > FAITHFUL TO POINT, NO DELETION > FAITHFUL TO CONSONANT /l/, NOCODA CLUSTER > NO DELETION	*[mɑoʊ̯k^{h} for] instead of [mɑlts for]
Pages 70-71	MINIMAL ARTICULATORY DIFFERENCES > NO DELETION	*[kæt nɑʊ̯] instead of [kæts nɑʊ̯] *[mæp nɑʊ̯] instead of [mæps nɑʊ̯]

Page 71	NOCODA CLUSTER > NO DELETION	*[nɛk^{h}] instead of [nɛkst] *[nɛks] instead of [nɛkst] *[tɛks] instead of [tɛkst]
Page 72	NO DELETE VOICELESS > NOCODA CLUSTER > NO DELETE VOICED	*[hæn] instead of [hænd] *[lɛn] instead of [lɛnd]
Page 72	NOCODA CLUSTER > NO DELETE VOICELESS > NO DELETE VOICED	*[pæn] instead of [pænt] *[rɛn] instead of [rɛnt]
Page 73	NO DELETE VOICELESS > NOCODA CLUSTER	*[bʌp] instead of [bʌmp]
Page 73	NOCODA CLUSTER, MINIMAL SONORITY CODA DESCENT > NO DELETION	*[lɪf] instead of [lɪft] *[gɪf] instead of [gɪft] *[wɑs] instead of [wɑsp]
Page 74	NO LABIAL CODA > FAITHFUL TO POINT	*[lɪst] instead of [lɪft]
Page 75	NOCODA CLUSTER, NO DELETE STOPS > NO DELETION	*[gæp] instead of [gæsp] *[wɑp] instead of [wɑsp]

REFERENCES

Adjemian, C. 1976. On the nature of interlanguage systems. *Language Learning* 26: 297-320.

Avery & Ehrlich. 1992. *Teaching American English pronunciation*. Oxford: Oxford University Press.

Barlow, J. 2001. Case study: Optimality Theory and the assessment and treatment of phonological disorders. *Language, Speech, and Hearing Services in Schools* 32: 242-256.

Barlow, J. A., and Gierut, J. A. 1999. Optimality theory in phonological acquisition. *Journal of Speech, Language and Hearing Research* 42: 1482-1498.

Bernhardt, B. & P. Stemberger. 1998. *Handbook of phonological development from the perspective of constraint-based nonlinear phonology.* San Diego, CA: Academic Press.

Broselow, E., Su-I Chen & Wang, C. 1998. The emergence of the unmarked in second language phonology. *Studies in Second Language Acquisition* 20: 261-280.

Broselow and Up. 2004. Differential difficulty in the acquisition of second language phonology. *International Journal of English Studies* 4: 135-163.

Carlisle, R. 1994. Markedness and environment as internal constraints on the variability of interlanguage phonology. In M. Yavas (ed.), *First and second language phonology.* San Diego: Singular Publishing Group Inc.

Clements, G. 1990. The role of the sonority cycle in core syllabification. In J. Kingston and M.E. Beckman (eds.), *Papers in laboratory phonology I: Between the grammer and physics of speech,* pp. 283-333. Cambridge: Cambridge University Press.

Cooper, F. S., P. C. Delattre, A. M. Liberman, J. M. Borst, and L. J. Gerstman (1952). Some experiments on the perception of synthetic speech sounds. *Journal of the Acoustical Society of America* 24, 6: 597-606.

Corder, S. P. 1967. The significance of learners' errors. *International Review of Applied Linguistics* 5: 161-170.

Demuth, K. 1997. Multiple optimal outputs in acquisition. University of Maryland *Working Papers in Linguistics* 5: 53-71.

Eckman, F.R. 1987. The reduction of word-final consonant clusters in interlanguage. In A. James and J. Leather (eds.), *Sound patterns in second language acquisition.* Dordrecht: Foris Publications.

Edge, B.A. 1991. The production of word-final voiced obstruents in English L1 speakers of Japanese and Cantonese. *Studies in Second Language Acquisition* 13: 377-393.

Gnanadesikan, A. 1996. *Markedness and faithfulness constraints in child phonology.* Amherst: MS. University of Mass.

Hancin-Bhatt, B. 2000. Optimality in second language phonology: Codas in Thai ESL. *In Second Language Research,* pp. 201-232.

Hancin-Bhatt, B. & R. Bhatt 1997. Optimal L2 syllables. *Studies in Second Language Acquisition* 19: 331-378.

Hazan, V. & Barrett, S. 2000. The development of phonemic categorization in children aged 6 to 12'. *Journal of Phonetics* 28: 377-396.

Hyman, L. M. 1975. *Phonology: Theory and Analysis*. New York: Holt, Rinehart and Winston.

Ingram, D. 1989. *First Language Acquisition: Method, description, and explanation.* Cambridge: Cambridge University Press.

Jarkey, Nerida. 1985. Consonant phonemes of White Hmong. ms.

Kirk & Demuth. 2003. Onset/Coda asymmetries in the acquisition of clusters. In Beachley, B., Brown, A., and Frances, C. (eds.), *Proceedings of the 27th annual Boston University Conference on Language Development,* pp. 437-448. Somerville, MA: Cascadilla Press.

Knoebel, S. 1986. *Hmong Production of Word-Final Obstruents in English.* (Master's Thesis, University of Minnesota , 1986). University of Minnesota.

Ladefoged, Peter. 1993. A course in phonetics, 3rd edition. Orlando, FL: Harcourt Brace Jovanovich, Inc.

Ladefoged, Peter. 1982. A course in phonetics. New York: Harcourt Brace Javanovich.

Lado, R. 1957. *Linguistics across cultures, applied linguistics language teachers.* Ann Arbor, MI: University of Michigan Press. Location: Dallas SIL Library 410.7L156.

Locke, J.L. 1983. *Phonological acquisition and change.* New York: Academic Press.

McCarthy, John & Alan Prince. 1994. The Emergence of the Unmarked: Optimality in Prosodic Morphology. In Merce Gonzalez (ed.), *Proceedings of the North-East Linguistics Society* 24. Amherst, MA: Graduate Linguistic Student Association. 333-379. ROA- 13. Rutgers Optimality Archive, http://roa.rutgers.edu/

McCarthy, John & Alan Prince. 1995. Prosodic Morphology. In John Goldsmith (ed.), *A Handbook of Phonological Theory*, pp. 318-366. Basil Blackwell, Oxford.

Nemser, W. 1971. Approximative systems of foreign language learners. *International review of applied linguistics* 9: 115-23.

Ohala, Diane. 1999. The Influence of Sonority on Children's Cluster Reductions. New York, NY: Elsevier Sciences Inc.

O'Malley, J.M., & Chamot, A.U. 1990. *Learning strategies in second language acquisition.* Cambridge: Cambridge University Press.

Prince, Alan & Smolensky, Paul. 1993. Optimality theory: constraint interaction in generative grammar. To appear, MIT Press. TR-2, Rutgers University Cognitive Science Center. pp. 234.

Seidenberg, M. S. 1997. Language acquisition and use: learning and applying probabilistic constraints. *Science* 275: 1599-1604.

Selinker, L. 1972. Interlanguage. *International review of applied linguistics* 10: 209-31.

Smalley, W. A. 1990. *Mother of writing: The origin and development of a Hmong messianic script.* The University of Chicago Press.

Smalley, W. A. 1976. The problems of consonants and tone: Hmong (Meo, Miao). In W.A. Smalley (ed.), *Phonemes and orthography: Language planning in ten minority languages of Thailand*, pp. 85-123. Department of Linguistics, Research School of Pacific Studies, Canberra, Australia: The Australian National University.

Steriade, D. 1982. *Greek prosodies and the nature of syllabification*. Unpublished Doctoral Dissertation. MIT, Cambridge.

Swain, M. 1995. Three functions of output in second language learning. In G. Cook & B. Seidlhofer (eds.), *Principles and practice in applied linguistics.* Oxford and New York: Oxford University Press.

Tesar, B. and P. Smolensky 1998. Learnability in Optimality Theory. *Linguistic Inquiry* 29: 229-268.

White, L. 2003. On the nature of interlanguage representation: Universal grammar in the second language. In Doughty, C. and Lang, M. (eds.), *The handbook of second language acquisition,* pp. 19-42. Blackwell Publishing.