AN INVESTIGATION OF SONORITY DISPERSION IN THAI-ENGLISH INTERLANGUAGE CODAS

Namassawan Patibat and Caroline Cochran

INTRODUCTION

Linguists have been searching for evidence of Universal Grammar in many aspects of language, including phonology. One area of recent phonological study is the types of sounds that can occur together in a syllable and their relative degrees of sonority. Some sound combinations are preferred to others across languages, and it is thought that Universal Grammar plays a role in determining which syllable types are most preferred. This study investigates one small part of syllable preferences: whether presumed UG principles of sonority are evidenced in the codas of the interlanguage of native Thai speakers of English.

Theoretical Background. Clements (1992) draws on earlier studies of sonority sequencing across languages and in child language acquisition to develop his theory of Sonority Dispersion, which states, in part, that "The preferred final demisyllable [nucleus plus coda] minimizes sonority dispersion" (p. 68) and that consequently "we should find no tendency for languages to maximize sonority distances in final demisyllables" (p. 72). He develops a mathematical model to predict precisely which demisyllables should be preferred, concluding that V alone is the preferred (least complex, or least marked) final demisyllable, followed by VG, VL, VN, and VO[1], in ascending order of complexity. Where consonant clusters occur, he predicts that the least marked cluster would be VGL, followed by VLN / VGN, then VNO / VGO, and finally VLO. He combines stops and fricatives as O (obstruent) and, because of the way his mathematical formula is set up, does not allow for analysis of clusters containing two consonants in the same category, such as VOO.

Clements' work was in part based on Greenberg's (1978) study of 104 languages. In that study, Greenberg looked at the combinations of sounds that were possible in each language and drew conclusions about which combinations were most prevalent across languages. Unlike Clements, Greenberg separated stops and fricatives into two categories, and found that "...in final systems [codas] the presence of at least one combination of stop + stop implies the presence of at least one combination of fricative + stop" (p. 254). He added that most languages with stop + stop have both stop + fricative and fricative + stop, with a slight preference for fricative + stop. Another of his findings was that "in final systems the existence of at least one fricative + fricative combination implies the presence of at least one stop + fricative or at least one fricative + stop combination" (p. 255). Thus, he found the plateaus SS and FF to be more marked than FS and SF[2]. Although SF violates the sonority sequence, with the more sonorous F following the less sonorous S, he did not find it to be treated very differently from FS, which does not violate the sequence.

Clements and Greenberg dealt primarily with sound patterns of native languages. Eckman (1987 and 1991) extended the study of sonority sequencing to interlanguage, testing his hypothesis that "The universal generalizations that hold for the primary languages hold also for interlanguages" (Eckman 1991: 24). To do so, he used several of Greenberg's principles, including those regarding fricatives and stops, stated above. He tested these on Japanese, Korean, and Cantonese ESL learners

---

[1] Where V=vowel, G=glide, L=liquid, N=nasal, O=obstruent.

[2] Where S=stop, F=fricative.

and found that the interlanguage generally conformed to the universal principles. The study described here uses the interlanguage of native Thai speakers of English to investigate Clements' claims in general, and, more specifically, to present evidence supporting or refuting his decision to combine stops and fricatives under the single heading obstruent. It also presents further evidence on Eckman's hypothesis that interlanguage behaves like established languages in important respects.

About the Thai Language. Thai has a fairly large inventory of consonants in onset position, but a smaller inventory in coda position (Jantharet, 1978). Clusters (stop-glide and stop-liquid) can occur in onsets, but no clusters are found in codas.

Table 1. Thai Consonants

Consonant types	Single-C Onset	Single-C Coda
Glides	y, w	y, w
Liquids	r, l	--
Nasals	m, n, ŋ	m, n, ŋ
Fricatives/affricates	f, s, ʧ, h	--
Stops	b, p, pʰ, d, t, tʰ, k, kʰ, c, ʔ	p, t, k,ʔ

Sounds that occur in English but not in Thai are chiefly fricatives: v, z, θ, and ð. Also, the Thai [r] is trilled, and occurs only in onset position. Thus we would expect our subjects to have many problems with these sounds in coda position. All coda stops are unreleased in Thai, which could present problems in transcription because of the difficulty of hearing unreleased final stops.

Subjects. The data used to investigate sonority sequencing in this paper were gathered from the speech of five subjects. All are Thai students pursuing their master's degrees in the United States. At the time of the study, they had been living in Virginia for a period ranging from 1-1/2 to 2 years. Three of the subjects are female and two are male; all are between the ages of 24 and 31. English is their only second language.

The data were also obtained from two native English speakers as a control group. The backgrounds of the subjects are shown in Table 2.

Table 2. Subjects

Thai Speakers

Subject	Birthplace	NL	Age	Sex	Time in U.S.	Level of English Proficiency
S-1	Bangkok	Thai	26	M	1 1/2 years	Advanced
S-2	Bangkok	Thai	26	F	2 years	Advanced
S-3	Bangkok	Thai	24	M	1-1/2 years	Advanced
S-4	Bangkok	Thai	31	F	2 years	Advanced
S-5	Bangkok	Thai	26	F	1-1/2 years	Advanced

English Speakers

Subject	Birthplace	NL	Age	Sex
C-1	California	English	14	F
C-2	Wisconsin	English	46	M

Materials. The data were elicited from three reading tasks. The first task involved reading a passage consisting of a series of sentences. The passage was controlled by using simple words with straightforward spelling and by excluding clusters formed by "ed" morphology to minimize the effects of spelling and possible effects from cognitive misperceptions of morphology. (However, "s" morphology and "th" morphology were included, which could complicate interpretation of the data.) Each sentence ends with consonant clusters to construct true coda behavior and constrain interference from adjacent sounds. Each of the subjects was allowed to look over the passage briefly and then read it aloud. A list of questions following the passage was prepared. It was hoped that the subjects, knowing questions were to follow, would concentrate more on the meaning than the pronunciation of the passage, leading to more "natural" pronunciation. However, the subjects expressed anxiety about memorizing information to answer the questions. Therefore, the questions were disregarded.

The second task involved reading a separate list of short, unrelated sentences, presented after completion of the main passage. The purpose of this activity was to test whether subjects could pronounce the individual sounds that occur in English but not in Thai, and also whether they could pronounce, in a coda, sounds that occur only in onsets in Thai. Single consonants representing the individual sounds were presented at the end of sentences. A few unusual consonant clusters that could not be worked into the main passage also appear in this list.

The third task was a series of four unrelated sentences, each ending in a non-morphological VSF cluster.

These three data gathering instruments are presented in Appendix A.

As for the method of data collection, readings were recorded using a 33-1067 Dynamic microphone and Radio Shack SCR-59 tape recorder. The initial data-gathering process took place in one sitting at Bangkok Street Grill & Noodles Restaurant, where all subjects are employed as part-time waiters and waitresses. The on-site transcription was conducted as a valuable backup to transcribing from the tapes, since the reduced Thai consonants could be detected when visual as well as oral cues were present.

Forty-five sentence-final clusters were tested on each of five subjects and two controls, along with eight single-consonant codas. At first, each cluster was presented once. After an initial analysis of the results, it was decided to discard the data from two words (laughs and parades) because of probable interference from spelling or morphology. In addition, some unusual results in the tests for SS, FS, FF, and LS required more data for confirmation. Consequently, the subjects were tested two more times, using a series of unrelated sentences (shown in Appendix A, Parts II and III) to gather these additional data, and the results of all data collection sessions were combined. In all, the data include 60 cluster tokens and 8 single-consonant tokens for each of 5 subjects, for a total of 340 tokens. There are also 135 tokens from two controls (one control skipped one sentence).

The coda clusters and single consonants were transcribed in a close phonetic transcription. Two transcribers worked separately on the transcriptions in Parts I and II to determine a reliability measure. A point-to-point comparison of the transcription indicated the sum of 72 disagreements and 375 agreements. The number of agreements thus yielded 83.89%, which was judged to be acceptable. (Part III was transcribed by only one transcriber.)

Data. The data for each of the seven subjects are categorized according to whether the component sounds occur in Thai, and whether they occur in codas. Six categories involving two consonants are arranged as follows:

IA Both sounds occur in Thai codas.
IB Both sounds occur in Thai, but not in codas.
IC Neither sound occurs in Thai.

IIA Both sounds occur in Thai, but only one in codas.
IIB One sound occurs in Thai codas, one sound does not occur in Thai.
IIC Neither sound occurs in Thai codas, one sound does not occur in Thai.

We would expect that the data from Category I would be easier to analyze and would yield more convincing results than those in Category II, since Category I compares sounds that hold equal status in Thai, while Category II contains sounds with unequal status. Thus, in Category II, we would expect to find interference from native language (NL) preferences. For example, in a [nθ] cluster, we would expect that, if one sound were deleted, that the more familiar [n] would be retained and the less familiar [θ] would be deleted.

The data from single consonants are also divided into two groups:

I Individual sounds that occur only in Thai onsets.
II Individual sounds that do not occur in Thai at all.

The full transcriptions of the data appear in Appendix B.

Hypothesis. We predict that the native Thai speakers will find it difficult to pronounce English final consonant clusters, since final clusters do not occur in Thai. Where errors are made in pronunciation of these clusters, we predict that the resulting final demisyllables will have a lesser sonority dispersion than the target demisyllable. In other words, if the target word is "mask," we predict that errors will tend to result in [mæs], in accordance with Clements' (1992) theories, rather than [mæk], because [s] is more sonorous than [k], thus the sonority dispersion of VF [æs] is less than VO [æk].

With regard to Clements' rankings of demisyllable complexity, we expect our data to show that VLO is the hardest for our subjects to pronounce, followed by VNO/VGO, then VLN/VGN, and finally, VGL as the easiest to pronounce.

However, with regard to Clements' combining stops and fricatives under the single heading of obstruent, we expect to find, as Greenberg did, that some significant differences exist between the way stops and fricatives are treated by speakers, such that these two categories of sounds should be considered separately.

Finally, on a more general note, we expect that the Thai-English interlanguage will show, as Eckman (1991) predicts, that the same Universal Grammar processes that operate in native language are operating in the interlanguage of our subjects.

RESULTS

As expected, the subjects had considerable difficulty producing final consonant clusters. The principal strategy for dealing with this difficulty was deletion (cluster reduction). Epenthesis was rare (only one instance), and may have been motivated by spelling. There were several instances of substitution, especially, but not exclusively, when the substituted sound was not present in the NL. Metathesis occurred in a few instances. Devoicing was the most common process observed.

Among the control group, a few of the same processes were observed, but they were considerably less frequent. Specifically, there were 12 instances of devoicing and 8 of cluster reduction. (There was also one instance of voicing—"baths" [bæθs] became [bæðz]—w hich could have resulted from a confusion with "bathes.") Except where noted, the control data do not appear in the Results or Analysis sections. The full transcriptions appear in Appendix B.

Before analyzing the data for evidence supporting or refuting Clement's hypothesis, it is necessary to explain a few of the processes that could affect our analysis and discuss how we dealt with them.

Devoicing. Of 70[3] instances (14 clusters X 5 subjects) where one or more voiced stops or fricatives occurred in the cluster, devoicing occurred in 62 cases, or 89%. Among the five voiced single-stop or -fricative codas tested, 20 out of 25, or 80%, were devoiced. We decided not to treat every devoiced segment as an error, since the devoicing errors might obscure more subtle distinctions in the data. Instead, we have analyzed the data without regard to devoicing, Thus, a target of [dz] would be analyzed as simply a coronal SF cluster, and would be judged correct if [ts], [ds], or [tz] were produced, but incorrect if [dt] occurred. Given both the near-universality of devoicing among the subjects and the relatively high incidence among controls, this seemed a reasonable course.

Coronal Effect. Paradis and Prunet (1991) have pointed out the special status of coronals in language. In fact, one of the clearest tendencies in our data was for coronals to be treated differently from velars or labials. This tendency could influence our sonority results, as it could either magnify or diminish sonority dispersion effects, depending on which coronals were affected. Among Category I results (in which each of the two consonants in a given cluster held the same status within Thai), where a coronal and a consonant of another place node occur together and deletion occurs, the deleted element is almost always a coronal as shown in Table 3A.

Table 3A. Deletion Among Clusters Including One Coronal and One Labial or Velar: Category I

Type of target cluster	SS (kt,pt)	FF (fs,vz)	lf	lb	Total
# of tokens	30	15	5	5	55
Labials or velars deleted	3	0	0	0	3
Coronals deleted	13	5	1	1	20
Total deletions	16	5	1	1	23

Among clusters in Category II (each holding a different status in Thai), the coronal also tends to delete, regardless of whether it is the most or least "familiar" in that position. Thus, for example, the [s] deletes from [sp] and the [t] deletes from [ft], even though the stops [p,t] both occur in coda position and the fricatives [s,f] do not.

Table 3B. Deletion among Clusters Including One Coronal and One Labial or Velar: Category II

Target Cluster	sk	sp	ft	lk	lp	lm	ks	Total
# of tokens	10	10	10	5	5	5	15	60
Labials or velars deleted	4	0	0	1	0	0	0	5
Coronals deleted	3	3	7	3	4	4	5	29
Total deletions	7	3	7	4	4	4	5	34
Coronal is least familiar	x	x		x	x	x	x	22
Coronal is most familiar			x					7

[3] Recall that "laughs" and "parades" were not used in any of the analyses.

Coronals also predominated in additions and substitutions, though the small number of instantiations make the trend less clear. There were three instances in Category I where a place of articulation was changed (ŋk→sk, ŋk→nk, mp→pt) and two instances of consonant epenthesis (fs→fts, fs→lps). In each case, a coronal was added. In Category II, there were three such instances (sk→t[4], ŋθ→nθ, fθ→fp). In two cases, the change was to a coronal.

Finally, there was some difference in the error rate for coronal-coronal clusters vs. clusters containing a coronal plus a labial or velar, though the data are not consistent. Among the Category IIA clusters sk, st, sp, ft, lk, lt, and lp, subjects achieved the target cluster more frequently on coronal-coronal combinations than on coronal-other combinations. However, in the Category IA NS clusters, no difference is observed, and in the (voiced) FS combinations in Category IIC the reverse effect is seen.

For these reasons, all clusters containing a coronal plus a labial or velar are removed from the deletion analyses in Tables 7 and 8.

Problems with Clusters Containing Liquids. Our subjects had considerable more difficulty producing ɹ-clusters than l-clusters. Without exception, the [ɹ] is deleted in clusters with stops or nasals, yet it is retained in all ɹ-F clusters. By contrast, l-clusters show more of the same processes that are found in the rest of the data. Beebe (1987) mentions the difficulty of gathering accurate data from Thai [ɹ] because of socio-linguistic factors (the various types of initial trilled "r" sounds in Thai being marks of status). These factors led us to discount these data, and use only the l-data for analysis of liquid-clusters.

Problems with Clusters Containing Glides. The data for clusters containing glides presented some problems. There were only three such clusters in the tests—[wt] (out), [wl] (owl) and [jl] (boil)— and only one test of each cluster per subject. Thus the results include only 15 instances of clusters that include glides.

The results for the different types of clusters varied considerably. On the one hand, the [wt] cluster (Category IA) was produced accurately by all but one subject. On the other hand, the [wl] and [jl] clusters (Category IIA) were correctly produced by only one subject in each case.

Glides may be a special problem for Thai NL speakers. Thai contains a number of diphthongs. Perhaps the "glides" that we attempted to test were actually treated as diphthongs by our subjects. Perhaps the relative familiarity of [t] vs. [l] in coda position is a factor. Perhaps the familiarity of the words plays a part also: "out" is far more common than "owl." Further, "boil" can be easily understood by the speaker when the glide is omitted, whereas "out" can be confused with "ought." On the other hand, maybe it's the liquid in the [jl] and [wl] clusters that is somehow causing the errors.

The other possibility is that Clements is simply wrong in stating that VGL should be easier than VGO. However, due to the difficulty of interpreting our data on glide-clusters, we cannot draw any such conclusion based on these results. While we have included the glide data in our analysis, they cannot be given much weight in drawing conclusions.

Variations Among Individual Subjects. Each subject's responses were analyzed separately for accuracy to determine whether there were any major differences in the types of phonetic changes that were made by each subject. First the number of target productions was calculated for each subject, then the number of partially correct productions, discounting devoicing and errors in place of articulation (for example, [nd] was considered as "near-target" if it was produced as any NS cluster). Results are as follows:

---

[4] This could also have been deletion of k and stopping of s.

Subject	S-1	S-2	S-3	S-4	S-5
# of target clusters	16	24	14	23	12
# of near-target cluster types	23	33	24	32	22

While the subjects differed in quantity of correct answers, there were few differences in the quality of their responses. S-1 showed somewhat more tendency to produce fricatives (both correctly and incorrectly). S-5 produced the most unusual responses: two the three instances of C-epenthesis, both instances of OO→[ʃ], both instances of O→[ʧ] in single-C codas, and two of the four instances of metathesis. Other than S-5's [ʃ] and [ʧ], no subject produced a type of phonetic change that was entirely absent from the others' responses. With this degree of consistency among the subjects, it seems reasonable to group their responses for evaluation.

A Note on Percentages. In the analysis, percentages are used for comparing categories of data. It must be stressed that these percentages are given for convenience only. In fact, many of the categories are too small (as small as 5 tokens) for percentages to be calculated, and compared, with any reliability. In each case, the actual numbers of tokens are given alongside the percentages.

ANALYSIS

Clements assigns "complexity rankings" to sequences of consonant clusters according to a formula that takes into account the sonority distances between the members of the cluster.[5] Basically, his formula calculates the sums of the inverses of the sonority distances between members of a cluster. According to his analysis, the most favored final demisyllable should be VGL, followed by VLN / VGN, then VNO / VGO, and finally VLO. Because the inverse of 0 (1/0) is an impossible number, he cannot calculate the dispersion values for VOO, VNN, and the like, where the sonority distances between two members of the cluster is 0. However, we can extrapolate relative difficulty from the rankings he does calculate. It seems reasonable to say that VGG would have a low sonority difference and VOO a high one. Thus, VOO should be relatively complex—perhaps the most complex of all the two-consonant clusters. This analysis results in the following rankings of difficulty for two-consonant final demisyllables:

5	VOO	Hardest, least preferred
4	VLO	
3	VNO, VGO	
2	VLN, VGN	
1	VGL	Easiest, most preferred

If we separate obstruents into stops and fricatives, we can extrapolate about the relative difficulty of clusters involving these sounds as well. Linguists generally agree (e.g., Tropf, 1986) that the sequence of least sonorous to most sonorous is as follows: S,F,N,L,G,V. Thus, VFS should be

---

[5] V is the most sonorous, followed by G, L, N, and O. Thus, VO has a sonority difference of 4, while VG has a difference of 1. The 3-member cluster VLO has values of 2, 2, and 4, while VGL has 1, 1, and 2. These values are inserted into his formula to obtain the sonority dispersion values.

$$D= \sum_{i=1}^{m} 1/d_i^2$$

where D = dispersion; m= the number of pairs of segments; and d = sonority distances.

less complex than VSS. In fact, Greenberg's (1978) findings support this conjecture. However, by the same reasoning, VSF should be more complex than either VFS or VSS, since it violates the sonority sequence. However, Greenberg's findings do not confirm this, nor do they confirm VFF as less marked than VSS. What they do show is that VFF and VSS are highly marked, and that VFS and VSF are somewhat less so. These relationships are investigated in our study.

We analyze the data from two different angles: First, we look at which cluster types result in the most correct productions of the target (this should tell us which clusters are the easiest, or least complex) and second, we look at patterns of deletion in consonant clusters, assuming that, other factors being equal, the least sonorous element should be deleted. We do not attempt to analyze substitutions or additions, even though some of these appeared quite interesting.

Evidence from Correct vs. Incorrect Productions of Clusters. The evaluation of the demisyllable types to determine which were the easiest for our subjects to pronounce yielded little evidence to support Clements' complexity rankings of demisyllables, and considerable evidence against his combination of stops and7 fricatives under the single heading of obstruent. The data are tabulated in Table 4 according to category and demisyllable type. (Note that the ɹ-cluster data have been omitted, but that the questionable glide-cluster data are included.) In this table, clusters are considered "correct" if the subject produced the correct cluster *type*, regardless of errors in voicing or place of articulation. Thus, for example, when the target was [nd], any NS combination was considered "correct."

Table 4. Proportions of Correct Productions by Demisyllable Type

Complexity Ranking	Syllable Type	Number of Tokens	% Correct (target)
Category IA			
5	VOO (VSS)	30	37%
3	VNO (VNS)	15	53%
3	VGO (VGS)	5	80%
Category IB			
5	VOO (VFF)	10	10%
4	VLO (VLS)	10	20%
4	VLO (VLF)	5	80%
Category IC			
5	VOO (VFF)	9[6]	22%
Category IIA			
5	VOO (VSF)	30	77%
5	VOO (VFS)	40	35%
4	VLO (VLS)	20[7]	37%
3	VNO (VNS)	5	40%
2	VLN	10	20%

[6] Only 9 of 10 tokens are used, because of probable interference from spelling in one case.

[7] Ten of these were coronal stops, 5 velar and 5 labial. The proportions were adjusted so that each place category had equal representation in the final percentage.

1	VGL	10	20%
Category IIB			
3	VNO (VNF)	25	84%
Category IIC			
5	VOO (VSF)	15	80%
5	VOO (VFF)	10	20%
4	VLO (VLF)	5	100%

There was considerable agreement across categories on the percentages correct for each demisyllable type. The biggest deviation was from the data for clusters that included a single, final fricative. Table 5 summarizes the data for each demisyllable type, first with S and F treated separately, then combined. However, the combined percentages *exclude* the final-fricative results.

Table 5. Summary of Correct Productions

Complexity Ranking	Demisyllable Type	# of Tokens	Percentage Correct	Combined % Correct, *excluding final fricatives*
5	VOO --VSS	30	37%	30.2%
	-- VFS	40	35%	
	-- VFF	29	17%	
	-- VSF	45	79%	
4	VLO -- VLS	30	31.3%	31.3%
	-- VLF	10	90%	
3	VNO -- VNS	20	50%	50%
	-- VNF	30	83%	
	VGO	5	80%	80%
2	VLN	10	20%	20%
1	VGL	10	20%	20%

As the tables show, some of the results were rather startling, while others conformed rather well to what was expected. The most surprising phenomenon was the ease with which our subjects pronounced all clusters ending in a single fricative. Another surprise was the extreme difficulty of the VFF cluster compared to the VSS cluster. What factors could account for these results?

The first possibility is that morphology is playing a major part. Two-thirds of the VSF clusters included a plural [s]. Perhaps our subjects, all advanced speakers of English, have learned the English plural very thoroughly, and are extremely conscientious in retaining this morphology. While this is possible, it cannot entirely explain the results, because 15 of the tokens were non-morphological [ks] sounds elicited by words ending in "x" (tax, fax, and box). These "x" words showed 65% accuracy: not as accurate as the morphological "s" endings (87%), but considerably more accurate than the other VOO results. Further, some of the VNF data were not morphological: "nymph" was produced with 80% accuracy. Ten of the other VNF tokens used less common morphologies: "tenth" and "strength" were each produced with 60% accuracy. Thus, even the fricative [θ], which does not even occur in Thai, is pronounced rather accurately in coda-final position following another consonant.

Sonority sequencing cannot help us at all with our mystery: it would predict that VSF should be harder than VFS, and this is obviously not the case. One possibility is that the sonority reversal is causing the [s] in the VSF clusters to be treated as extrasyllabic. This may be the case in the VSF data, but there would seem to be no motivation for extrasyllabicity in VLF and VNF clusters, which are also pronounced with surprising accuracy.

Another factor is NL transfer. Perhaps since fricatives and liquids are not found in Thai codas, they are especially difficult for our subjects to pronounce. This factor may account for the difficulty of VFF relative to VSS and VFS, but it cannot account for the VSF results, nor can it account for the difference between VLS and VLF. If both liquids and fricatives are unfamiliar to our subjects in codas, why is VLF pronounced with much greater accuracy than VLS?

The OCP (Obligatory Contour Principle) is another factor to consider. OCP constraints would dictate that VSS and VFF are harder to pronounce than VSF or VFS, and this is partially true: VFF is definitely harder than VSF and VFS. But the fact that VFS is about equally difficult as VSS partially contradicts this notion. And of course the OCP cannot explain the vast difference between VFS and VSF, nor can it shed any light on the relative difficulty of pronouncing VNS/VLS compared to VNF/VLF.

Table 6 summarizes this discussion of the competing effects that may bear on our data. A simple numerical score is used to indicate whether each factor applies to a given cluster. No attempt is made to quantify the relative strength of any factor, thus the measure is very crude. Note that some clusters receive a "-2" ranking in a particular box. This is because both members of the cluster contain a given trait. For example, recall that fricatives are prohibited in Thai codas. Thus, VFF is "-2" for NL transfer of coda constraints because it contains two fricatives, while VFS is "-1" because it contains only one fricative.

As Table 6 shows, the factors discussed above can explain some of the phenomena we observed: results for the VFF cluster are particularly illuminating. However, the factors still fail to fully explain the difficulty our subjects had with VLN and the startling ease with which they produced clusters ending in fricatives.

Table 6. Factors That Could Affect Production of Clusters

Cluster Type	NL Transfer of Coda Constraints	OCP	Sonority Reversal	Morpho-logy	Total	Percen-tage Observed
VFF	-2	-1		+1	-2	17%
VSS		-1			-1	37%
VFS	-1				-1	35%
VSF	-1		-1	+1*	-1	79%
VLS	-1				-1	31.3%
VLF	-2			+1	-1	90%
VLN	-1				-1	20%
VNS					0	50%
VNF	-1			+1*	0	83%

* Of the VSF data, 15 of 45 were not morphological; of the VNF data, 5 of 30 were not morphological.

Looking next at the question of how our data correlate with Clements' specific complexity rankings, we can see that the results are inconclusive in Table 4. However, Table 5 shows some tendency for the demisyllables to become easier from Ranking 5 to Ranking 3 once we set aside the clusters that include final fricatives. On the other hand, Rankings 2 and 1 fail entirely to confirm Clements' model. As mentioned in the "Results" section, some of the discrepancies in Rankings 1 and 2 may relate to problems with glide-clusters. However, there would seem to be no good explanation for the failure of the VLN demisyllable to conform to Clements' theory.

Unfortunately, Rankings 1 and 2 include only 10 tests each, so it is difficult to draw further conclusions.

Evidence from Deletion. How was sonority of the final demisyllable affected by cluster reduction? To avoid problems with native language transfer of coda preferences, we will look first at Category I results. In Category I, a total of 32 deletions occurred (excluding "laughs" and the [ɹ]-cluster data). Of these deletions, only 11 affected sonority (most were deletions of one member of the VSS clusters). Of the remaining 11 deletions, 8 retained the more sonorous member of the cluster, and 3 retained the less sonorous member. However, 3 of the tokens involved clusters containing a coronal and a velar or labial. Recall from the Results section that coronals behaved differently than other sounds, tending to predominate in deletions. Thus, we must purge the data of the coronal effect by expunging these 3 tokens. Of the remaining 8 deletions, 7 produced a more sonorous coda, and 1 produced a less sonorous coda. These data are illustrated in Table 7 below.

Table 7. Sonority Changes in Category I

Type of Change Observed	More Sonorous (no. of tokens)	Less Sonorous (no of tokens)
IA: mp→m	2	
nt→t		1
nt→n	1	
IB: ld→l	4	
Totals	7	1

This is strong evidence in support of Clements' general claim that sonority is maximized in codas.

Category II data present additional problems for analysis because the coda clusters are not of equal status in Thai. This introduces the extra factor of possible transfer of coda preferences from the native language. With this factor in mind, we will attempt to analyze the Category II data. In this category, a total of 63 deletions occurred, 59 of which affected sonority. Of the 59, 22 resulted in a more sonorous coda and 37 in a less sonorous coda. However, many of these tokens included coronal/velar or coronal/labial clusters. When the data are purged of the coronal effect, 22 tokens remain, of which 12 produced more sonorous codas and 10 less sonorous. Of the 10 less sonorous, 4 were glide-clusters, which, as noted in the Results section, present special problems in Thai. If they were eliminated from the data, that would leave 12 more sonorous and 6 less sonorous codas.

Table 8. Sonority Changes in Category II

Change Observed		More Sonorous (no. of tokens)	Less Sonorous (no. of tokens)	(NL Coda Preference)
IIA:	st→s	4		
	st→t		1	(1)
	nd→n	3		
	mf→f		1	
	lt→l	1		
	lt→t		1	(1)
	ln→l	1		
	ln→n		2	(2)
	jl→l		4	
IIB:	ŋθ→n	1		(1)
IIC:	dz→s	2		
	dz→t		1	(1)
Totals		12	10	6

As Table 8 shows, 5 of the instances in which a less sonorous sound was retained in the coda can be explained by that sound being more familiar to the speaker, in other words, by NL transfer of coda preferences. Specifically, st→s is very strong evidence for Clements' views, as the least familiar sound is chosen over the more familiar. Conversely, the preference for ln→n is weakened by the fact that [n] is the more familiar sound in coda position.

In summary, the evidence for more sonorous codas is very strong in Category I, where both sounds have equal coda status in Thai. In Category II, preferences are more difficult to discern because of the extra factors of native language coda preferences and problems with glides, in addition to the OCP and coronal effects that are found in both sets of data. However, even in these data, a preference is shown for more sonorous consonants in codas.

CONCLUSION

First, evidence was found to support Clements' general views that sonority differences are minimized in final demisyllables: the deletion data showed that the less sonorous member of the cluster tended to be deleted, leaving the more sonorous consonant, and hence less "sonority distance" between the vowel and the remaining consonant.

Second, Clements' precise rankings of preference for coda types could not be confirmed. Table 5 showed some trend toward greater accuracy in pronounciation as sonority distances decreased from our categories 5 to 3, but then the trend broke down for Categories 2 and 1. However, other factors besides a preference for particular coda types (as shown in Table 6) could have accounted for the trend in Categories 5 through 3, just as a number of other factors could have accounted for the breakdown in the trend in Categories 1 and 2. In both instances (Categories 5-3 and Categories 2-1) our evidence is inconclusive.

Third, strong evidence was found against Clements' practice of grouping stops and fricatives, as these two consonant types were treated dramatically unequally by our subjects. VFF was considerable harder for our subjects than was VSS or VFS, while VSF (even when the morphological data were discounted) was dramatically easier.

Most of the results could be explained by a combination of Clements' theory, NL transfer, and OCP and coronal effects. However, the fact that clusters ending in a single fricative were produced with astonishing accuracy remains a mystery. To further explore this problem would require more research, including data from beginning and intermediate speakers; more data involving final-fricative clusters that are not morphological; data employing the "ed" morphology, for comparison with the "s" morphology data; and finally, a search of the literature for data on final-fricative coda clusters in other interlanguages.

Finally, we found ample evidence for Eckman's (1987 and 1991) hypothesis that interlanguage exhibits many of the same universals as do established languages. Both our subjects and our controls employed final devoicing and cluster reduction. Our subjects found VSS and VFF plateaus, which violate the OCP, very difficult to pronounce. Coronals were treated differently from labials or velars, predominating in deletions and substitutions. Only the affinity by our subjects for the VSF, VNF and VLF combinations remains anomalous.

REFERENCES

Beebe, Leslie M. 1987. Myths About Interlanguage Phonology. In G. Ioup and S. Weinberger (eds.), *Interlanguage Phonology: The Acquisition of a Second Language Sound System*. Cambridge, MA: Newbury House Publishers.

Clements, G. 1992. The Sonority Cycle and Syllable Organization. In W. Dressler, H. Luschutzky, O. Pfeiffer, and J. Rennison (eds.), *Phonologica 1988*. Cambridge: Cambridge University Press.

Eckman, F. 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.

Eckman, F. 1991. The Structural Conformity Hypothesis and the Acquisition of Consonant Clusters in the Interlanguage of ESL Learners. *Studies in Second Language Acquisition*. Cambridge: Cambridge University Press, 13: 23-41.

Greenberg, J.H. 1978. Some Generalizations Concerning Initial and Final Consonant Clusters. In J.H. Greenberg (ed.), *Universals of Human Languages*, vol. 2: Phonology. Stanford: Stanford University Press, 243-279.

Jantharat, P. 1995. *Thai Sound System and Reading Rules*. Washington, D.C.: Siam West Service.

Paradis, C. and J-F. Prunet. 1991. Introduction: Asymmetry and Visibility. In C. Paradis and J-F. Prunet (eds.), *Phonetics and Phonology 2: The Special Status of Coronals*. San Diego: Academic Press.

Tropf, H. 1986. Sonority as a Variability Factor in Second Language Phonology. In A. James and J. Leather (eds.), *Sound Patterns of Second Language Acquisition*. Dordrecht: Foris.

Appendix A: Reading Tasks

Part I: Initial Task

IA: Story Sentences

There are many kinds of animals on earth.
Every day we see cats.
We see dogs.
Maybe a squirrel or a chipmunk.
A raccoon with a mask.
Or a bee or a wasp.
But we usually don't see many tigers.
Or lion cubs.
Except maybe in parades.
We hear a dog bark.
Sometimes we hear it yelp.
We hear a bird chirp.
Some people live on a farm.
They might hear other animals.
For example, pigs, chickens or ducks.
If they raise bees, they can hear buzzing in the hives.
At night, maybe they hear an owl.
But at a zoo, people see and hear other things.
They see a lion or a wolf.
Maybe they see deer and elk.
Is the weather cold?
Then maybe there's a polar bear outside, sitting on a stump.
The lion roars.
The hyena laughs.
It's interesting to watch how the animals act.
How do they adapt?
Do they try to hunt?
If it's a nocturnal animal, maybe it just sleeps.
For some animals, life in a zoo is easy.
For others, it's hard.
For example, elephants like to take baths.
But most zoos have no streams!
Their skin can get dried out.
Some animals need lots of exercise.
If they can't exercise, they lose a lot of strength.

Questions: True or false?

1. Tigers live on a farm
2. Ducks live on a farm.
3. Birds say "yelp."
4. Nocturnal animals sleep at night.
5. Dogs wear masks.

6. Elephants like baths.
7. Bees like to take baths.
8. An elk says "chirp."

IB: Unrelated Sentences

It's on the left.
It's a helm.
It's a kiln.
It's a bag.
It will boil.
I like math.
I like beer.
I like puffs.
I take five.
I like jazz.
Call a cab.
I am mad.
She bathes.

Part II: Supplemental Reading Task

I like cuffs.
I like to do my best.
I like them all.
I like to stand.
Read the script.
I like beds.
He is the fifth.
Use tact.
She is the tenth.
I see a bulb.
I have a belt.
At last.
On the desk.
It's a lisp.
I like craft.
He is apt.
Make a pact.
It's a cult.

Part III: Supplemental Reading Task

I paid the tax.
I sent a fax.
It's a box.
It's a nymph.

Appendix B: Complete Transcriptions

Category IA: Both in Thai Codas

Target	S-1	S-2	S-3	S-4	S-5	C-1	C-2
kt (pact)	k	kt	k	k	t	`kt	kt
(tact)	ks	kt	k	kt	kt	kt	kt
(act)	ks	kt	kt	k	ʃ	kt	kt
pt (adapt)	ps	pt	p	pt	p	pt	pt
(script)	p	p	p	pt	p	p	pt
(apt)	pt	pt	p	p	t	pt	pt
ŋk	ŋk	ŋk	ŋk	sk	nk	ŋk	ŋk
nt	ns	nt	n	nt	t	nt	nt
mp	m	m	mp	pt	mp	mp	mp
wt	wt	wt	w	wt	wt	wt	wt

Category IB: Neither in Thai Codas, both in Thai Onsets

Target	S-1	S-2	S-3	S-4	S-5	C-1	C-2
fs (puffs)	f	ps	ps	ps	fts	fs	fs
(cuffs)	fs	ps	ps	f	lps	f	fs
(laughs)	fs	f	ʃ	fs	ʃ	f	fs
lf	f	lf	lf	lf	lf	lf	lf
lb	blʌp	lb	lp	b	blap	lb	lb
ld	ls	l	l	l	l	ld	ld

Category IC: Neither in Thai

Target	S-1	S-2	S-3	S-4	S-5	C-1	C-2
ðz	dəs	s	ts	θ	ʃ	ð	ðz
vz	f	fs	fs	f	f	vz	vs
ɹz	ɹs	ɹs	ɹs	ɹs	ɹs	ɹz	ɹs
ɹθ	θ	θ	đ	θ	t	ɹθ	ɹθ

Category IIA: One in Thai Codas, One Only in Thai Onsets

Target	S-1	S-2	S-3	S-4	S-5	C-1	C-2
ks (ducks)	ks	ks	ks	ks	ks	ks	ks
(tax)	k	ks	k	ks	ks	ks	ks
(fax)	ks	ks	k	ks	ks	ks	ks
(box)	k	ks	k	ks	kt	ks	ks
ts	ts	ts	ts	ts	ts	ts	ts
ps	fs	ps	ps	ps	ps	ps	ps

Category IIA: One in Thai Codas, One Only in Thai Onsets (cont'd)

Target	S-1	S-2	S-3	S-4	S-5	C-1	C-2
sk (mask)	sk	t	s	sk	k	sk	sk
(desk)	s	k	s	sk	k	sk	sk
st (best)	s	st	st	st	s	st	s
(last)	s	s	st	st	t	st	st
sp (wasp)	sp	p	p	sp	ps	p	sp
(lisp)	sp	ps	sps	pt	p	sp	sp
ft (left)	f	ft	f	f	f	ft	ft
(craft)	f	ft	f	f	ft	ft	ft
nd	n	n	n	nd	nt	nt	nd
mf	mf	mf	mf	mf	mf	mpf	mf
lk	l	k	k	lk	k	lk	lk
lt (belt)	lt	lt	l	lt	lt	lt	lt
(cult)	f	lt	lt	lt	t	lt	lt
lp	p	p	lp	p	p	lp	lp
lm	lm	m	m	m	m	lm	lm
ln	l	nn	n	n	ln	ln	ln
jl	l	jl	l	l	l	jl	jl
wl	ls	l	wl	l	l	wl	wl

Category IIB: One in Thai Codas, One Not in Thai

Target	S-1	S-2	S-3	S-4	S-5	C-1	C-2
mz	ms	ms	ms	ms	ms	mz	ms
nz	ns	ns	ns	ns	ns	ns	ns
ŋz	ŋs	ŋs	ŋs	ŋs	ŋs	ŋs	ŋs
nθ	nθ	nθ	nt	nθ	nt	nθ	nθ
ŋθ	ŋθ	n	ŋθ	nθ	ŋt	ŋθ	ŋθ
ɹm	m	m	m	m	m	ɹm	ɹm
ɹk	k	k	k	k	k	ɹk	ɹk
ɹp	p	p	p	p	p	ɹp	ɹp

Category IIC: One Only in Thai Onsets, One Not in Thai

Target	S-1	S-2	S-3	S-4	S-5	C-1	C-2
bz	ps	ps	ps	ps	ps	bz	bs
dz (beds)	t	s	ts	s	ts	dz	dz
(parades)	ds	s	s	dəs	dIs	ds	ds
gz	ks	ks	kθ	ks	gs	ks	gz
fθ	fθ	ft	f	fs	fp	fθ	fθ
θs	ts	θ	ts	t	t	θ	đz
lz	ls	ls	ls	ls	ls	lz/ls	lz/ls
ɹd	t	t	d	d	d	ɹd	ɹ

Single Consonants: Occur in Thai only as Onsets

Target	S-1	S-2	S-3	S-4	S-5	C-1	C-2
b	p	p	p	p	p	b	b
d	t	d	d	d	d	d	d
g	k	k	k	g	ʧ	(skip	g
l	l	l	l	l	l	l	l

Single Consonants: Do Not Occur in Thai

Target	S-1	S-2	S-3	S-4	S-5	C-1	C-2
ɹ	Ø	ɹ	ɹ	ɹ	Ø	ɹ	ɹ
θ	t	t	t	t	ʧ	θ	θ
z	s	s	s	s	s	z	z
v	f	f	f	f	f	v	v