THE SONORITY SEQUENCING PRINCIPLE IN INTERLANGUAGE PHONOLOGY

Sheryl Sherwin

INTRODUCTION

It is widely recognized that the Sonority Sequencing Principle plays a significant role in the organization of syllables in natural languages. This study looks at the possible role that the Sonority Sequencing Principle (SSP) plays in the syllables of interlanguages. Specifically, it examines the pronunciations of initial two-consonant clusters in English that violate the SSP by L2 students whose native language does not include initial consonant clusters. The question posed is this: If students have no knowledge of consonant clusters from their own language, will they treat initial consonant clusters that do not violate the SSP differently from those that do? If the SSP is not a universal principle in interlanguage phonology it is speculated that the two types of consonant clusters will not be treated differently. If, on the other hand, it does play a role in interlanguage phonology, it is predicted that the students will treat them differently.

THE SONORITY SEQUENCING PRINCIPLE

First, what is the Sonority Sequencing Principle? Blevins (1996) defines it this way: Between any member of a syllable and the syllable peak, a sonority rise or plateau must occur. This in turn asks the question: What is sonority? Carr (1993) describes it in articulatory terms as the degree to which the airsteam is blocked or constricted and adds that voicing is required to produce sonority. Blevins (1996) suggests that, although it is contested, acoustic intensity is often used to measure saliency or loudness of segments. Those segments that are the most salient are the most sonorous. Within the context of the various definitions it is accepted that vowels are the most sonorous segments and thus form the peak or nucleus of each syllable. Segments in the syllable are less sonorous as they "move out" from the syllable peak. A scale of sonority for the natural classes of sounds or segments has been developed. Clements' s (1992) sonority scale included five natural classes (going from most sonorous to least): vowels, glides, liquids, nasals, and obstruents.

Carr (1993) and others suggest that obstruents be subdivided into fricatives and stops. The Sonority Index developed by Broselow and Finer (1991), for example, lists the stops and fricatives as separate classes, as shown in (1).

(1)

Class	Scale
Stops	1
Fricatives	2
Nasals	3
Liquids	4
Glides	5

They go one step further by proposing that there is a scale of sonority within the stops and fricatives. They suggest that voicing is also a factor and present this sub-scale of sonority:

(2) Least Sonorous — Most Sonorous
Voiceless Stops | Voiced Stops | Voiceless Fricatives | Voiced Fricative

According to Broselow and Finer these scales form the basis for identifying degrees of markedness in consonant clusters which in turn help to predict the degree of difficulty that L2 learners will have in mastering different consonant clusters.

Tropf (1986) also proposed that in the canonical syllable structure, going from the syllable peak to the edges of the syllable, the fricatives come before the plosives, or stops. Since the fricative /s/, appearing before the stops /p, t, k/, represents the supposed SSP violation in English, the following scale, which recognized a distinction between stops and fricatives, will be recognized for this study:

(3) Most Sonorous — Least Sonorous
Vowels > Glides > Liquids > Nasals > Fricatives > Stops

As just mentioned, there are exceptions or violations of this principle found in English and some other languages. In English the violations occur in the syllable-initial consonant clusters of /sp/, /st/, and /sk/, where the stops (/p, t, k/), which are the least sonorous, are closer to the syllable peak. The fricative /s/, which is more sonorous than the stops, is on the outer edge of the syllable. /s/ is exceptional in that it is the only English phoneme involved in SSP violations. Clements (1992) suggests that the /s/ may be extrasyllabic, that is it is a syllable itself. This idea will be discussed further in this paper.

According to Carlisle (1992), consonant clusters that violate the SSP are considered more marked than clusters that abide by the SSP. In that regard it is hypothesized that the more marked consonant clusters will be more difficult for second language learners to pronounce and this is the focus of the current study.

BACKGROUND OF INTERLANGUAGE STUDIES

The importance of studying interlanguages within the field of linguistics has not always been recognized. Major (1996) provides some historical perspective. Early research focused on the native language and its influence on second language acquisition. Analysis contrasting the native language and the target language was the primary means of research. Selinker (1972) first introduced the term "interlanguage" as the language of a second language learner and put forth the idea that it was a language system in its own right. Adjemian (1976) agreed, as did Eckman (1991). Eckman proposed that interlanguages obey certain universal principles that apply to native languages and developed what he termed the Interlanguage Structural Conformity Hypothesis (Eckman, Moravesik, & Wirth, 1989). This hypothesis states that: "The universal generalizations that hold for the primary languages hold also for interlanguages." Researchers began to see parallels between the acquisition of native languages and the acquisition of second languages. As a result, they began recognizing and accepting the importance of L2 data in the development of linguistic theory.

PREVIOUS STUDIES INVOLVING SSP VIOLATIONS IN INTERLANGUAGE

A review of the literature resulted in finding three studies that looked at SSP violations in interlanguages. As will be seen, the results are mixed. It should be noted that in all three studies, unlike the current study, the native language of the L2 speakers has initial consonant clusters.

Tropf (1986) tested 11 adult Spanish speakers on German onset clusters. He found that speakers modified onsets that violate the SSP more than those that do not. Specifically, his speakers had difficulty with /ʃCC/ clusters, where the initial position of the /ʃ/ violates the SSP. They either deleted the /ʃ/ or they epenthesized /ə/ before the cluster. Tropf noted that the /ʃ/ is not a Spanish phoneme and the consonant clusters that remained when the /ʃ/ was deleted are acceptable Spanish clusters. Therefore these modifications to the cluster could be attributed to native language transfer. Although he notes both factors, Tropf does not say whether he believes that the speakers' difficulty was due to the nature of the cluster (i.e., that it violates the SSP) or the influence of their native language.

Carlisle (1991) also looked at SSP violations in the interlanguage clusters of native Spanish speakers. Prior to reporting on his own results however, he offered what he believed to be three problems with Tropf's study: Tropf collected his data from conversations and so did not control the environment in which the clusters were spoken; he didn't distinguish between two-consonant and three consonant clusters; and he did not run a statistical test on the data.

Carlisle tested 11 adult Spanish speakers learning English. He tested their pronunciation of words beginning with the /st/ consonant cluster and the /sl/ consonant cluster. Unlike Tropf he also looked at the variability of the pronunciation of these two clusters in relation to the environment, i.e., How did the last segment of the word immediately preceding the consonant cluster affect the pronunciation? He found that the speakers modified the /st/ clusters more frequently than the /sl/ clusters. He also found that there were more modifications if the preceding segment was a consonant than if it was a vowel. He concluded that the SSP, as well as the environment, were factors in accounting for interlanguage variations.

Major (1996) tested 4 adult Brazilian Portuguese speakers learning English as a second language. Unlike Tropf and Carlisle, he found that the fricative-stop clusters that violate the SSP (st, sp, sk) had *lower* error rates than those that do not (the fricative-liquids or stop-liquids). He suggested that these results could be due to native language transfer in that, although Portuguese does not allow a *#/sC/ cluster, it does have #/is$C/ sequences. In fast speech Portuguese speakers will delete the /i/ resulting in an #/sC/ onset cluster. In addition, he notes that the fricative-liquid clusters in the test were /sl/ and /ʃr/, neither of which occurs in Portuguese. Major offers another explanation for his results by suggesting that the /s/ segment is special in phonology. This idea will be further examined later in this report.

NATIVE LANGUAGES OF THE SPEAKERS FOR THE CURRENT STUDY

As mentioned, the current study involves speakers whose native language does not have initial consonant clusters. The four languages represented are Chinese, Vietnamese, Amharic, and Arabic. A brief description of each is provided:

Chinese: Karlgren (1962) states that as early as 500 A.D. the Chinese language has allowed no more than one consonant at the beginning of the word. The Chinese syllable is composed of the following: (C) (G) V (N or G) + Tone. In this formula
C = Consonant, G = Glide (nonsyllabic vowel), V = Full Vowel, N = Nasal.

Vietnamese: Chaudhary (1983) states that the Vietnamese language does not permit consonant clusters and that the canonical syllable structure is CVC, CVVC or CVVVC. However, Nguyen-Dang-Liem (1967) states that Vietnamese does have consonant clusters consisting only of /Cw/. Anthony Nguyen (personal communication, May 6, 1999) agrees with Chaudhary.

Amharic: According to Leslau (1997) Amharic has no initial consonant clusters although it has final two consonant clusters in verbal forms. The syllable structure of the language is: V, VC, VCC, CV, CVC, and CVCC.

Arabic: Bateson (1967) states that all Arabic syllables must begin with a single consonant. Syllable types are generally CV or CVC.

THE SUBJECTS

Three adult subjects for each language group were selected for the study. The Vietnamese, Amharic, and Chinese students are currently studying English at the Carlos Rosario Charter School in Washington DC. They are in low and intermediate beginning level classes. Two of the Arabic speakers are in the Advanced Beginning (Level 10) class at George Mason University's English Language Institute (ELI). The ages of the subjects range from 18 to 51. The age of onset for learning English ranged from 6 years to 50. All have learned English within an academic environment. Profiles of the 11 subjects whose data were analyzed for this study are found in Appendix A.

THE METHODOLOGY

The subjects were asked to say single syllable English words that have initial two-consonant clusters. The words were presented on 5 X 7 index cards within the carrier phrase "Now I say...". The carrier phrase was used in order to maintain a consistent phonological environment before each word. Each student was presented with three practice words. I explained only that these recordings would help me with a project that I was doing for the class I was taking at the university. I did not explain the nature of the test.

The Carlos Rosario students were recorded in my classroom, after class. The GMU students were recorded in a room at the ELI offices. All students were recorded using a Sony TC-D5M tape recorder with a separate Electro-Voice microphone.

RESULTS AND DISCUSSION

I transcribed the pronunciations of each subject along with Marietta Bradinova, a graduate student from the Masters in Linguistics program at George Mason University, using The International Phonetic Alphabet. Complete transcriptions of each subject's pronunciations are provided in Appendix B. Only modifications to the initial consonant cluster of each word were considered errors since this was the focus of the study. Pronunciations of the English /ɹ/ as

a trilled aveolar were transcribed as /r/ and were not considered an error. Error types fell into three basic categories:

a. - substitution of one segment for another in the cluster (retention of the cluster)
b. - epenthesis before or after the first consonant in the cluster (deletion of the cluster)
c. -other errors that deleted or corrupted the cluster such as deletion of a segment, metathesis, and long hesitations between the two segments of the cluster.

The initial clusters were categorized into three groups: 1) consonant clusters that do not include the segment /s/ and also do not violate the SSP, such as /bl/ and /gr/; 2) consonant clusters that include the segment /s/ but do not violate the SSP, such as /sl/ and /sm/; and 3) consonant clusters that include the segment /s/ and do violate the SSP, which are the clusters /st/, /sp/, and /sk/. Results of the number of errors by cluster type are shown in Table 1.

Statistically there was no difference in error rates for the three groups. Within the first group, (made up of non /s/ clusters) the highest rate of error was in the two clusters with a /k/: the /kl/ and the /kr/ clusters. Sixty-six percent of the errors were a simple matter of changing the voicing, i.e. the subjects substituted a /ý/ for the /k/. This is particularly puzzling as all four languages have word initial /k/. Thus, this high error rate can not be attributed to native language transfer. One possible explanation is that each of the words in these two groups orthographically begin with the letter "c." Phonetically speaking this letter does not represent either of the sounds associated with it, i.e., neither the /k/ nor the /s/ sound. Perhaps this is a source of confusion for students learning English.

Overall, SSP violations did not appear to be a significant factor in the interlanguage of these speakers. However, although there was virtually no contrast between SSP violating clusters and non SSP violating clusters, there was an interesting contrast between the /s/ clusters and the non /s/ clusters. This contrast involves the *type* of errors that were prevalent between the two groups. A summary of error types is presented in Table 2. (The number of errors in Table 2 for groups 1 and 2 is higher than in Table 1 because there were three instances where one error involved two types of modifications to the cluster.)

Table 1
ERRORS BY CLUSTER TYPE

	Cluster Type	No. of Tokens	No. of Errors	% Errors
Non /s/ Clusters				
	/br/	22	4	18.2
	/dr/	22	1	4.5
	/fr/	22	1	4.5
	/gr/	22	1	4.5
	/kr/	22	11	50.0
	/pr/	22	1	4.5
	/bl/	22	3	13.6
	/fl/	22	6	27.3
	/gl/	22	2	9.1
	/kl/	22	10	45.5
	/pl/	22	1	4.5
Total		**242**	**41**	**16.9%**
/s/ Clusters -- No SSP Violation				
	/sl/	44	5	11.4
	/sm/	44	7	15.9
	/sn/	44	6	13.6
	/sw/	44	12	27.3
Total		**176**	**30**	**17.0%**
/s/ Clusters -- SSP Violation				
	/sk/	44	6	13.6
	/sp/	44	12	27.3
	/st/	44	5	11.4
Total		**132**	**23**	**17.4%**

Table 2
TYPES OF ERRORS

Non /s/ Clusters					
Language	**Substitution**	**Epenthesis Before Cl.**	**Epenthesis Between Cl.**	**Other**	**Total**
Vietnamese	18		1		19
Amharic	8				8
Chinese	4		3	1	8
Arabic	5	1	1		7
Total Errors	35	1	5	1	42
Percent	83.30%	2.40%	11.90%	2.40%	

/s/ Clusters – No SSP Violation					
Language	**Substitution**	**Epenthesis Before Cl.**	**Epenthesis Between Cl.**	**Other**	**Total**
Vietnamese	2		13		15
Amharic		7		2	9
Chinese	1				1
Arabic		1	1	5	7
Total Errors	3	8	14	7	32
Percent	9.4%	25.0%	43.6%	21.9%	

/s/ Clusters – SSP Violation					
Language	**Substitution**	**Epenthesis Before Cl.**	**Epenthesis Between Cl.**	**Other**	**Total**
Vietnamese	1		3	2	19
Amharic		10		2	8
Chinese	1		1		8
Arabic				3	7
Total Errors	2	10	4	7	23
Percent	8.7%	43.5%	17.4%	30.4%	

For those clusters that did not include an /s/, 83.3 % of the errors involved substitutions. The target form was not realized; however, the cluster was retained. By comparison, for those clusters with no SSP violation that did include the segment /s/, only 9.4% of the errors involved substitution. The majority of the errors involved some type of modification that corrupted the cluster. Similarly, those clusters that violated the SSP and included an /s/ segment had a substitution error rate of 8.7%. Again, the majority of the errors included a modification that corrupted the cluster.

Even within the substitution errors the modifications were greater in the /s/ clusters than in the non /s/ clusters. Sixty-six percent of the substitution errors for the non /s/ clusters consisted of a simple voicing change. Eighty percent of the substitution errors for the /s/ clusters

Regarding those changes that corrupted the cluster, the majority of the modifications involved epenthesis. The Vietnamese and Chinese speakers epenthesized between the two consonants. The Amharic speakers epenthesized before the first consonant in the cluster. The Arabic speaking students did both, although the number of times that they employed this strategy was small.

Other errors not involving epenthesis but corrupting the cluster involved one occasion of /l/ deletion and three occasions of metathesis. One of the Arabic speaking students had five instances of a significant hesitation between the pronunciation of the /s/ and the following consonant. He also had two occasions where he drew out the pronunciation of the /s/, to the point that it could be considered either a double/s/ or a syllabic /s/. Two of the Amharic students also had instances of a long hesitation between the /s/ and the following consonant or a drawn out pronunciation of the /s/. Table 3 summarizes the errors by language group.

Table 3

Errors by Language Group

Vietnamese							
Type of Cluster		Epenthesis	Epenthesis		Total	Total	
	Substitution	Before Cl.	Between Cl.	Other	Errors	Tokens	% Errors
Non /s/ Clusters	18		1		19	66	28.8%
/s/ Clusters-No Viol.	2	3	10		15	48	31.3%
/s/ Clusters-Violation	1		3	2	6	36	16.6%
Totals	21	3	14	2	40	150	26.7%
Amharic							
Type of Cluster		Epenthesis	Epenthesis		Total	Total	
	Substitution	Before Cl.	Between Cl.	Other	Errors	Tokens	% Errors
Non /s/ Clusters	8				8	66	21.1%
/s/ Clusters-No Viol.		7		2	9	48	18.8%
/s/ Clusters-Violation		10		2	12	36	33.3%
Totals	8	17		4	29	150	19.3%
Chinese							
Type of Cluster		Epenthesis	Epenthesis		Total	Total	
	Substitution	Before Cl.	Between Cl.	Other	Errors	Tokens	% Errors
Non /s/ Clusters	4		3	1	8	66	12.1%
/s/ Clusters-No Viol.	1				1	48	2.1%
/s/ Clusters-Violation	1		1		2	36	5.5%
Totals	6		4	1	11	150	7.3%
Arabic							
Type of Cluster		Epenthesis	Epenthesis		Total	Total	
	Substitution	Before Cl.	Between Cl.	Other	Errors	Tokens	% Errors
Non /s/ Clusters	5	1	1		7	44	15.9%
/s/ Clusters-No Viol.		1	1	5	7	32	21.9%
/s/ Clusters-Violation				3	3	24	12.5%
Totals	5	2	2	8	17	100	17.0%

As the data in Table 3 show, results are mixed when comparing the four language groups. The Chinese speakers had the highest error rate in the non /s/ clusters. The Vietnamese and Arabic speakers had the highest error rate in the /s/ clusters that do not violate the SSP. Only the Amharic speakers had the highest error rate in the /s/ clusters that violate the SSP. Looking at the error rates for the individual speakers the results are also mixed for three of the four language groups. Only the three Chinese speakers had, consistently, the highest error rate in the non /s/ cluster group. A summary of errors by the individual speakers is provided in Appendix C.

By testing speakers whose languages do not include initial consonant clusters the native language is viewed as having a limited influence on the pronunciations of these clusters in the target language. The overall error rates show that the Sonority Sequencing Principle is not a primary factor either, at least not with these data. However, the segment /s/ does appears to play a significant role in the interlanguage of these speakers. Major (1996), in discussing the results of his study (in which his subjects had lower error rates for the consonant clusters that violated the SSP) advised that it is important to look not only at the sonority of a segment but at the specifics of that segment. He noted that in phonology the /s/ is special. He cites Selkirk (1984), who observed that, universally, obstruent plus /s/ sequences have the "peculiar" characteristic of functioning at some level as a single consonant. Major also cites Kaye (1989) who stated that no sequence of /s/ plus consonant can form an onset. That is, the /s/ falls outside the syllable. In offering an explanation as to why the SSP violating clusters had lower error rates in his study, Major suggests that the speakers treated the /s/ as not part of the cluster but as a singleton. Thus it was less marked than the two-consonant clusters.

This view of /s/ complements the idea of extrasyllabicity. As mentioned previously, Clements (1992) states that consonants violating the SSP usually occur at the edges of the syllable where they can plausibly be analyzed as extrasyllabic, i.e., the consonant at the outer edge is itself a syllable and not part of the consonant cluster. Bradinova and Welch (1998) looked at SSP violations in Russian, Polish and Bulgarian. The segment /s/, along with two other fricatives (/z/ and /v/), was the first consonant of the two and three consonant clusters they analyzed. They concluded that these segments were extrasyllabic and not part of the cluster. The remaining segments in the cluster abided by the SSP.

CONCLUSION

The results of this study showed virtually no difference in the overall error rates for the three types of consonant clusters that were presented to the speakers of the four language groups. A significant contrast was found, however, between those clusters with no /s/ and those clusters with an /s/, the difference being in the *types* of errors rather than the number of errors. The speakers' modifications to the /s/ clusters resulted in breaking up the clusters, whereas the modifications to the non /s/ clusters simply changed one of the segments while retaining the cluster. These subjects appear to recognize that the /s/ is "special" and, by epenthesizing, they made it a separate syllable rather than treating it as part of the consonant cluster. This supports the concept of extrasyllabicity as a way to explain supposed violations to the Sonority Sequencing Principle. The extrasyllabic nature of /s/ appears to have been a stronger influence on the interlanguage of the subjects of this study than the Sonority Sequencing Principle and the initial consonant clusters that violate it. This study, along with the mixed results of the previously cited studies, indict that futher research would be valuable to understand the many factors that play a role in the interlanguage of students learning a second language.

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APPENDIX A
SUBJECT PROFILES

Subject 1

Place of Birth	Native Language	Other Second Languages	Age and Sex	Age of English Onset	English Learning Method	Length of Residence
Hue City, Vietnam	Vietnamese	None	48, Female	40	Academic	9 years

Subject 2

Place of Birth	Native Language	Other Second Languages	Age and Sex	Age of English Onset	English Learning Method	Length of Residence
Addis Ababa, Ethiopia	Amharic	None	47, Female	9	Academic	4.5 years

Subject 3

Place of Birth	Native Language	Other Second Languages	Age and Sex	Age of English Onset	English Learning Method	Length of Residence
Hanoi, Vietnam	Vietnamese	None	51, Female	50	Academic	2 years

Subject 4

Place of Birth	Native Language	Other Second Languages	Age and Sex	Age of English Onset	English Learning Method	Length of Residence
Addis Ababa, Ethiopia	Amharic	None	21, Female	11	Academic	1.5 years

Subject 5

Place of Birth	Native Language	Other Second Languages	Age and Sex	Age of English Onset	English Learning Method	Length of Residence
Beijing, China	Chinese	None	35, Female	35	Academic	5 months

Subject 6

Place of Birth	Native Language	Other Second Languages	Age and Sex	Age of English Onset	English Learning Method	Length of Residence
Hanoi, Vietnam	Vietnamese	None	41, Female	40	Academic	3 years

Subject 7

Place of Birth	Native Language	Other Second Languages	Age and Sex	Age of English Onset	English Learning Method	Length of Residence
Addis Ababa, Ethiopia	Amharic	None	20, Female	6	Academic	6 months

Subject 8

Place of Birth	Native Language	Other Second Languages	Age and Sex	Age of English Onset	English Learning Method	Length of Residence
Beijing, China	Chinese	None	46, Female	14	Academic	6 months

Subject 9

Place of Birth	Native Language	Other Second Languages	Age and Sex	Age of English Onset	English Learning Method	Length of Residence
Hunan, China	Chinese	None	50, Female	16	Academic	2 years

Subject 10

Place of Birth	Native Language	Other Second Languages	Age and Sex	Age of English Onset	English Learning Method	Length of Residence
Rial, Saudi Arabia	Arabic	None	18, Male	13	Academic	4 months

Subject 11

Place of Birth	Native Language	Other Second Languages	Age and Sex	Age of English Onset	English Learning Method	Length of Residence
Sanaa, Yemen	Arabic	None	26, Male	21	Academic	6 months

Appendix B
IPA Transcriptions

Bold Type = Clusters that violate the SSP.
* = Error in pronunciation of the initial consonant cluster.
$ = Hesitation

Subject 1 - Vietnamese

	IPA		IPA		IPA
green	[grɪnə]	**skull**	[skʊl]	**stun**	[stʌn]
snit	[snɪt]	plan	[plæn]	prim	[prim]
press	[prɛs]	snack	[snæsk]	sleep	[slip]
spit	[drɪt] *	drop	[drɔpə]	swing	[skwɪn] *
blouse	[blaʊs]	brim	[prɪm] *	glad	[glæd]
slim	[slim]	smack	[smæk]	snot	[snɑt]
class	[glæs] *	slam	[sklæm] *	floss	[glɔs] *
swell	[swɛlə]	flat	[blæt] *	**stop**	[stɔp]
gloss	[glɔ:z]	snake	[snæk]	small	[smɔl]
smile	[smaʊl]	black	[blæk]	plot	[plɔt]
skate	[skɛɪt]	**spot**	[spɔs]	**spam**	[spæm]
crass	[klæs] *	from	[frɔm]	clean	[klin]
sweet	[swɪt]	swat	[skwɔt] *	**step**	[stɛp]
spin	[driŋ] *	brat	[præt] *	fret	[prɛt] *
skin	[skin]	smell	[smɛl]	**skit**	[skɪt]
grape	[grɛp]	crap	[kræp]	slip	[slip]
still	[stɪl]	dress	[drɛs]		

Subject 3 - Vietnamese

	IPA		IPA		IPA
green	[grin]	**skull**	[skɪn]	**stun**	[stɪn]
snit	[snɪt]	plan	[plɛn]	prim	[prɪm]
press	[prɪs]	snack	[snɛk]	sleep	[slɪp]
spit	[spɪt]	drop	[drɔp]	swing	[swɪŋ]
blouse	[blus]	brim	[brɪm]	glad	[glɪb]
slim	[slɪm]	smack	[smɛk]	snot	[snɑt]
class	[glæs] *	slam	[slæm]	floss	[flɔs]
swell	[swit]	flat	[flæt]	**stop**	[stɑp]
gloss	[glɔs]	snake	[sneik]	small	[smaɪl]
smile	[smɪl]	black	[blæk]	plot	[plɑt]
skate	[skɛt]	**spot**	[spɔt]	**spam**	[spæm]
crass	[sræs] *	from	[frɑm]	clean	[klin]
sweet	[swit]	swat	[swɛt]	**step**	[stɛp]
spin	[spɪn]	brat	[brɛt]	fret	[frɛt]
skin	[skɪn]	smell	[svɛn] *	**skit**	[slɪt]
grape	[græpɪ]	crap	[sræp] *	slip	[slip]
still	[stɪn]	dress	[drɛs]		

Subject 6 - Vietnamese

	IPA		IPA		IPA
green	[grɪn]	skull	[səkʊl] *	stun	[stʊn]
snit	[sənɪt] *	plan	[plɛn]	prim	[prɪm]
press	[bliz] *	snack	[sənɛk] *	sleep	[slɪpə]
spit	[spɪt]	drop	[drʊp]	swing	[səwɪŋ] *
blouse	[blous]	brim	[brim]	glad	[glæd]
slim	[slɪm]	smack	[səmʌk] *	snot	[snɑt]
class	[glæs] *	slam	[səlæm] *	floss	[flɔs]
swell	[səwɛl] *	flat	[plæt] *	stop	[stɔp]
gloss	[glouf]	snake	[snɛk]	small	[smɑl]
smile	[gəmɪl] *	black	[blæk]	plot	[plɑt]
skate	[skæt]	spot	[spɔt]	spam	[səpæm] *
crass	[græs] *	from	[frɔm]	clean	[glin] *
sweet	[səwɛt] *	swat	[səwɪt] *	step	[stɛp]
spin	[spɪn]	brat	[bræt]	fret	[frɛt]
skin	[skɪn]	smell	[səmɛl] *	skit	[səkɪt] *
grape	[gəreɪpə] *	crap	[græp] *	slip	[slip]
still	[spil] *	dress	[drɛs]		

Subject 2 - Amharic

	IPA		IPA		IPA
green	[grɪn]	**skull**	[skil]	**stun**	[stɑn]
snit	[sʌn] *	plan	[plo]	prim	[praɪm]
press	[prɪsəs]	snack	[snaɪk]	sleep	[sleip]
spit	[spɑt]	drop	[dro]	swing	[swiŋk]
blouse	[blʊz]	brim	[braɪm]	glad	[glɑd]
slim	[slɑm]	smack	[smaɪk]	snot	[snɑt]
class	[glæsəs] *	slam	[slaɪ]	floss	[flɔsəs]
swell	[swɪl]	flat	[flæt]	**stop**	[stop]
gloss	[glɔsəs]	snake	[snɑk]	small	[smaɪl]
smile	[smɛl]	black	[blɔk]	plot	[plɔt]
skate	[skæt]	**spot**	[spɔt]	**spam**	[spaɪ]
crass	[græsəs] *	from	[frɔm]	clean	[glɛn] *
sweet	[swit]	swat	[swit]	**step**	[stɛp]
spin	[spɛn]	brat	[braɪt]	fret	[fret]
skin	[ʂkʌn] *	smell	[smaɪl]	**skit**	[skɛt]
grape	[grɑp]	crap	[græp] *	slip	[slaɪp]
still	[stɑ]	dress	[drɛsəs]		

Subject 4 - Amharic

	IPA		IPA		IPA
green	[grin]	**skull**	[skʌl]	**stun**	[stʌn]
snit	[snɛt]	plan	[plen]	prim	[praɪm]
press	[prɛsəs]	snack	[snɑk]	sleep	[slip]
spit	[spaɪt]	drop	[drɔp]	swing	[swɛŋ]
blouse	[blɛs]	brim	[braɪm]	glad	[glɑd]
slim	[sleɪm]	smack	[smɔk]	snot	[snɔt]
class	[klæs]	slam	[slɑm]	floss	[flɔsəs]
swell	[swɪl]	flat	[flɑt]	**stop**	[stɔp]
gloss	[glɔsəs]	snake	[snɑk]	small	[smɛl]
smile	[smaɪl]	black	[blæk]	plot	[plɔt]
skate	[sskɑt] *	**spot**	[spɔt]	**spam**	[spɑm]
crass	[krɑs]	from	[frɔm]	clean	[klin]
sweet	[swɪt]	swat	[swit]	**step**	[stɛp]
spin	[spɪn]	brat	[brɑt]	fret	[frit]
skin	[skɪn]	smell	[smɛl]	**skit**	[skɪt]
grape	[greɪp]	crap	[krɑp]	slip	[slip]
still	[stɪl]	dress	[drɛs]		

Subject 7 - Amharic

	IPA		IPA		IPA
green	[gɾɪn]	**skull**	[əskʌl] *	**stun**	[əstʌn] *
snit	[sɛnt] *	plan	[plæn]	prim	[pɹɪm]
press	[pɹɪɛs]	snack	[snæk]	sleep	[əslɛp] *
spit	[əspɛt] *	drop	[drɔp]	swing	[əswɪŋk] *
blouse	[blɔs]	brim	[drim] *	glad	[glæd]
slim	[slæm]	smack	[əsmæk] *	snot	[snɔt]
class	[glæs] *	slam	[əslæm] *	floss	[klɔs] *
swell	[swɛl]	flat	[flæt]	**stop**	[əstɔp] *
gloss	[glɔs]	snake	[snɛk]	small	[əsmaɪl] *
smile	[əsmaɪl] *	black	[blæk]	plot	[plɔt]
skate	[skeɪt]	**spot**	[əspɔt] *	**spam**	[əspɑm] *
crass	[kɹɑs]	from	[fɹɔm]	clean	[klin]
sweet	[əswɪt] *	swat	[swɔt]	**step**	[əstɪp] *
spin	[əspɪn] *	brat	[brɑt]	fret	[fɹɪtz]
skin	[skɑn]	smell	[smaɪl]	**skit**	[əskɪtz] *
grape	[gɹeɪp]	crap	[grɑp] *	slip	[slɪp]
still	[əstə˞] *	dress	[dɹɛs]		

Subject 5 - Chinese

	IPA		IPA		IPA
green	[gɹin]	**skull**	[skʊl]	**stun**	[stju]
snit	[snit]	plan	[plæn]	prim	[pɹim]
press	[pɹɛs]	snack	[snæk]	sleep	[slip]
spit	[spit]	drop	[dɔɹɔp] *	swing	[svɪŋgĩ] *
blouse	[blɔs]	brim	[bɹimə]	glad	[glɛndə]
slim	[slɪm]	smack	[smæk]	snot	[snɔt]
class	[kəlɑs] *	slam	[slæm]	floss	[flɔs]
swell	[swɛl]	flat	[flæt]	**stop**	[stɔp]
gloss	[glovs]	snake	[snɛk]	small	[smɛl]
smile	[smɛl]	black	[blæk]	plot	[plɔt]
skate	[skæt]	**spot**	[spɔt]	**spam**	[spɛm]
crass	[kɛɹɪs] *	from	[fɹɔm]	clean	[klæslə˞]
sweet	[swit]	swat	[swɛtə˞]	**step**	[stɛp]
spin	[spĩ]	brat	[bɹɛtə˞]	fret	[fɹɛt]
skin	[skĩ]	smell	[smɛl]	**skit**	[skɪt]
grape	[gɹɛpɔ]	crap	[kɹæpə]	slip	[slɪp]
still	[stil]	dress	[dɹɛsə˞]		

Subject 8 - Chinese

	IPA		IPA		IPA
green	[gɹin]	**skull**	[skʊl]	**stun**	[stʌn]
snit	[snit]	plan	[plaɪ]	prim	[pɹim]
press	[pɹis]	snack	[sneɪk]	sleep	[slip]
spit	[spit]	drop	[dɹɔp]	swing	[swiŋ]
blouse	[blʊs]	brim	[bɹim]	glad	[glæd]
slim	[slɪm]	smack	[smɑk]	snot	[snɔtʰ]
class	[klæs]	slam	[slim]	floss	[flɑs]
swell	[swɛl]	flat	[plɑt] *	**stop**	[stɑpʰ]
gloss	[glous]	snake	[sneɪk]	small	[smɛl]
smile	[smɛl]	black	[plæk] *	plot	[plɑt]
skate	[skɪt]	**spot**	[spɔt]	**spam**	[səpim] *
crass	[gɹaɪs] *	from	[fɹɔm]	clean	[klin]
sweet	[swit]	swat	[swit]	**step**	[stɛp]
spin	[spin]	brat	[bɹit]	fret	[fɹit]
skin	[skin]	smell	[smɛl]	**skit**	[skit]
grape	[gɹip]	crap	[kɹɑp]	slip	[slip]
still	[stil]	dress	[dɹaɪs]		

Subject 9 - Chinese

	IPA		IPA		IPA
green	[gɹin]	**skull**	[skɪl]	**stun**	[stɔ̃]
snit	[snɪt]	plan	[plæn]	prim	[pɹɪm]
press	[pɹɛs]	snack	[sneɪk]	sleep	[slip]
spit	[spɪt]	drop	[dɹɔp]	swing	[swiŋ]
blouse	[blɔs]	brim	[bɹɪm]	glad	[glæd]
slim	[slɪm]	smack	[smɑk]	snot	[snɔt]
class	[klæs]	slam	[slɑm]	floss	[flɔs]
swell	[swɛl]	flat	[flaɪt]	**stop**	[stɔp]
gloss	[glɑs]	snake	[sneɪk]	small	[smaɪ]
smile	[smaɪl]	black	[bæk] *	plot	[plɔt]
skate	[skeɪt]	**spot**	[stɔp] *	**spam**	[spɛm]
crass	[gɹɑs] *	from	[fɹɔm]	clean	[kɹiən] *
sweet	[swɪt]	swat	[swit]	**step**	[stɛp]
spin	[spɑn	brat	[bɹɪt]	fret	[fɹɪt]
skin	[skɪn]	smell	[smɛl]	**skit**	[skɪt]
grape	[gɹɪp]	crap	[kɹʊp]	slip	[slɪp]
still	[stɪl]	dress	[dɹaɪs]		

Subject 10 - Arabic

	IPA		IPA		IPA
green	[grin]	**skull**	[skɪl]	**stun**	[stɪn]
snit	[ssɛnt] *	plan	[plæn]	prim	[prɛm]
press	[pɹɪs]	snack	[snɛk]	sleep	[slɪp]
spit	[s$paɪt] *	drop	[drɔp]	swing	[sswɪŋk] *
blouse	[blɔs]	brim	[brɪm]	glad	[glæd]
slim	[slɛm]	smack	[smɛk]	snot	[əsnɔt] *
class	[klɔs]	slam	[s$læm] *	floss	[əflɔs] *
swell	[əəsssuls wɛl] *	flat	[flæt]	**stop**	[stɔp]
gloss	[glɔs]	snake	[snɛki]	small	[smɛl]
smile	[smɛl]	black	[blæk]	plot	[plɔt]
skate	[skɛt]	**spot**	[sspɔt] *	**spam**	[spɛm]
crass	[kɹɔs]	from	[fɹɔm]	clean	[ʃɛlɛn] *
sweet	[swit]	swat	[swit]	**step**	[stɔp]
spin	[spɪn]	brat	[brɛt]	fret	[fɹɛt]
skin	[skɪn]	smell	[smɛl]	**skit**	[skɪt]
grape	[gɹɛp]	crap	[kɹɑp]	slip	[slɪp]
still	[stɪl]	dress	[drɛs]		

Subject 11 - Arabic

	IPA		IPA		IPA
green	[grin]	**skull**	[skɔl]	**stun**	[stɔn]
snit	[snɪt]	plan	[plæn]	prim	[prim]
press	[pris]	snack	[snɪk]	sleep	[slip]
spit	[spit]	drop	[drɔp]	swing	[swæŋk]
blouse	[plaʊs] *	brim	[prɛm] *	glad	[klæp] *
slim	[slim]	smack	[smɑk]	snot	[snɔt]
class	[klæs]	slam	[slæm]	floss	[flɔs]
swell	[sʊwɛl] *	flat	[flæt]	**stop**	[stɑp]
gloss	[klɔs] *	snake	[sneɪk]	small	[smaɪl]
smile	[smaɪl]	black	[blæk]	plot	[plɔt]
skate	[skaɪt]	**spot**	[sæspɔt] *	**spam**	[spɑm]
crass	[krɑs]	from	[frɔm]	clean	[klin]
sweet	[swit]	swat	[swɛt]	**step**	[stip]
spin	[spɪn]	brat	[brɑt]	fret	[frit]
skin	[skɪn]	smell	[smaɪl]	**skit**	[skaɪt]
grape	[gɹɑbɪ]	crap	[krɑp]	slip	[slɛp]
still	[stɪl]	dress	[dris]		

Appendix C
Errors by Individual Subjects

Subject 1 - Vietnamese			
Type of Cluster	No. of Errors	No. of Tokens	Percent Errors
Non /s/ Cluster	7	22	31.8%
/s/ Cluster-No Violation	3	16	18.8%
/s/ Cluster-SSP Violation	2	12	16.6%
Total	12	50	24.0%
Subject 3 - Vietnamese			
Type of Cluster	No. of Errors	No. of Tokens	Percent Errors
Non /s/ Cluster	3	22	13.6%
/s/ Cluster-No Violation	1	16	6.3%
/s/ Cluster-SSP Violation	0	12	0.0%
Total	4	50	8.0%
Subject 6 - Vietnamese			
Type of Cluster	No. of Errors	No. of Tokens	Percent Errors
Non /s/ Cluster	7	22	31.8%
/s/ Cluster-No Violation	10	16	62.5%
/s/ Cluster-SSP Violation	4	12	33.3%
Total	21	50	42.0%
Subject 2 - Amharic			
Type of Cluster	No. of Errors	No. of Tokens	Percent Errors
Non /s/ Cluster	4	22	18.2.%
/s/ Cluster-No Violation	1	16	6.3%
/s/ Cluster-SSP Violation	1	12	8.3.%
Total	6	50	12.0%
Subject 4 - Amharic			
Type of Cluster	No. of Errors	No. of Tokens	Percent Errors
Non /s/ Cluster	0	22	0.0%
/s/ Cluster-No Violation	0	16	0.0%
/s/ Cluster-SSP Violation	1	12	8.3%
Total	1	50	2.0%
Subject 7 - Amharic			
Type of Cluster	No. of Errors	No. of Tokens	Percent Errors
Non /s/ Cluster	4	22	18.2%
/s/ Cluster-No Violation	8	16	50.0%
/s/ Cluster-SSP Violation	10	12	83.3%
Total	22	50	44.0%

Appendix C (cont.)

Subject 5 - Chinese			
Type of Cluster	No. of Errors	No. of Tokens	Percent Errors
Non /s/ Cluster	3	22	13.6%
/s/ Cluster-No Violation	1	16	6.3%
/s/ Cluster-SSP Violation	0	12	0.0%
Total	4	50	8.0%
Subject 8 - Chinese			
Type of Cluster	No. of Errors	No. of Tokens	Percent Errors
Non /s/ Cluster	3	22	13.6%
/s/ Cluster-No Violation	0	16	0.0%
/s/ Cluster-SSP Violation	1	12	8.3%
Total	4	50	8.0%
Subject 9 - Chinese			
Type of Cluster	No. of Errors	No. of Tokens	Percent Errors
Non /s/ Cluster	3	22	13.6%
/s/ Cluster-No Violation	0	16	0.0%
/s/ Cluster-SSP Violation	1	12	8.3%
Total	4	50	8.0%
Subject 10 - Arabic			
Type of Cluster	No. of Errors	No. of Tokens	Percent Errors
Non /s/ Cluster	2	22	9.1%
/s/ Cluster-No Violation	5	16	31.3%
/s/ Cluster-SSP Violation	2	12	16.7%
Total	9	50	18.0%
Subject 11 - Arabic			
Type of Cluster	No. of Errors	No. of Tokens	Percent Errors
Non /s/ Cluster	4	22	18.8%
/s/ Cluster-No Violation	1	16	6.3%
/s/ Cluster-SSP Violation	1	12	8.3%
Total	6	50	12.0%