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Modern Hebrew: A Challenge for Sympathy

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0. Introduction

The current version of Optimality Theory (OT) is unable to deal with opaque outputs. In order to accommodate this shortcoming, McCarthy (1999) proposes an amendment to classical OT called Sympathy Theory. A direct consequence that follows from the architecture of the theory is that if “two notionally distinct processes ... violate exactly the same faithfulness constraints, then they must always act together in rendering a third process opaque” (McCarthy 1999: §3.2). However, Modern Hebrew provides an example where this type of rule sandwiching occurs. In derivational terms, the rules of ʔ -deletion and ʕ -deletion straddle a rule that lowers /e/ before two consonants. To accommodate this apparent counterexample, we will investigate a solution using narrow constraints, but this fix will ultimately be dismissed. We will conclude that Sympathy Theory cannot account for the example from Modern Hebrew.

1. Background

1.1 Opacity

There are two types of phonological opacity, those created by counter-feeding orders and those created by counter-bleeding orders (Kiparsky 1971, 1973). In the case of counter-bleeding orders, we find cases of non-surface apparent opacity. That is, there are surface forms in which some rule has applied, but the reason for its application is no longer apparent or present on the surface. This type of opacity occurs in a nonstandard dialect of Modern Hebrew. The data are given in (1). We will be primarily interested in the first person singular forms in the second column.

(1) Data from Modern Hebrew (Mizrahi/Eastern dialect) (Kenstowicz and Kisseberth 1979, S. Bolozky PC, M. Kenstowicz PC)¹

<i>UR</i>	<i>1 sg. (-ti)</i>	<i>3 sg. masc. (∅)</i>	<i>3 pl. (-u)</i>	<i>Gloss</i>
itpaleʔ	itpaleti	itpale	itpalʔu	become surprised
itnaseʔ	itnaseti	itnase	itnasʔu	feel superior
itpareʕ	itparati	itparea	itparʕu	cause disorder
itʃageʕ	itʃagati	itʃagea	itʃagʕu	become mad

The three rules we will consider are given in (2). Rule (i) bleeds rule (ii), while rule (ii) counter-bleeds rule (iii), creating cases of non-surface apparent opacity. This type of rule *sandwiching* occurs when one rule is stuck between two other rules that could bleed it if they were ordered before it. Here rule (ii) is sandwiched between two potential bleeders, ʔ-deletion and ʕ-deletion. An example of each of these interactions is given in (3).

(2) (i) ʔ deletion in coda.

(ii) Lower e to a before two consonants.

(iii) ʕ deletion in coda.

(3)	(a) /itpaleʔ ti/	(b) /itpareʕ ti/
(i) ʔ → ∅ in coda	itpale ti	-----
(ii) e → a / ____ CC	-----	itparaʕ ti
(iii) ʕ → ∅ in coda	-----	itpara ti
	[itpaleti]	[itparati]

¹ Though the data come from Kenstowicz and Kisseberth 1979, they were confirmed with one of the authors and with one of the native speakers who contributed to the data set.

In (3a), we see that rule (i) bleeds rule (ii). As a result, rule (ii) cannot apply and the surface form retains the [e] of the underlying form. In (3b), we have a counter-bleeding order. The environment that triggered the lowering is no longer present on the surface and we have an example of non-surface apparent opacity.

1.2 Opacity meets OT

Opaque rule interactions cause problems for classical OT (McCarthy 1999). Consider the case discussed in §1.1. Using the constraints in (4), we see that $*\text{ʔ}]_{\sigma} \gg \text{MaxC}$ because there are surface forms that have deleted an underlying ʔ. Furthermore, because there are surface forms that have lowered an underlying /e/, we know that $*\text{eCC} \gg \text{Ident}(\text{lo})$. We do not know the relative order of the other constraints, thus we have the tableau in (5) for the bleeding example from (3a). Standard OT has no problem accommodating transparent forms that result from such a relationship.

- (4) a. $*\text{ʔ}]_{\sigma}$: Do not allow ʔ in coda.
- b. $*\text{ʃ}]_{\sigma}$: Do not allow ʃ in coda.
- c. MaxC: Maximize all consonants from the input.
- d. $*\text{eCC}$: Do not allow [e] before two consonants.
- e. Ident(lo): The value of the feature [lo] in a candidate must match that of the corresponding vowel in the underlying representation.

(5) Partially ordered tableau for the bleeding case

/itpaleʔti/	$*\text{ʔ}]_{\sigma}$	$*\text{ʃ}]_{\sigma}$	$*\text{eCC}$	MaxC	Ident(lo)
a. itpaleʔti	*!		*		
b. itpalaʔti	*!				*
c. itpaleʔti itpaleti				*	
d. itpalati				*	*!

Standard OT, however, cannot accommodate the case of non-surface apparent opacity found in (3b). This tableau is given in (6).

(6) Partially ordered tableau for the opaque counter-bleeding case

/itpareʔti/	*ʔ]σ	*ʔ]σ	*eCC	MaxC	Ident(lo)
a. itpareʔti		*!	*		
b. itparaʔti		*!			*
c. itpareti				*	
d. itparati				*	*j

This tableau exemplifies the problems that counter-bleeding relationships yield for classical OT. The actual output (6d) cannot be generated from this tableau. There is no way to rearrange the constraints in order to yield the correct output because the set of violations incurred by (6d) is a superset of those incurred by (6c). Therefore, it will never be selected as optimal. McCarthy notes, “the presence of an “extra” faithfulness violation is typical of non-surface-apparent opacity.” (McCarthy 1999: §5.1). Thus, standard OT is unable to account for the cases of non-surface apparent opacity.

1.3 Sympathy Theory: a fix for opacity in OT (McCarthy 1999)

In section 1.2 we saw that occurrences of phonological opacity cause problems for classical OT. McCarthy (1999) offers a solution to the problem called Sympathy Theory. By choosing a *sympathetic candidate*, McCarthy’s theory can deal with the case of opacity discussed above. The theory works as follows. In languages that have opaque outputs, one of the faithfulness constraints acts as a *selector* constraint. This selector constraint picks out a candidate to be the *sympathetic* candidate. The language also has a *sympathetic constraint*, which is itself a faithfulness constraint that requires faithfulness not between the underlying form and the output, but between the sympathetic candidate and the output. These terms are given below in (7).

- (7) a) (★) **Selector constraint:** picks out a sympathetic candidate. The selector constraint is often the constraint that corresponds to *not* doing the second process in an opaque order.
- b) (⊗) **Sympathetic candidate:** The most harmonic candidate that passes the selector constraint.
- c) (⊗) **Sympathetic constraint:** A constraint that requires faithfulness between the sympathetic candidate and the rest of the candidate set.

In order to implement Sympathy in the example from Modern Hebrew, we must first find the selector constraint. Recall that the rule of lowering counter-bleed the rule of f -deletion (cf. (3b)). In this case, the second process is f -deletion. Thus, *not* deleting f means that MaxC is satisfied. Hence, ★MaxC is the selector.

In order to pick the sympathetic candidate, we must find the most harmonic candidate that passes the selector. In other words, of the candidates that pass the selector, we must find the one which one is the winner of this smaller set. In tableau (8), only the first two candidates pass the selector. Of these two, the second one is the most harmonic, for its second violation is ranked lower than the second violation incurred by the first candidate. The selector picks out the candidate that has undergone the process of lowering *and should have*. Therefore, *itparafti* is the sympathetic candidate.

(8) Selecting the sympathetic candidate

	/itparefti/	* f] _{σ}	* f] _{σ}	*eCC	★ MaxC	Ident(lo)
faithful	itparefti		*!	*	✓	
sympathetic	⊗ itparafti		*!		✓	*
transparent	itpareti				*	
opaque	↯ itparati				*	*

The third step is to pick the sympathetic constraint. To find the sympathetic constraint, we must consider what the sympathetic candidate and the actual output have in common. In this example, they share the height of the penultimate vowel. Therefore, $\textcircled{*}\text{Ident}(\text{lo})$ is the sympathetic constraint.

(9) Opaque form with sympathy

	/itpareʔti/	*ʔ] _σ	*ʔ] _σ	*eCC	$\textcircled{*}\text{Ident}(\text{lo})$	★ MaxC	Ident(lo)
faithful	itpareʔti		*!	*	*	✓	
sympathetic	$\textcircled{*}$ itparaʔti		*!			✓	*
transparent	itpareti				*!	*	
opaque	it parati					*	*

The transparent candidate *itpareti* that won in tableau (8) now has a higher ranking violation than the opaque candidate. By appealing to sympathy, we have created a tableau that generates the correct output. In counter-bleeding cases, the sympathetic constraint has a complementary set of violations to its corresponding *plain* constraint. This is because the sympathetic candidate has undergone lowering and the sympathetic constraint requires faithfulness to this candidate. From our sympathetic analysis and tableau (9), we can conclude the following: (i) the process of deleting ʔ in coda produces MaxC violations, (ii) this process renders lowering opaque, creating cases of non-surface apparent opacity, and (iii) $\textcircled{*}\text{Ident}(\text{lo}) \gg \text{Ident}(\text{lo})$.

2. McCarthy's Implication

Following directly from the architecture of Sympathy Theory is the following implication:

- (10) If “two notionally distinct processes ... violate exactly the same faithfulness constraints, then they must always act together in rendering a third process opaque” (McCarthy 1999: §3.2).

In other words, McCarthy predicts that a situation like (11) cannot occur if it involves rule *sandwiching*. The faithfulness constraints in the second column are those that are violated as a result of the process in the first column. Sandwiching occurs when (i) the faithfulness constraint that is violated as a result of process 1 and process 3 is the same, (ii) process 3 opacifies process 2, and (iii) process 1 does not opacify process 2. In (11), ★A would be the selector because it corresponds to *not* doing the second process of the opaque interaction, in this case process 3.

(11) Three Processes	Faithfulness Constraints
1 (does not opacify 2)	A
2	B
3 (opacifies 2)	A

The reason sandwiching is so problematic for sympathy is that the selector constraint ★A has no way of distinguishing forms that have undergone process 3 and should opacify process 2 from forms that have undergone process 1 and should not. An analogous sympathetic candidate is chosen for both the transparent interaction and the opaque interaction. Sympathy Theory cannot simultaneously account for the transparent and the opaque outputs in a sandwiching scenario. In the following section, we will examine a specific case of rule sandwiching that produces a situation like that in (11).

3. Modern Hebrew as a counterexample to Sympathy Theory (Mizrahi/Eastern dialect)

3.1 Problematic Situation

The non-standard dialect of Modern Hebrew discussed in §1 offers a counterexample to the implication in (10). The derivations from (3) are repeated below as (12).

(12)	/itpaleʔ ti/	/itpareʕ ti/
ʔ → ∅ in coda	itpale ti	-----
e → a / ___ CC	-----	itparaʕ ti
ʕ → ∅ in coda	-----	itpara ti
	[itpaleti]	[itparati]

As discussed in §2, a direct consequence of Sympathy Theory is that a situation of rule sandwiching cannot occur. If, however, there is such a case, the architecture of Sympathy Theory will be jeopardized. One such example exists in Modern Hebrew.

(13) Rule *sandwiching* in Modern Hebrew.

Three Processes	Faithfulness Constraints
1. ʔ deletion	A. MaxC
2. Lowering	B. Ident(lo)
3. ʕ deletion	A. MaxC

In Modern Hebrew we find the three processes given in (13). ʔ-deletion and ʕ-deletion cause MaxC violations while lowering causes Ident(lo) violations. From (12), we conclude that ʔ-deletion (process 1) bleeds Lowering (process 2) and ʕ-deletion (process 3) counter-bleeds it. As we saw in §1.3, ★MaxC is the selector constraint for the counter-bleeding case for it corresponds to not undergoing ʕ-deletion.

3.2 Sympathy with both forms

Recall that the opaque form [itparati] was correctly generated once we were able to appeal to sympathy. Tableau (9) is repeated here as (14).

(14) Opaque form with sympathy

	/itpareʔti/	*ʔ] _σ	*ʔ] _σ	*eCC	⊗ Ident(lo)	★ MaxC	Ident(lo)
faithful	itpareʔti		*!	*	*	✓	
sympathetic	⊗ itparaʔti		*!			✓	*
transparent	itpareti				*!	*	
opaque	↗ itparati					*	*

Once a selector and a sympathetic constraint are posited to be in a language, they must be present in every tableau. Thus, for the transparent form involving ʔ-deletion, we must use the same constraints and the same ranking as we did in (14).

(15) Sympathy and the transparent form

	/itpaleʔti/	*ʔ] _σ	*ʔ] _σ	*eCC	⊗ Ident(lo)	★ MaxC	Ident(lo)
faithful	itpaleʔti	*!		*	*	✓	
sympathetic	⊗ itpalaʔti	*!				✓	*
transparent	↗ itpaleti				*!	*	
opaque	↘ itpalati					*	*

As was the case with the opaque form, the selector picks the second candidate (the one that has undergone lowering and should have) as the sympathetic candidate. Because an analogous candidate is selected as sympathetic in both the transparent and the opaque forms, there is no way to distinguish forms that should opacity lowering from forms that should not. The result of tableaux (14) and (15) is a contradiction. ⊗Ident(lo) must outrank Ident(lo) in order to accommodate the opaque form in (14) and Ident(lo) must outrank ⊗Ident(lo) for the transparent form in (15). In cases of counter-bleeding relationships, the sympathetic constraint and its corresponding *plain* constraint (which corresponds to not doing the first process of the opaque interaction) have complementary sets of violations. The result is that there is no way to rearrange them in order to satisfy both the transparent and the opaque forms. This “chaotic” result is typical of analyses that appeal to sympathy (Idsardi 1997:26). That is, the introduction of sympathetic constraints and candidates makes transparent forms, which should not be difficult to handle, suddenly unmanageable.

The data from Modern Hebrew show that McCarthy's implication is not true for all cases. Here we have an example where η -deletion and ζ -deletion violate the same faithfulness constraint MaxC, but do not act together in rendering lowering opaque. Only the rule of ζ -deletion opacifies lowering. We find lowering in the output, but it is non-surface apparent. η -deletion, on the other hand, does not opacify the rule of lowering because underlying forms with a η in coda do not undergo lowering. Given this data, we have a counterexample to McCarthy's implication.

4. Potential Solution: Narrow Constraints

4.1 Benefits

In the previous tableaux, we assumed that both η -deletion and ζ -deletion corresponded to MaxC violations. One way to accommodate the data from Modern Hebrew is posit two different Max constraints. By doing so, OT and Sympathy Theory can generate the correct outputs. Instead of assuming only MaxC, we assume that we have two separate constraints, Max η and Max ζ . Under this assumption, the selector constraint is \star Max ζ because it corresponds to not doing the second process in the opaque order, namely ζ -deletion. With these assumptions, we are able to create tableaux that correctly yield both the transparent and the opaque outputs.

(16) Opaque form

	/itpare ζ ti/	* η] _{σ}	* ζ] _{σ}	*eCC	⊗ Ident(lo)	\star Max ζ	Ident(lo)	Max η
faithful	itpare ζ ti		*!	*	*	✓		
sympathetic	⊗ itpara ζ ti		*!			✓	*	
transparent	itpareti				*!	*		
opaque	⊗ itparati					*	*	

Consider tableau (16). It does not differ significantly from the tableau in (14). \star Max ζ acts just as \star MaxC did, and picks *itpara ζ ti* as the sympathetic candidate. The constraint Max η does not affect this example, for no candidates in (16) violate it. Its

placement is irrelevant to the opaque form. Hence, tableau (16) correctly predicts the output of the opaque form.

(17) Transparent form

	/itpaleʔti/	*ʔ] _σ	*ʃ] _σ	*eCC	⊗ Ident(lo)	★ Maxʃ	Ident(lo)	Maxʔ
faithful	itpaleʔti	*!		*		✓		
	itpalaʔti	*!			*	✓	*	
transparent & sympathetic	⊗ ↗ itpaleti					✓		*
	itpalati				*!	✓	*	*

Now consider tableau (17). All of the forms pass the selector constraint because there is no ʃ in the underlying form. To choose the sympathetic candidate, we must now pick the most harmonic candidate of those remaining. In this case, we have eliminated none. Since no forms are discarded, the selector simply picks the actual output [itpaleti]. In other words, the selector ★Maxʃ has no effect on forms with no ʃ and the most harmonic candidate wins as if there were no sympathy at all. Now the sympathetic constraint simply reinforces the violations from the lower ranked Ident(lo) and the tableau generates the correct output.

We now have a possible solution to the problem revealed above. We no longer have two processes that incur the same faithfulness violations, but two processes that incur different faithfulness violations. These constraints can be ordered independently and separately from each other, thus, they need not act together in rendering a third process opaque. The process that deletes ʃ and causes Maxʃ violations opacifies lowering. The process of ʔ-deletion causes Maxʔ violations and does not opacify lowering. Under this revised scenario, we are no longer answerable to McCarthy’s implication, for we no longer have identical faithfulness violations.

4.2 Problems

Though providing a solution to the problem in §3.2, this method of narrow constraints is rather inelegant in nature. This minute altering of faithfulness constraints

runs into problems with the notion of natural classes (Idsardi 1997: 26). If we propose the constraints $\text{Max}\eta$ and $\text{Max}\zeta$, then we must also provide a constraint or several constraints that maximize all other consonants except η and ζ in order to avoid surface forms such as /itpale η ti/ \rightarrow *[iae η i]. For this we have two choices. We can posit one of the two constraints in (18).

- (18) (a) $\text{MaxC}-(\eta/\zeta)^2$: Maximize all consonants except η and ζ .
 (b) MaxC_i for every C_i in the consonant inventory

The drawback of these two possibilities is that they require reference to groups of sounds that do not form a natural class. The group of sounds from (18a), $\text{C}-(\eta/\zeta)$, does not form a natural class (Idsardi 1997:26). (18b) is unsatisfying because it loses the notion that phonological processes occur to a natural class of sounds (Idsardi 1997:26). Therefore, this method of specifying which segment to maximize does not provide a satisfying solution.

5. Conclusion

A direct result of Sympathy Theory is that if two distinct processes violate the same faithfulness constraints, then they must both opacity or not opacity a third process because there is no way to distinguish them in the constraint ranking. This was not the case for the dialect of Modern Hebrew discussed in this paper. We considered two processes that had the same faithfulness violations, η -deletion in coda and ζ -deletion in coda. ζ -deletion caused the rule of lowering to be opaque while η -deletion did not. Furthermore, there was no way to rearrange the constraints in such a way as to accommodate both the opaque cases and the transparent ones. This dialect exists as a counterexample to Sympathy Theory.

We also considered a possible solution to this problem which relied on narrowing the constraints in order to target specific segments or feature bundles. By using narrow

constraints such as $\text{Max}^?$ or Max^{f} , we were able to create tableaux that accounted for both the transparent and the opaque forms. This was not a satisfying solution for it created a set of very specific rules that did not make reference to natural classes.

In conclusion, the example from Modern Hebrew shows that Sympathy Theory cannot simultaneously account for both the opaque and the transparent forms that exist in a language that exhibits rule *sandwiching*. In Modern Hebrew, we found that there was a constraint contradiction that resulted from Sympathy Theory. It was necessary to have both $\text{Ident}(\text{lo}) \gg \text{Ident}(\text{lo})$ and $\text{Ident}(\text{lo}) \gg \text{Ident}(\text{lo})$. The solution proposed in §4 had its own difficulties and did not satisfactorily resolve the problem in Modern Hebrew. Because a direct consequence of Sympathy Theory is the implication discussed in (10), the data from Modern Hebrew challenge the theory as stated in McCarthy 1999.

References

- Archangeli, Diana. 1997. Optimality Theory: An Introduction to Linguistics in the 1990s. Optimality Theory: An Overview, ed. by Diana Archangeli and D. Terence Langendoen. 1-32.
- Barkai, Malachi. 1978. Phonological Opacity v. Semantic Transparency: Two Cases from Israeli Hebrew. *Lingua* 44. 363-78.
- Bat-El, Outi. 1989. Phonology and Word Structure in Modern Hebrew. Los Angeles, CA: UCLA dissertation.
- Bolozky, Shmuel. 1977. Fast Speech as a Function of Tempo in Natural Generative Phonology. *Journal of Linguistics* 13. 217-38.
- 1978. Some Aspects of Modern Hebrew Phonology. *Modern Hebrew Phonology*, ed. by Ruth Aronson Berman. 11-67.
- 1985. The Domain of Casual Processes in Modern Hebrew. *Linguistic Analysis* 15, 1. 19-27.
- 1997. Israeli Hebrew Phonology. *Phonologies of Asia and Africa Vol. 1*, ed. Alan S. Kaye. 287-311.
- Bolozky, Shmuel and Ora Rodrigue Schwarzwald. 1990. On Vowel Assimilation and

² Here “-“ stands for the complement of the set in parentheses. This constraint maximizes all consonants *minus* ? and f.

- Deletion in Casual Modern Hebrew. *Hebrew Annual Review* 12. 23-48.
- Blanc, Haim. 1964. *Israeli Hebrew Texts*. *Studies in Egyptology and linguistics in honour of H. J. Polotsky*, ed. Haiim B. Rosen. 132-152.
- Devens, Monica Schaefer. 1978. *The Phonetics of Israeli Hebrew: "Oriental" versus "General" Israeli Hebrew*. Los Angeles, CA: UCLA dissertation.
- Hualde, J. I., G. Elordieta, and A. Elordieta. 1994. *The Basque dialect of Lekeitio*. Bilbao and Donostia--San Sebastian: Press and Diputacion Foral de Gipuzkoa.
- Idsardi, William J. 1997. *Sympathy Creates Chaos*. ms. University of Delaware.
- Kaisse, Ellen M. 1976. Rule reordering, local order, and the function of rules. *Papers from the 12th regional meeting of the Chicago Linguistics Society*, ed. S. Mufwene, C. Walker, and S. Steever, 321-336.
- Kaye, Jonathan. 1974. *Opacity and Recoverability in Phonology*. *Canadian Journal of Linguistics* 19. 134-149
- 1975. *A Functional Explanation of Rule Ordering in Phonology*. *Papers from the Parasession on functionalism*. Chicago Linguistic Society. 244-52.
- Kenstowicz, Michael and Charles Kisseberth. 1979. *Generative Phonology: Description and Theory*. New York: Academic Press.
- Kiparsky, Paul. 1971. *Historical Linguistics. A Survey of Linguistic Science*, ed. by W. O. Dingwall. 576-649. Reprinted in *Explanation in phonology* (1982), ed. by Paul Kiparsky. 57-80.
- 1973. *Abstractness, Opacity, and Global Rules. Three Dimensions of Linguistic Theory*, ed. O. Fujimura, 57-86.
- Laufer, Asher and Thomas Baer. 1988. *The Emphatic and Pharyngeal Sounds in Hebrew and in Arabic*. *Language and Speech* 31, 2. 181-205.
- McCarthy, John. J. 1999. *Sympathy and Phonological Opacity*. *Phonology* 16, 3. 331-399
- Rodrigue-Schwarzwald, Ora and Ramat Gan. 1978. *The Influence of Demographic Variables on Linguistic Performance*. *Glottometrika* 1, ed. G. Altmann. 173-97.
- Roca, Iggy and Wyn Johnson. 1999. *A Course in Phonology*. Oxford: Blackwell Publishers.

Measurable Degrees of Foreign Accent: A Correlational Study of Perception, Production, and Acquisition *

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1.0 Introduction

Most people who learn a second language in late adolescence or adulthood speak it with some degree of foreign accent. Native speakers of the language purportedly can identify a non-native speaker of their language; hence the use of native speaker judgments in many empirical and theoretical studies of second language acquisition (Birdsong, 1989). Native speaker intuition is often trusted, yet it isn't clear exactly what people attend to when they make decisions about the nativeness of another's speech (Sorace, 1996). From another angle, it isn't clear what people attend to when they make decisions about whether speech is foreign-accented and to what degree. The present study investigates whether objective correlates can be found in the acoustic signal for native speakers' subjective judgments of degrees of accentedness. This does not assume that an invariant correlate can be found in the acoustic signal for each sound across all speakers explored in this study. I am looking to see whether a measurable intra-factor variability in the speech signal correlates with ratings of degree of accentedness, and whether there is an allowable deviation from native speaker norms corresponding to accentedness ratings of "little accent" or "no accent". The objective measurements of subjects' speech and the subjective ratings of degree of accent will first be analyzed for correlational properties. Then, these data will be assessed in terms of subjects' second language acquisition experiences to investigate whether they indicate Critical Period or maturational effects in subjects' second language acquisition.

* Many sincere thanks to my advisors Julia Herschensohn and Richard Wright; David Birdsong; James Flege; my UW colleagues; and NWLC 2000 participants for their guidance, encouragement, comments and constructive feedback.

I will present empirical evidence that significant correlation relationships exist between the acoustic intra-factor measurement of subjects' speech and the subjective perceptions of foreign accent in their speech, implying that listeners are sensitive to specific, measurable variances in the acoustic signal. I also find variance in the perception of accent in the native speaker controls' speech; that is, they were not consistently described as having no accent. Finally, I will present evidence that the comparison of accentedness ratings and age-related facts about the non-native speakers' second language acquisition experiences yield support for maturational effects on phonetic and phonological acquisition.

2.0 Theory and Background

2.1 Purpose for Study

The non-nativeness of second language learners (hereafter "L2ers") can be evident in many facets of their linguistic processing. Semantic uncertainty and lexical misuse can impede ease of communication. Organization of lexical items and morphology can reveal an incomplete syntax. Deficits in the phonetic and phonological realization of the target language create a foreign accent in spoken language. While L2ers show great variability in all of these areas, any one of them is enough to reveal an L2er to a native speaker.

Highly competent L2ers may pass for natives in the areas of syntax, morphology, and lexicon, a phenomenon coined by Scovel (1988) as the *Joseph Conrad effect*. Conrad was a native Polish speaker whose written English prose was syntactically, morphologically, and lexically flawless. However, Conrad reputedly had a strong accent in his spoken language. Speakers who have excellent command of L2 syntax and morphology and produce utterances which are "fluent" in these areas often reveal their non-native status with their phonetic realization of the language.

Scovel used writing sample judgments in his foreign accent experiments and showed that American English native speakers could correctly identify non-native speakers at 97% in the oral judgment but at only 47% in the written judgment (Scovel,

1998). Native speakers' judgments are commonly used in L2 research (Sorace, 1996) as determiners of the "nativeness" of the producers of the experimental data. When reviewing a written corpus, a native speaker will be sensitive to various aspects of structural grammar and will use his/her perception of the structural and lexical appropriateness of the language used in the corpus to make a decision about the writer's language proficiency. When presented with an oral corpus, to what, exactly, does the native listener attend? To be sure, the listener will say, "the amount of foreign accent I hear." What constitutes "foreign accent" to a native listener? If the spoken corpus is based on written material provided by the non-native speaker, the listener could be attending to syntactic, morphological, and lexical factors as well as pronunciation and prosodic information. If the non-native speaker is given material written by a native speaker to read aloud, the syntactic, morphological, and lexical factors are reduced. However, L2ers will undoubtedly show individual variability in overall accuracy of pronunciation simply because of individual differences (not necessarily related to their native phonology), possibly related to non-linguistic factors such as personality, motivation, and cultural factors. Brown (1980) claimed that the L2er's attitude towards the L2's society and culture is a constraint on L2 acquisition success. Zuengler (1988) put forth evidence that L2ers use social, biological, and affective markers in their L2 pronunciation at all ages and across all levels of L2 proficiency. Other researchers think these kinds of factors are hardly amenable to objective evaluation (Gass & Selinker, 1994).

I expect that the respondents will be able to identify Korean L2ers who began using English before some critical period for phonological acquisition as having little or no accent, while the L2ers who began using English after this time will be identified as having greater, but varying, degrees of foreign accent.

In this correlational study, I have attempted to isolate some measurable elements of speech that may contribute to native listeners' perception of foreign accent. The purposes of this study are to identify some of the factors people pay attention to when they determine another's speech to be accented, to measure the amount of intra-factor speech variability that is permitted by the listener at different perceived degrees of accentedness, and to determine whether these elements support the tenets of the Critical

Period Hypothesis. To accomplish these goals, the study was conducted in four parts: Perception of accent data was collected and analyzed; aspects of the speech presented for subjective judgment were measured and analyzed; the perception data and the measurement data were assessed together to determine whether a correlation exists between subjective perception of accent and acoustic production characteristics; and the perception data were assessed together with details of the subjects' L2 acquisition experiences to determine whether a correlation exists between perceived foreign accent and the ages at which aspects of L2 acquisition occur. The design of the experiment was motivated by previous attempts to isolate determining factors of accentedness; I have tried to reduce possibly interfering variables as much as possible.

2.2 Previous research

Some researchers have tried to acoustically qualify the perception of speech by searching for invariant correlates in the acoustic signal associated with specific perceptual units. Stevens and Blumstein (1981) attempted to identify invariant spectral templates associated with each of a language's phonemes. The idea that invariant acoustic correlates exist for linguistic units used by the brain in processing language is very attractive; however, many factors make a one-to-one mapping nearly impossible. First of all, phonemes are abstract theoretical units that have been posited as a tool for understanding the way the brain categorizes sounds and gives them linguistic validity. In fact, they are artificial and therefore a step removed from natural speech (Borden, Harris, and Raphael, 1994). Stevens and Blumstein's approach assumes that the acoustic signal is mapped onto these categorical units at some point in speech processing. (Other research explores the possibility that the brain looks for diphone patterns in the acoustic signal, or even larger units, such as syllables or entire lexical items—see Lively, Pisoni and Goldinger, 1994, and Klatt, 1989 for a review). Secondly, the spectral templates suggested by Stevens and Blumstein were constructed from CV syllables spoken in isolation. This kind of assessment cannot possibly account for the spectral variation in natural speech due to coarticulation effects. The acoustic signal is a continuous entity

laden with transitions between sounds and phonological interventions as well as intonation effects, not a linear arrangement of individual phonemes or diphones.

The speech perception process has been investigated in terms of other phonological phenomena as well. Harriet Magen (1998) made an intriguing attempt at isolating the factors to which people attend when they perceive a foreign accent. She used natural speech sentences produced in English by a native Spanish speaker as the bases for her experiment stimuli. She then synthetically altered one factor at a time and presented the resulting stimuli to native English speakers for judgment of foreign accent. She attempted to isolate the following factors: Vowel quality; aspiration on voiceless stops, consonant elision, voicing, vowel epenthesis, sentence-level intonation and word-level stress. She found that vowel epenthesis, final /s/ deletion, consonant manner, and lexical and phrasal stress had the greatest impact on listeners' perception of foreign accent. The design of the experiment revealed some drawbacks, however. First, since only one source speaker was used for the production of all stimuli, the listeners surely would have noticed that each "voice" they heard was the same person. Even though the listeners in her experiment were apprised of this, the potential for some kind of bias in judgments cannot be ruled out. Secondly, Magen's stimuli preparation processes included much cutting, splicing, extending, and tweaking of the original signal, and even included the splicing in of aspiration from an entirely different speaker—an English speaker, since the Spanish speaker didn't produce aspiration anywhere in his recordings that could be spliced in. She synthesized the entire f_0 contour for the production of some stimuli to remove the f_0 aspect of prosody which is characteristic for Spanish, and replaced it with an English f_0 contour (both at the word and sentential levels). This is problematic not only because of the non-naturalness of the synthesis, but also because the f_0 contour is just one aspect of several that provide prosodic information (see Cutler, Dahan, and van Donselaar, 1997 for a review of duration, amplitude, and frequency aspects of prosody in speech comprehension). Unfortunately, there does not exist a natural group of L2ers, willing and available for research, who all vary in their L2 speech production by exactly one of the factors that could contribute to foreign accent. Magen's detailed stimuli preparation was impressive and certainly careful, but synthesized speech, even if altered from a natural speech signal base, simply is not natural speech. Thirdly, I think her goals of isolating

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and ranking factors which contribute to foreign accent would have been better met by doing everything exactly the other way around. Magen's study essentially evaluated which combinations of factors (all factors minus the one factor that was removed for each stimulus) contributed to perception of accent. If she had started out with English natural speech bases and then introduced one potential factor at a time (synthesized according to native Spanish, English L2 production data), she could have measured the effect that each factor had, in isolation, on perception of foreign accent.

Patkowski (1990) concluded that a definite critical period for speech learning exists, noting an abrupt difference in the foreign accents of speakers who arrived in an immersion environment before and after the age of 15. In an attempt to replicate Patkowski's findings, Flege et al. (1995) also found a relation between the age of arrival in an L2 immersion environment and judgments of pronunciation accuracy, indicating that earlier immersion is better; however, no discontinuity was evident in judgments around any particular age. His results were thus inconsistent with the view that the end of some critical period is followed by a sharp decline in the development of pronunciation abilities. The results also suggest that some factors other than age of arrival contributed to Patkowski's results. Judges in Patkowski's study were trained ESL instructors, and stimuli were natural speech samples drawn from interviews with subjects. The spontaneous speech could have revealed subjects' non-native status through their syntactic and lexical choices. The ratings could have reflected a critical period of some other aspect of linguistic development than phonetic and phonological acquisition (Flege, 1999). One feature of the results obtained by Flege et al. (1995) was consistent with the Critical Period Hypothesis: None of the subjects who began learning the L2 after the age of 15 received a rating within two standard deviations of the mean rating received by the control group, which could be interpreted to mean that none of them learned to speak the L2 without a detectable foreign accent (Flege, 1999). It is important to note that Patkowski's and Flege et al.'s analyses compared age of arrival in the immersion environment to judgments of foreign accentedness. Flege (1999) claims that the study explored the connection between foreign accentedness and the age at which naturalistic learning began, implying that he equates the onset of naturalistic learning with the age of arrival. The age of arrival is not necessarily the age at which a learner begins to

naturalistically acquire an L2. It is not uncommon for immigrants to move to a new country and immerse themselves in a community where the L1 is used almost exclusively. I consider the age of naturalistic learning to be the age at which the use of the L2 becomes important and useful to the learner, when s/he takes the L2 outside the classroom and begins to try to use it to express and negotiate meaning. This event may occur before or after the learner relocates to an L2 immersion environment; therefore, it may be more informative to compare the age of naturalistic, communicative use to the judgments of accent, rather than the age of arrival.

The tools used in second language research should receive as careful scrutiny as the outcomes. Using native speakers to provide ratings is inherently problematic. Sorace (1996) acknowledges that while linguistic intuition has long been a prominent part of L2 research, it has not produced the kinds of quantitative models that have emerged in other fields. Since there are no other ways of accessing the mental representation of language than asking for intuitions or judgments of some kind, it is essential to give as much meaningful structure as possible to the responses of informants. For example, in research on L2 syntax, symbols such as “*”, “**”, “?”, and “??” are often used to indicate levels of acceptability of sentences, but these kinds of marks give no indication of the scale of the difference—whether two marks means that a sentence is twice as bad as another, or just less acceptable—nor do they indicate whether the differences indicate crucial or trivial elements of linguistic competence (Sorace, 1996). She suggests that a response mechanism should estimate magnitude to provide a better defined picture of competence. In this study, I constructed an ordinal rating scale of equal intervals, labeled to describe the equidistant nature of each rating, to estimate magnitude regularly.

Another quandary of the tool of native speaker intuition is that listeners can be influenced by cognitive, contextual, or extralinguistic factors and may cast their judgments for reasons other than those anticipated by the researcher (Sorace, 1996). Beliefs about forms they habitually use; beliefs about the forms they think ought to be used; and willingness to tolerate variability can all be reflected in listeners' judgments (Greenbaum and Quirk, 1970). While the results of this study show that the factors which were being measured had an impact on the judgments given by the listeners, it is also

evident that other factors which were not specifically being measured contributed to the ratings. This will be discussed in section 5.0.

3.0 The present study

3.1 Overview

The aim of this study is to investigate whether subjective judgments of foreign accentedness by native speakers can be correlated with acoustic observations of L2 speech and with the age-related L2 acquisition experiences of the subjects. Because this is a correlational study, the perception experiment and the acoustic production measurements will be detailed first, and the correlation analyses will follow.

3.11 Perception Experiment

Native speakers of English were presented with stimuli produced by native Korean speakers of varying English L2 proficiency and by native English speakers as controls. The stimuli were English word tokens which contained three phonetic elements known to differ between Korean and English phonologies: the pronunciation of [l] and [ɾ]; tense-lax vowel quality; and consonant clusters. The respondents rated each token in terms of the degree of foreign accent they perceived. The perception experiment results were aggregated and mean ratings were calculated in relation to each speaker and each kind of phonological contrast.

3.12 Production Analysis

The tokens used in the perception experiment stimuli were analyzed acoustically for variation in the production of each of the three factors indicated previously. Detailed measurements were made and organized for comparison to the perception of accent ratings.

3.13 Correlation: Perception-Production

The perception results and production measurements were assessed together to determine whether a correlation exists between the subjective perception of foreign accent and objective acoustic measurement data.

3.14 Correlation: Perception-L2 Acquisition Experiences

The perception results were assessed together with information about the subjects' L2 acquisition experiences—including age of exposure to the L2, age of communicative use of the L2, age of arrival in the L2 immersion environment, and self-perception of foreign accent—to determine whether accent perceptions correlate with age-related aspects of L2 acquisition. A correlation would indicate support for the Critical Period Hypothesis in terms of phonetic and phonological acquisition.

3.2 Methods

3.21 Recording Methods

3.211 Subjects

Six native speakers of Korean (three male, three female) and two native English speakers (one male, one female) were recorded as they read prepared token lists. Subjects ranged in age from 19-41 years, with a mean age of 25 years. All of the Korean subjects were born in South Korea and began learning English at ages ranging from 4-14 years. They moved to an English immersion environment (the United States) at ages ranging from 2-28 years, and reported that they began really using English to communicate at ages ranging from 4-27 years. Five of the six Korean subjects currently spend at least 80% of their day speaking English. Four of the Korean subjects felt it was important to have an American English accent. The Korean native speakers displayed varying degrees of proficiency in English, and their self-perceptions of degree of foreign accent in English

ranged from moderately heavy accent to no accent (spanning 4 points on a 5-point scale). (See Appendix A for the biographical questionnaire administered to the Korean subjects.) The English native speakers are both monolingual speakers of Western Washington English. They were chosen because they represent the dominant dialect of the region and share the same dialect of the respondents in the perception experiment. All subjects were unpaid volunteers.

3.212 Tokens

Twelve English tokens were selected to highlight some differences between Korean and English phonologies, potentially creating opportunities for accented speech. One difference was contained in each token subgroup; therefore, only one posited marker of foreign accent was present in each token.

Four tokens were designed to extract subjects' ability to produce the English [l] and [ɾ] in both syllable-final and syllable-initial position (*ball, bar, light, right*). These liquids are not contrastive in Korean, rather, Korean's phonemic /l/ alternates allophonically with [ɾ], [ʎ], and [P] (Ahn, 1998). The situation of learning that parts of a single phoneme in L1 represent two phonemes in an L2 is thought to be the most difficult to overcome when learning a second language (Lado, 1957).

Four tokens were designed to extract subjects' ability to produce both tense and lax vowels in closed syllables (*date, debt* [e]/[E]; *bead, bid* [i]/ [I]). Western Washington English includes all four vowels phonemically; Korean includes /i/ and /E/ phonemically, and some phonologists and dialectologists posit either an /e/ or an /ə/ phonemically (Ahn, 1998). Vowels tend to show some laxing effects in closed syllables in Korean (Kim-Renaud, 1986). Also, vowels tend to lengthen in English when they are tense or in syllables closed by a voiced segment, and tend to shorten when they are lax or in syllables closed by a voiceless segment. Korean still retains phonemic vowel lengthening in many dialects, and thus vowel lengthening is not a result of the same function in Korean as in English.

Four tokens were designed to extract subjects' pronunciation of syllable-final consonant clusters (*picked* [pɪkt], *debts* [dɛts], *begged* [bɛgd], *bids* [bɪdz]). Consonant clusters in syllable-final position are avoided phonetically as much as possible in Korean. Common cluster avoidance strategies include deleting one consonant or inserting an epenthetic [→] (Kim-Renaud, 1986).

3.213 Recordings

The 12 tokens were randomized and listed three times, and nonce-tokens were added to the beginning and end of each list to reduce list-reading intonation effects, such as pitch and amplitude reduction at the end of a spoken list. Thus, three lists of 14 items each were presented to each subject for recording. (See Appendix B for the token lists as presented to subjects). Analog recordings were made at the University of Washington Phonetics Lab using an Electro-Voice RE20 microphone with a frequency response between 45-18,000 Hz, plus amplification as needed to maximize the signal-to-noise ratio for each subject. The recordings were digitized using the Kay Computerized Speech Lab (model 4300B) at 16 bits with a 22050 Hz sampling rate.

3.22 Perception Experiment Methods

The second repetition of each token on the first and second token lists was selected for presentation to a respondent group for subjective perception of degree of foreign accent. A total of 192 digital audio files were matched with single slides of each word typed in lower case in a Power Point presentation. The visual display was included to ensure that respondents knew what the target word was as they listened to each word being spoken. Each slide was shown for four seconds, with the corresponding audio file played once. The sound was played out over loudspeakers at a comfortable listening level in a small classroom setting.

Sixty-nine monolingual native speakers of Western Washington English watched and listened to the presentation and rated each token according to the degree of foreign accent they perceived. Respondents were told that they would be hearing words spoken

by both native and non-native speakers of English and that their task was to decide the degree of foreign accent they thought they heard on each word. The respondents rated each word on a five-point scale, ranging from 0-4. A mark of 0 indicated “heavy accent”; 2 indicated “some accent”; and 4 indicated “no accent”. They recorded their judgments on scannable forms. The respondents were unpaid volunteers from an introductory linguistics class at the University of Washington. They received credit equivalent to one homework assignment for participating.

3.23 Production Measurement Methods

The tokens which were presented to the respondent group for subjective judgment were also analyzed acoustically. Measurements were made of aspects of the acoustic signal according to the phonological factor of interest in each token.

3.231 [l] and [ɹ] distinction—tokens *ball, bar, right, light*

Spectrograms were produced for the tokens containing the [l]-[ɹ] contrast (*ball, bar, light, right*). Points in the spectrogram were selected for Fast Fourier Transform (FFT) and Linear Predictive Coding (LPC) analyses. A 512-point window was selected for the FFT and the LPC used 12 coefficients. The selected points on the spectrogram were the beginning of each liquid in word-initial position and the end of each liquid in word-final position. The first, second, and third formant frequencies (F1, F2, and F3) were recorded for each liquid. F1 generally remains constant for liquids and glides, while F2 and F3 fluctuate to distinguish each liquid and glide (Lieberman & Blumstein, 1988). In [l], F3 is relatively high and in [ɹ] it is relatively low. The behavior of F1 and F3 in these two sounds allows us to quantify each liquid’s *space* by subtracting its F1 center frequency from its F3 center frequency. Subsequently, the *distance* between a single speaker’s [l] and [ɹ] can be quantified by subtracting the [ɹ] space from the [l] space. Formulas for [l] and [ɹ] space and [l]-[ɹ] distance are given in (1) and (2), respectively.

- (1) $(F3-F1)_{[i]} = [i]$ space
 $(F3-F1)_{[ɪ]} = [ɪ]$ space
- (2) $[(F3-F1)_{[i]} - (F3-F1)_{[ɪ]}] = [i]-[ɪ]$ distance

Means were calculated for the F1 and F3 of each speaker's [i] and [ɪ]. These means were used in the above formulas to generate the mean [i] and [ɪ] space and distance across tokens for each speaker. These results were plotted in a two-dimensional F1 x F3 space to illustrate the [i]-[ɪ] spaces and distances.

3.232 Vowel quality—tokens *bead*, *bid*, *date*, *debt*

The midpoint of each vowel ([i], [I], [e], [E]) was selected by looking at a spectrogram of each token. Careful attention was paid to find the midpoint of the [e] portion of each token *date* and not just the midpoint of the vowel area on the spectrogram, as many dialects of English produce the diphthong [eI] for the phoneme [e]. FFT and LPC analyses were performed on each focus vowel's midpoint to identify the first two formant frequencies (F1 and F2) of each vowel. Each data point was input to the Hypercard program Plot Formants for the purposes of plotting a visual representation of each vowel's space by each subject. F1 and F2 measurements and means were calculated and plotted. The vowel space is plotted with F1 along one axis and F2-F1 along the other axis in accordance with a convention established to represent perceptual distance. The distance between the two vowels [i] and [I] and between [e] and [E] is calculated using the formula in (3).

- (3) $[(F3-F1)_{[i]} - (F3-F1)_{[I]}] = [i]-[I]$ distance
 $[(F3-F1)_{[e]} - (F3-F1)_{[E]}] = [e]-[E]$ distance

3.233 Consonant clusters—tokens picked, begged, debts, bids

The consonant cluster portion of each token was analyzed for cluster avoidance. Spectrograms were examined to determine whether inter-consonantal vowel epenthesis, post-cluster vowel epenthesis and resyllabification, or the deletion of either consonant occurred. Voicing variation among the consonant clusters was also noted as some subjects devoiced one of the consonants in some clusters.

3.3 Results

The results are divided according to the natural segments of this study. The results for the perception experiment will be addressed first, followed by the acoustic measurement results; the results of the correlation between perception ratings and acoustic measurements; and finally, the results of the correlation between perception ratings and details of subjects' L2 acquisition experiences.

3.31 Perception experiment

The first and last quartile of the perception rating results showed no significant changes in respondents' judgment behavior over the course of the 192-item perception task. On the five-point scale ranging from 0 (heavy accent) to 4 (no accent), the mean rating given by all 69 respondents was 2.312. 75% of the respondents gave mean ratings within one standard deviation (0.366) of the group mean, and 95% gave mean ratings within two standard deviations (0.732) of the group mean. Mean ratings did not differ significantly when ratings were isolated for each type of token. The respondents showed the greatest inter-rater consistency for the native English speakers (controls), as expected.

The results for males and females will generally be described separately in this analysis. This is to accommodate comparison of subjective rating data with acoustic measurement data, since acoustic signal information produced by male and female speakers is not comparable.

Labels were assigned to subjects according to the gender, native language, and mean perception rating for each subject. Labels beginning with *m*- indicate a male subject and labels beginning with *f*- indicate a female subject. For the purpose of separating the native English speaking control group, labels containing an *E* indicate the subject's native language as English, and those containing a *K* indicated the subject's native language as Korean. The remaining part of the labels indicate subjects' ranking in terms of the degree of accent rating they received. Thus, *1* indicates the highest rating (least accent) of the Korean native speakers, and *3* indicates the speaker attributed with the lowest rating (heaviest accent). Naturally, the English control group were not attributed with this part of the label. In summary, the label *f-K2* indicates a female Korean speaker who was rated as having a heavier accent than *f-K1* but a lighter accent than *f-K3*.

The male, native English control (*m-E*) was rated 3.340 (little to no accent). The male Korean speakers were rated as follows: *m-K1* was rated 1.991 (some to moderately heavy accent); *m-K2* was rated 1.556 (some to moderately heavy accent); *m-K3* was rated 0.974 (moderately heavy to heavy accent).

The female, native English control (*f-E*) was rated 3.611 (little to no accent). The female Korean speakers were rated as follows: *f-K1* was rated 3.332 (little to no accent); *f-K2* was rated 2.833 (some to little accent); *f-K3* was rated 0.961 (moderately heavy to heavy accent).

The following table summarizes the mean rating for all subjects, for each subject individually, and the standard deviation from the means.

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Table 1. Mean ratings of perceived foreign accent. Mean perception ratings and standard deviation from means for all subjects (Total) and by individual subject. Subjects are listed at left.

	Mean	Std. Dev.
Total	2.312	1.514
f-E	3.611	.826
f-K1	3.332	.986
f-K2	2.833	1.158
f-K3	.961	1.128
m-E	3.340	.977
m-K1	1.991	1.294
m-K2	1.558	1.275
m-K3	.974	1.180

The following box plot illustrates the mean perception rating and the range of ratings given for each subject. The mean is represented by a horizontal line, and the shaded area includes the 25% of ratings above and the 25% of ratings below the mean rating.

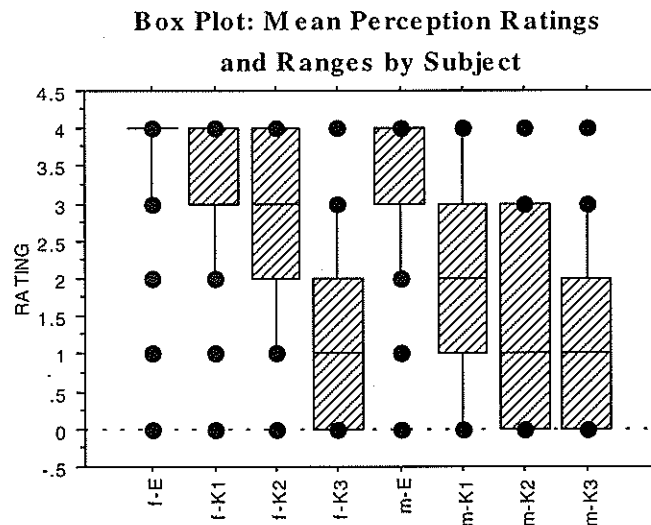


Figure 1. Box Plot: Mean Perception Ratings and Ranges by Subject. Box plot illustrating mean and range perception of foreign accent ratings for all subjects across all tokens. Ratings are plotted along the y-axis; subjects are plotted along the x-axis.

3.311 [l]-[ɹ] token results

The ratings for the tokens which contained the contrast between the liquids [l] and [ɹ] were aggregated to the exclusion of all other tokens. Some subjects' ratings were higher (less accent) for the [l]-[ɹ] tokens than their overall mean ratings, and some subjects' were lower (more accent). The subjects rated overall as having the heaviest accents (m-K3 and f-K3) were rated as having a heavier accent on the [l]-[ɹ] tokens than on any other kind of token. Subject m-K2 was actually rated nearly 0.5 points lower (heavier accent) on the [l]-[ɹ] tokens. The following table summarizes the mean perception ratings and associated standard deviations for the [l]-[ɹ] token subset of the perception experiment results.

Table 2. Mean ratings of perceived foreign accent on [l]-[ɹ] tokens. Mean perception ratings and standard deviations on aggregated [l]-[ɹ] tokens.

Subjects listed at left.

	Mean	Std. Dev.
Total	2.363	1.531
f-E	3.644	.794
f-K1	3.585	.802
f-K2	2.753	1.196
f-K3	.835	1.031
m-E	3.399	.993
m-K1	1.947	1.345
m-K2	1.964	1.285
m-K3	.777	.997

The following box plot illustrates the mean perception rating and the range of ratings given for each subject on [l]-[ɹ] token production. The ratings clustered more tightly around the means on the [l]-[ɹ] tokens than on all tokens, as can be seen by the smaller areas of shading for subjects f-K3, m-K2, and m-K3. This indicates greater inter-rater consistency on the [l]-[ɹ] tokens than across all tokens.

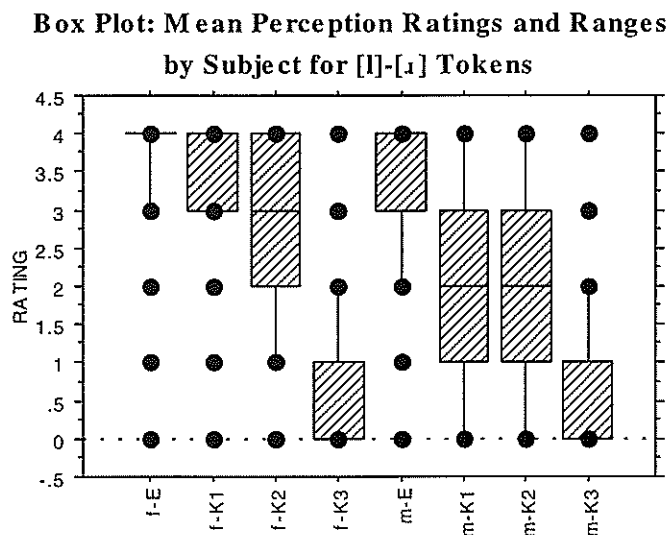


Figure 2. Box Plot: Mean Perception Ratings and Ranges by Subject for [l]-[ɫ] Tokens. Box plot illustrating mean and range perception ratings on [l]-[ɫ] tokens for each subject. Ratings are plotted along the y-axis, and subjects are plotted along the x-axis.

3.312 Vowel quality token results

Vowel quality appeared to contribute less to respondents' judgments of heavier accent than the [l]-[ɫ] distinction did. The most-accented subjects' vowel-based accentedness ratings were higher than their overall accentedness ratings. Subject f-K3 was rated 1.159 (some to moderately heavy accent), as compared to her overall rating of .961 (moderately heavy to heavy accent). Subject m-K3 was rated 1.142 (some to moderately heavy accent), as compared to his overall rating of .974 (moderately heavy to heavy accent). Thus, vowel quality contributed less to respondents' perception of their "heavy" accents. The following table summarizes the mean perception ratings and associated standard deviations for the vowel quality token subset of the perception experiment results.

Table 3. Mean ratings of perceived foreign accent on vowel tokens. Mean perception ratings and standard deviations on aggregated vowel quality tokens. Subjects listed at left.

	Mean	Std. Dev.
Total	2.306	1.509
f-E	3.657	.756
f-K1	3.303	1.001
f-K2	2.967	1.121
f-K3	1.159	1.237
m-E	3.313	.984
m-K1	1.737	1.257
m-K2	1.429	1.243
m-K3	1.142	1.278

The following box plot illustrates the mean perception rating and range of ratings given for each subject on vowel quality token production.

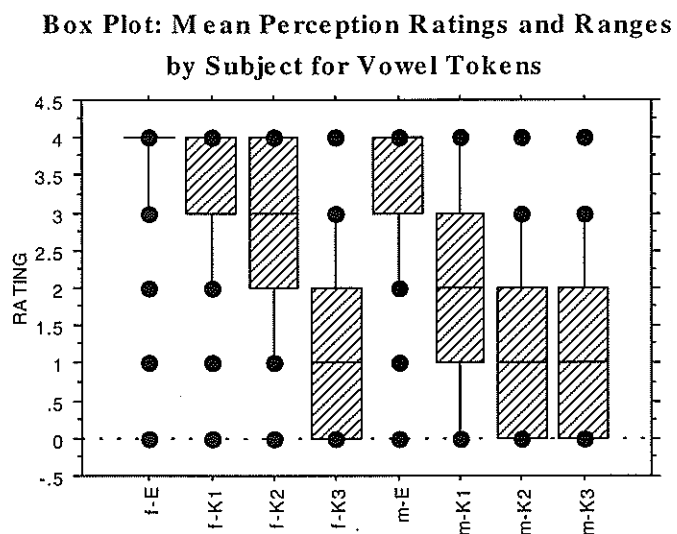


Figure 3. Box Plot: Mean Perception Ratings and Ranges by Subject for Vowel Tokens. Box plot illustrating mean and range perception ratings on vowel quality tokens for each subject. Ratings are plotted along the y-axis, and subjects are plotted along the x-axis.

3.313 Consonant cluster token results

Nearly all subjects were rated with a heavier degree of accent on their pronunciation of the consonant cluster tokens than on any other kind of token, indicating that the listeners were affected by subjects' pronunciation of consonant clusters. The native English controls were rated as having more foreign accent on the consonant cluster tokens (compared to their ratings on the other tokens), but their ratings were not affected as much as the ratings of the non-native speakers. The following table summarizes the mean perception ratings and associated standard deviations for the consonant cluster token subset of the perception experiment results.

Table 4. Mean ratings of perceived foreign accent on consonant cluster tokens. Mean perception ratings and standard deviations on aggregated consonant cluster tokens. Subjects listed at left.

	Mean	Std. Dev.
Total	2.267	1.500
f-E	3.521	.932
f-K1	3.140	1.068
f-K2	2.779	1.147
f-K3	.889	1.081
m-E	3.303	.954
m-K1	2.333	1.201
m-K2	1.306	1.205
m-K3	.982	1.207

The following box plot illustrates the mean perception rating and the range of ratings given for each subject on consonant cluster token production.

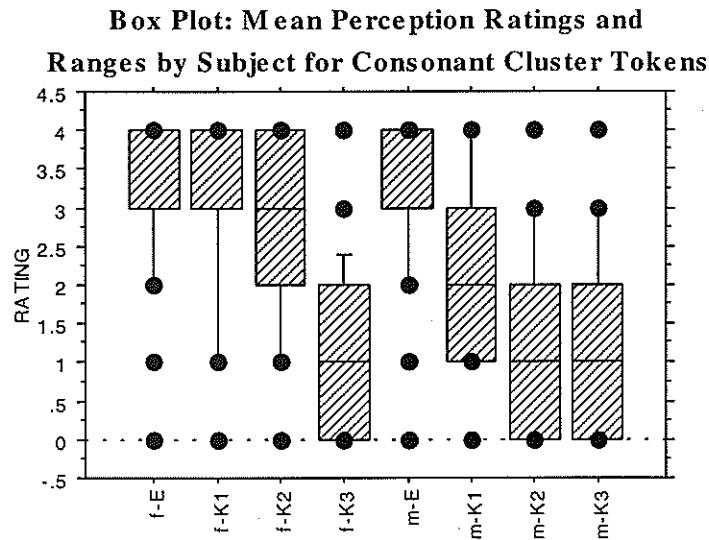


Figure 4. Box Plot: Mean Perception Ratings and Ranges by Subject for Consonant Cluster Tokens. Box plot illustrating mean and range perception ratings on consonant cluster tokens for each subject. Ratings are plotted along the y-axis, and subjects are plotted along the x-axis.

3.32 Production Analysis

Acoustic measurements were made of aspects of each token. The types of measurements and processes of assessing them were determined in accordance with the phonological contrast of interest in each token subgroup. The set of tokens used for acoustic analysis was the same set presented to listeners for subjective perception of foreign accent judgments.

3.321 [l]-[ɹ] token measurements

The contrast between subjects' productions of [l] and [ɹ] was measured by determining each phone's *space* and then measuring the *distance* between the two sounds

in each subject's speech. That is, the difference between the two sounds was quantified for each speaker.

The following diagram shows the mean F1, F2, and F3 frequencies for the production of [l] and [ɹ] by each speaker. The subjects are arranged from top to bottom according to mean perception of accent ratings, with the male subjects on the left and the female subjects on the right. Below each frequency plot, the [l] space and the [ɹ] space have been quantified using the formulas in (1). The [l] space ranged from 2374-1817 Hz and the [ɹ] space ranged from 1106-1675 Hz for the male subjects. The native English speaker had the largest [l] space and the smallest [ɹ] space among the male subjects, while the subject with the heaviest accent rating (m-K3) had the smallest [l] space and the largest [ɹ] space. The female subjects' [l] space ranged from 2889-2175 Hz and their [ɹ] space ranged from 1455-1640 Hz. The native English speaker among the female subjects had the largest [l] space and the smallest [ɹ] space. Subject f-K3 had the smallest [l] space, while subject f-K1 had the largest [ɹ] space.

Quantification of [l] and [ɹ] space by speaker

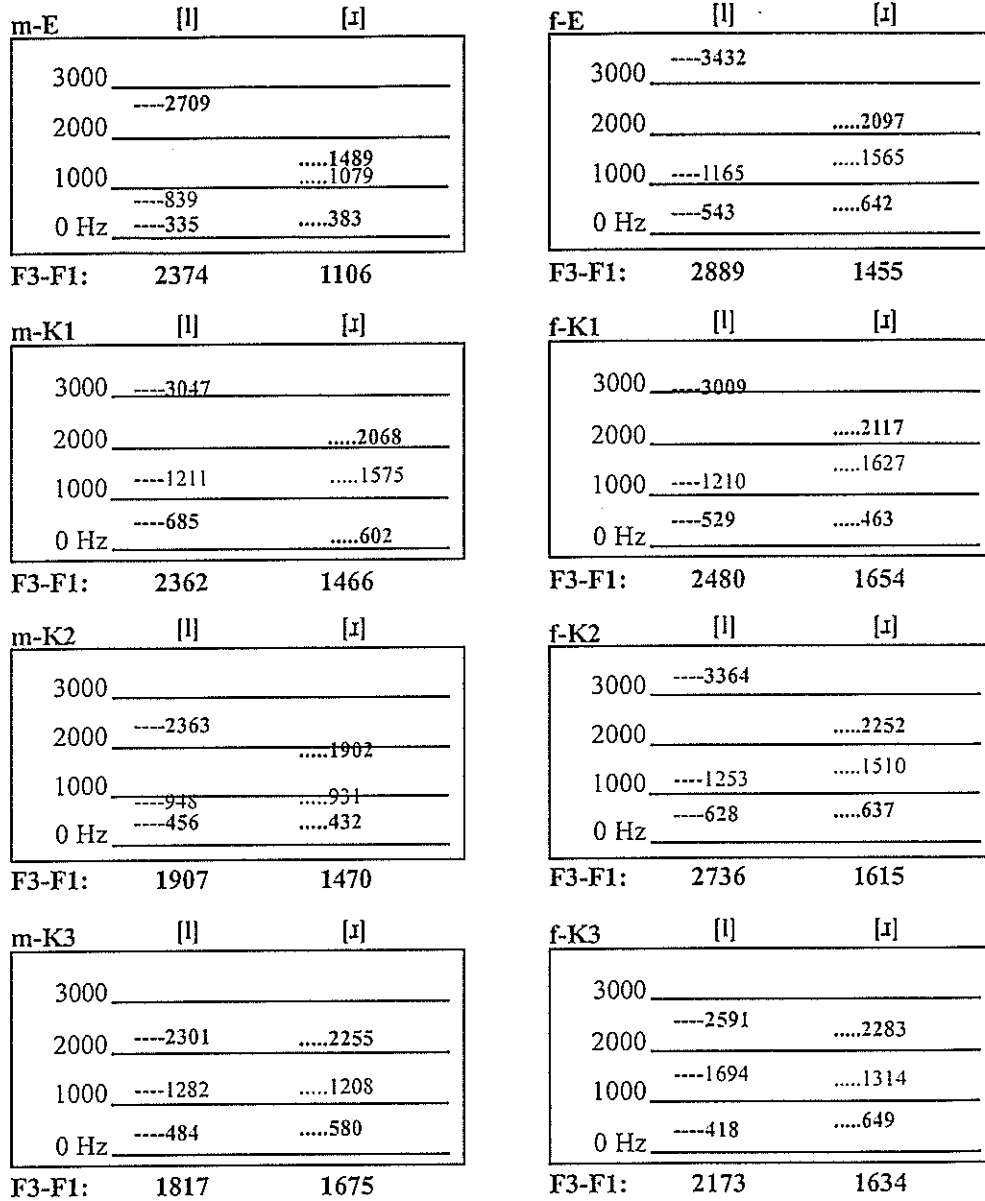


Figure 5. Quantification of [l] and [ɹ] Space by Speaker. Visual display and quantification of the [l] space and [ɹ] space of each subject, with [l] on the left and [ɹ] on the right in each frequency plot. Mean F1, F2, and F3 are plotted for each phone, and F3-F1 is quantified below each plot. Plots are organized from top to bottom by mean perception of accent rating. Male subjects are in the left column and female subjects are in the right column.

The [l]-[ɹ] distance is visually presented in Figures 6 and 7 for each subject. Males are represented in the top diagram and females are represented in the bottom diagram. The [l] and [ɹ] spaces for each subject are plotted in an F1 x F3 space, and a line is drawn to connect each speaker's [l] space to his/her [ɹ] space to visually represent the acoustic difference between the two sounds for each speaker. The [l]-[ɹ] distance is calculated by applying the mean F1 and F3 frequencies for [l] and [ɹ] to the formula in (2). The results of the formula for each speaker are listed below each diagram.

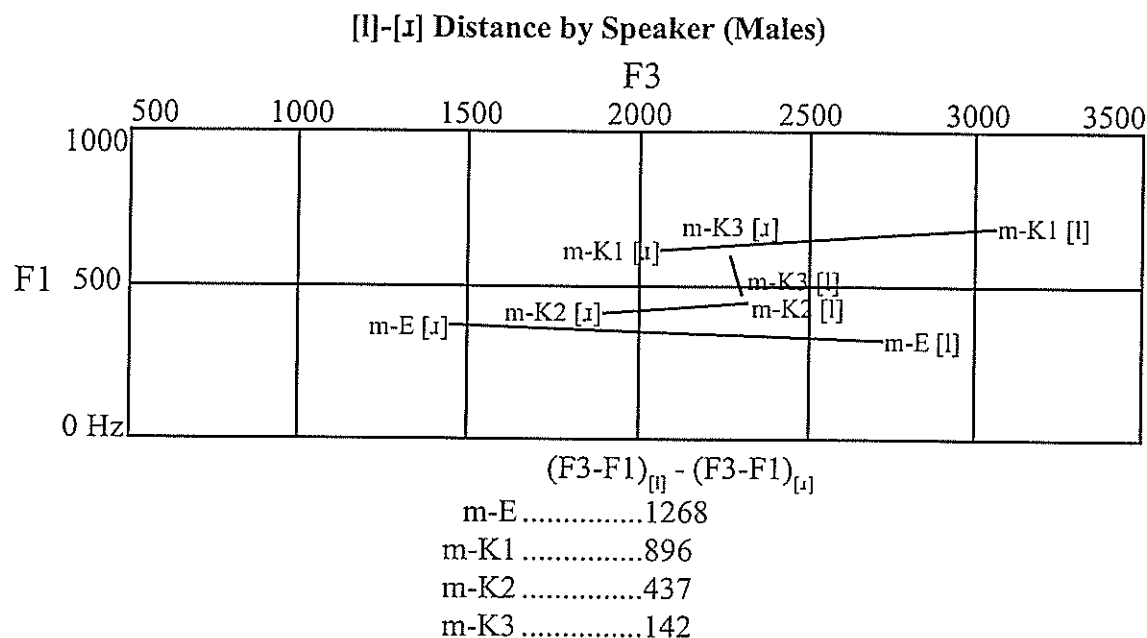


Figure 6. [l]-[ɹ] Distance by Speaker (Males). The [l]-[ɹ] distance for each male speaker is represented by a line connecting each speaker's [l] space to his [ɹ] space. Mean F1 is plotted along the y-axis and mean F3 is plotted along the x-axis.

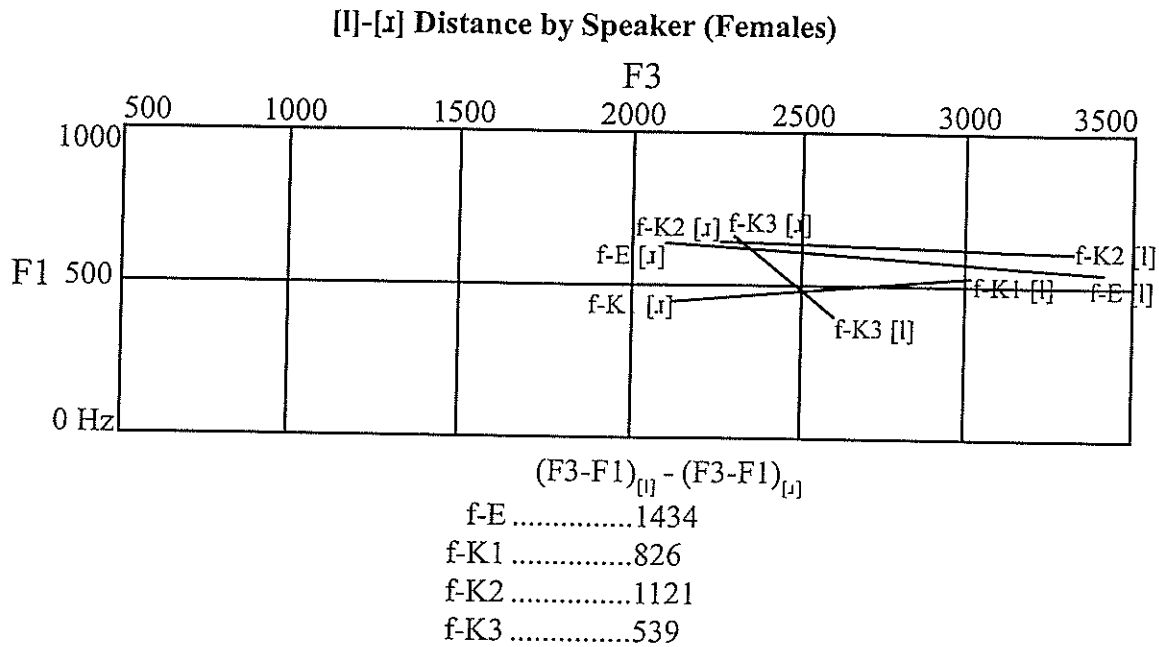


Figure 7. [I]-[ɪ] Distance by Speaker (Females). The [I]-[ɪ] distance for each female speaker is represented by a line connecting each speaker's [I] space to her [ɪ] space. Mean F1 is plotted along the y-axis and mean F3 is plotted along the x-axis.

3.322 Vowel quality token measurements

Each subject's vowel quality production was determined by calculating the space of each vowel for each speaker and plotting them in a two-dimensional F1 x F2-F1 space. The visual representation of vowel space allows us to see the perceptual distance between the sounds; that is, whether a non-native speaker's [i] and [I] share acoustic attributes (Syrdal and Gopal, 1986). In particular, these measurements are expected to determine whether a vowel space overlap exists between the tense and lax counterparts of vowels which share height and backness features (i.e., the high front vowels [i] and [I], or the mid front vowels [e] and [E]), and whether the tense and lax counterparts are significantly different from each other. Based on the lack of phonemic distinction

between [i] and [I] in Korean phonology, an overlap is expected between [i] and [I] for speakers with heavier perception of accent ratings. Since the distinctiveness of [e] and [E] has variable acceptance in Korean phonology, an overlap is less clearly predictable.

For the female subjects in general, [i] and [E] were distinct from the other vowels. Subject f-K3 overlapped [i] and [I], and [e] and [I] clustered very close together for all other speakers, including the native English controls. In addition to the effect of coarticulation in the diphthong [eI] from which the vowel [e] was drawn, the diphthong is possibly a result of the closeness of [e] and [I] in many dialects of American English (Johnson et al., 1993). Figures 8-11 show the vowel spaces for each of the female subjects. Single measurements taken from their production of tokens are plotted with small characters and means are plotted with larger characters. Figure 12 presents the mean vowel spaces of all female subjects for visual comparison.

Vowel Space of Native English Speaker f-E

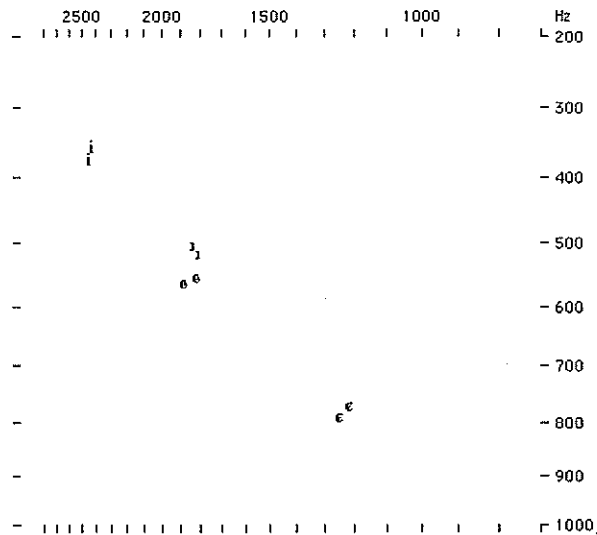


Figure 8. Vowel Space of Native English Speaker f-E. Individual and mean vowel spaces of subject f-E. F1 is plotted along the y-axis and F2-F1 is plotted along the x-axis.

Vowel Space of Korean Speaker f-K1

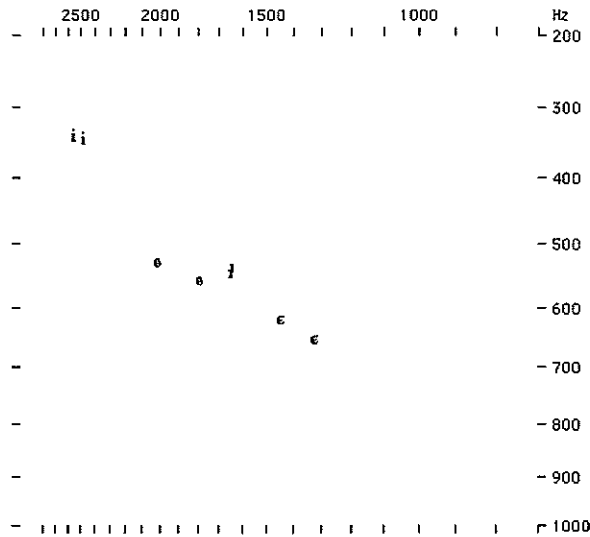


Figure 9. Vowel Space of Korean Speaker f-K1. Individual and mean vowel spaces of subject f-K1. F1 is plotted along the y-axis and F2-F1 is plotted along the x-axis.

Vowel Space of Korean Speaker f-K2

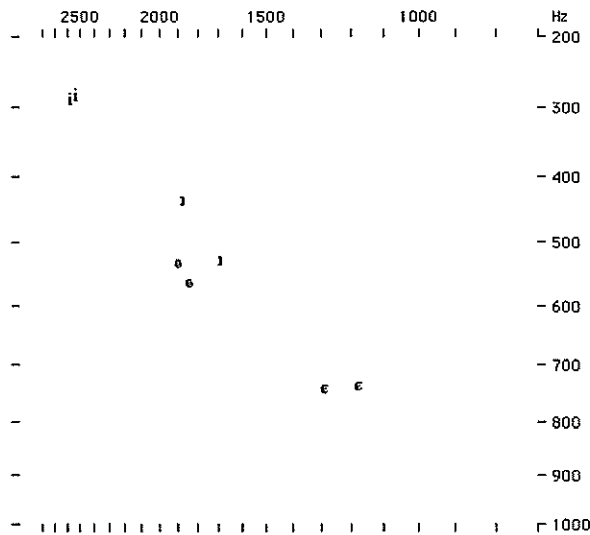


Figure 10. Vowel Space of Korean Speaker f-K2. Individual and mean vowel spaces of subject f-K2. F1 is plotted along the y-axis and F2-F1 is plotted along the x-axis.

Vowel Space of Korean Speaker f-K3

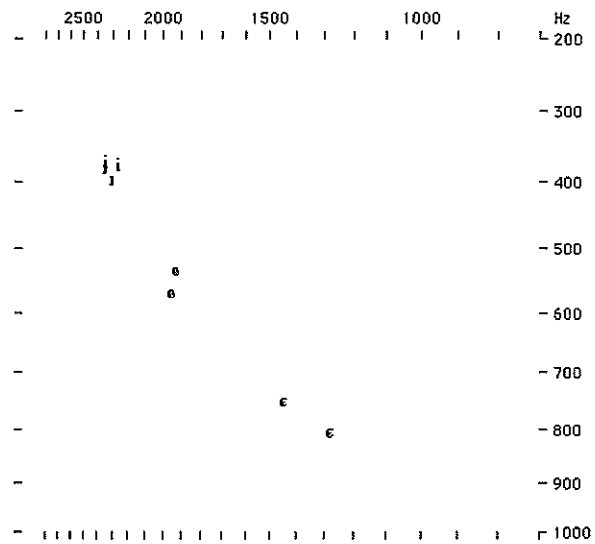


Figure 11. Vowel Space of Korean Speaker f-K3. Individual and mean vowel spaces of subject f-K3. F1 is plotted along the y-axis and F2-F1 is plotted along the x-axis.

Vowel Space of All Female Subjects

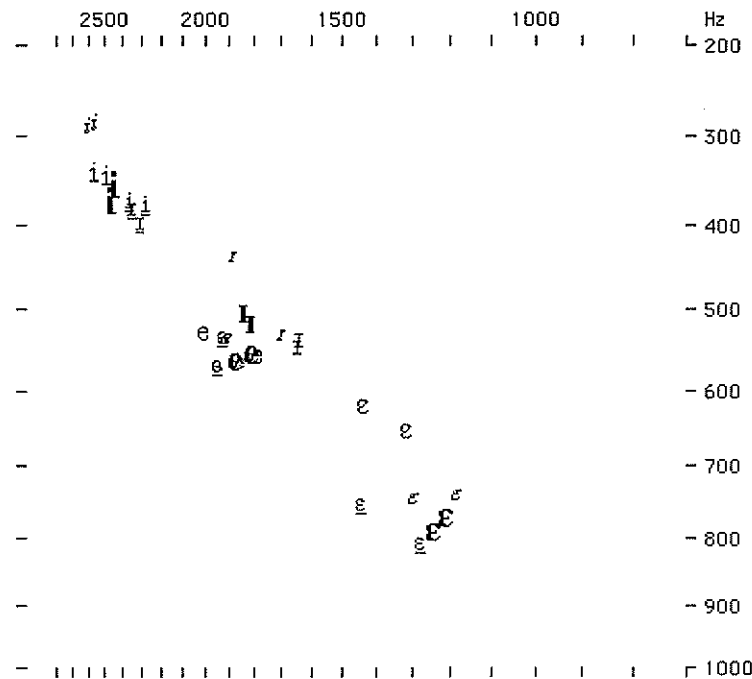


Figure 12. Vowel Space of All Female Subjects. Mean vowel spaces of all female subjects. F1 is plotted along the y-axis and F2-F1 is plotted along the x-axis. **Bold**=f-E; normal=f-K1; *italic*=f-K2; underline=f-K3.

The male subjects showed greater variance in vowel space. Subjects m-E and m-K2 clustered [e] and [ɪ] together, but the other two subjects had large spaces separating these two sounds. None of the male subjects had overlapping [i] and [ɪ] spaces, however, the degree of closeness (rather than only an outright overlapping) between the space of these two sounds may be relevant for perception of foreign accent. Figures 13-16 show the vowel spaces for each of the male subjects. Single measurements taken from their production of tokens are plotted with small characters and means are plotted with larger characters. Figure 17 presents the mean vowel spaces of all male subjects for visual comparison.

Vowel Space of Native English Speaker m-E

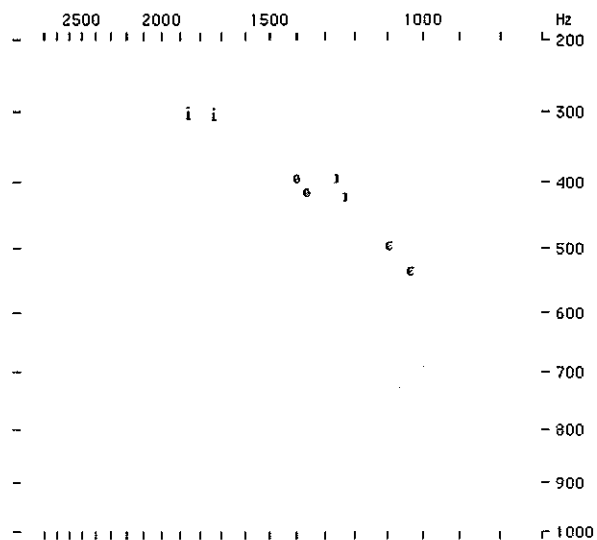


Figure 13. Vowel Space of Native English Speaker m-E. Individual and mean vowel spaces of subject m-E. F1 is plotted along the y-axis and F2-F1 is plotted along the x-axis.

Vowel Space of Korean Speaker m-K1

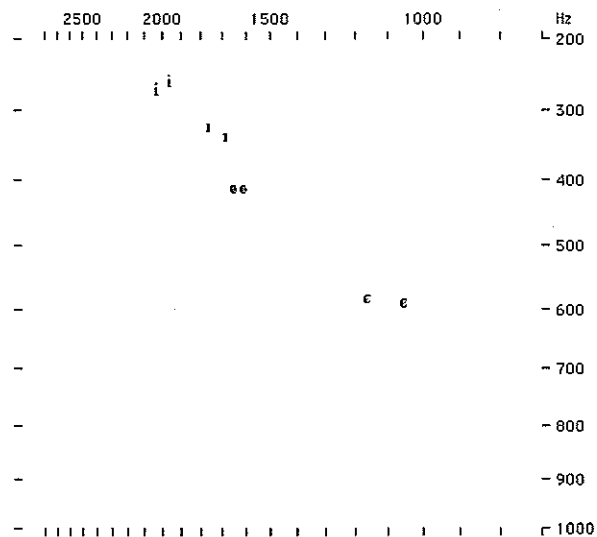


Figure 14. Vowel Space of Korean Speaker m-K1. Individual and mean vowel spaces of subject m-K1. F1 is plotted along the y-axis and F2-F1 is plotted along the x-axis.

Vowel Space of Korean Speaker m-K2

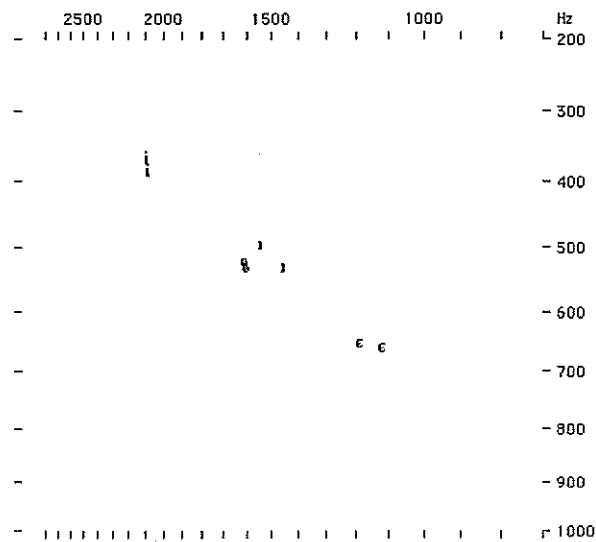


Figure 15. Vowel Space of Korean Speaker m-K2. Individual and mean vowel spaces of subject m-K2. F1 is plotted along the y-axis and F2-F1 is plotted along the x-axis.

Vowel Space of Korean Speaker m-K3

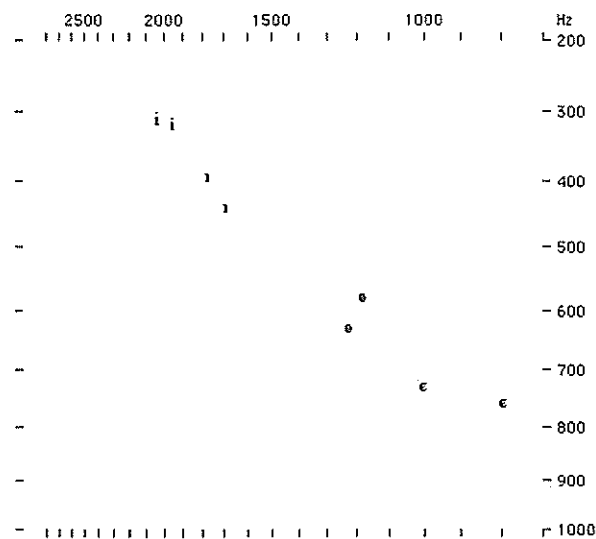


Figure 16. Vowel Space of Korean Speaker m-K3. Individual and mean vowel spaces of subject m-K3. F1 is plotted along the y-axis and F2-F1 is plotted along the x-axis.

Vowel Space of All Male Subjects

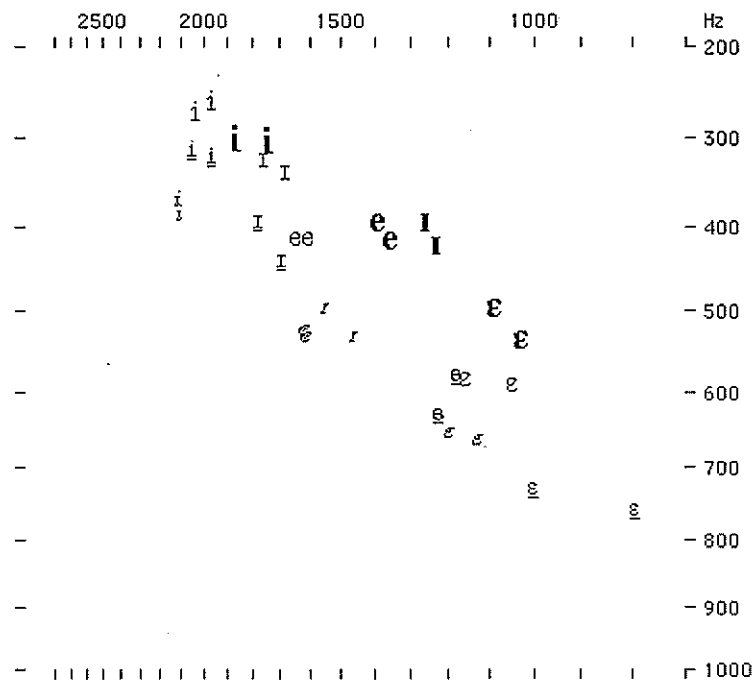


Figure 17. Vowel Space of All Male Subjects. Mean vowel spaces of all male subjects. F1 is plotted along the y-axis and F2-F1 is plotted along the x-axis. **Bold**=m-E; normal=m-K1; *italic*=m-K2; underline=m-K3.

3.323 Consonant cluster token measurements

Subjects used various strategies to avoid producing consonant clusters. Subject f-K3 epenthesized a schwa between the two consonants on one token and dropped the first consonant in the cluster on two other tokens. Subject m-K3 epenthesized a schwa after the final consonant on one token and dropped the first consonant in the cluster of one other token. Subjects m-K2 dropped the first consonant on two tokens and the second consonant on two tokens. All other subjects, including the native English speakers, devoiced the final consonant in a voiced consonant cluster on at least two tokens. In the cases where the second consonant was a voiceless stop, it was often followed by a heavily aspirated release when produced by non-native speakers. This was not produced by the native English controls. The following bar charts show the occurrence of cluster

avoidance techniques. The first two charts show the percentage of occurrences per speaker of *strong* cluster avoidance techniques: vowel epenthesis or consonant elision. Females are represented in Figure 18 and males in Figure 19. The next two charts show the percentage of occurrences of either *strong* cluster avoidance techniques (epenthesis and elision) or the comparatively *weak* cluster avoidance technique of devoicing the second consonant in a voiced cluster. Females are represented in Figure 20 and males in Figure 21.

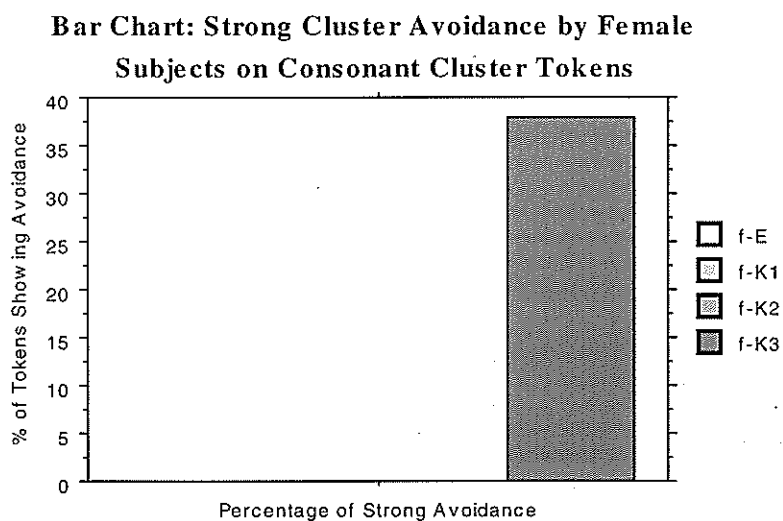


Figure 18. Bar Chart: Strong Cluster Avoidance by Females on Consonant Cluster Tokens. The percentage of consonant cluster tokens which were avoided by epenthesis or elision is illustrated by a bar for each subject. Percentages are indicated on the y-axis.

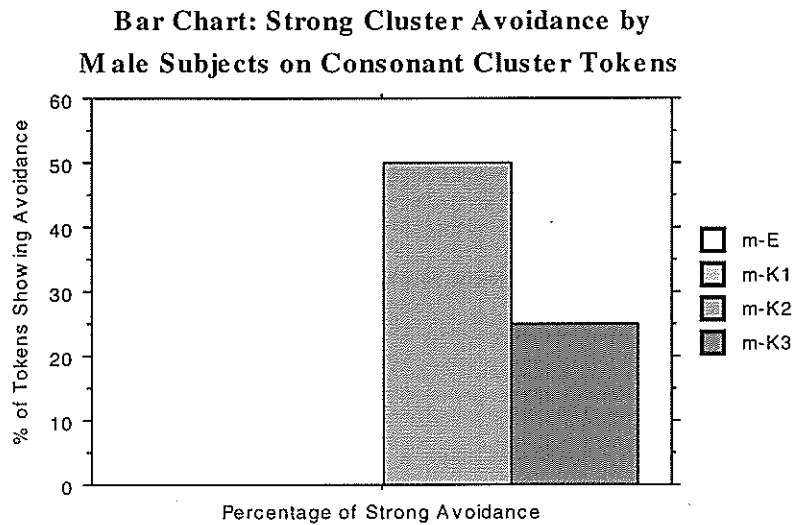


Figure 19. Bar Chart: Strong Cluster Avoidance by Males on Consonant Cluster Tokens. The percentage of consonant cluster tokens which were avoided by epenthesis, elision, or consonant devoicing is illustrated by a bar for each subject. Percentages are indicated on the y-axis.

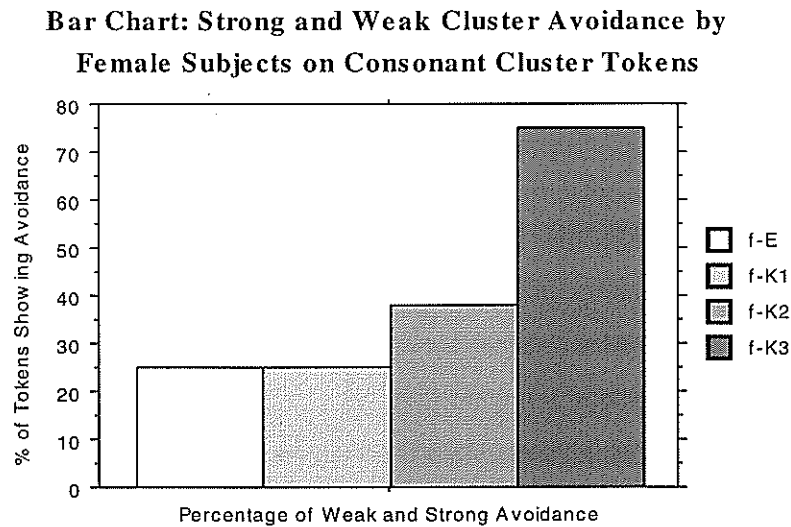


Figure 20. Bar Chart: Strong and Weak Cluster Avoidance by Females on Consonant Cluster Tokens. The percentage of consonant cluster tokens which were avoided by epenthesis or elision is illustrated by a bar for each subject. Percentages are indicated on the y-axis.

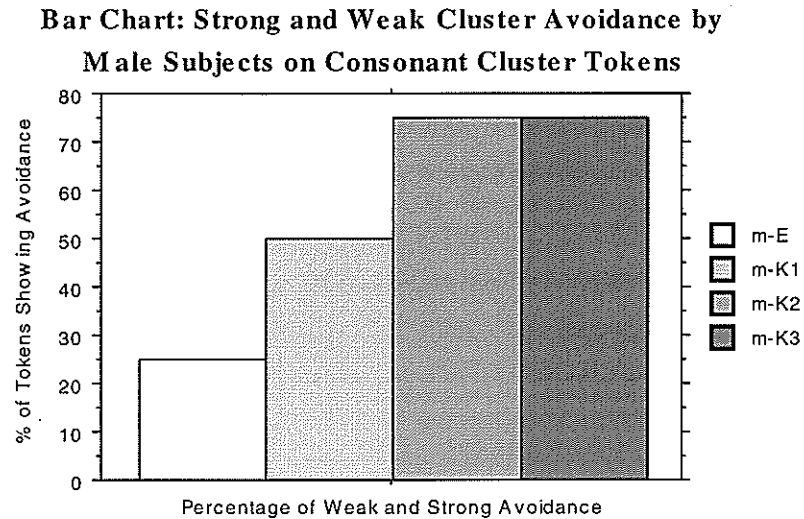


Figure 21. Bar Chart: Strong and Weak Cluster Avoidance by Males on Consonant Cluster Tokens. The percentage of consonant cluster tokens which were avoided by epenthesis, elision, or consonant devoicing is illustrated by a bar for each subject. Percentages are indicated on the y-axis.

3.33 Correlation: Perception-Production

The perception of accent ratings and the acoustic measurement data were assessed together to determine whether a correlation exists between listeners' perceptions of degree of foreign accent and measurable intra-factor variance in the acoustic signal.

3.331 [l]-[ɹ] tokens

A strong correlation was shown to exist between the mean rating of the [l]-[ɹ] tokens for each speaker and the [l]-[ɹ] distance for each speaker, with a correlation coefficient of .834, returning a p-value of <.0001. The following regression plot shows the correlation between the mean accentedness ratings for [l]-[ɹ] tokens and the [l]-[ɹ]

distances for the subjects. The regression returned a coefficient of determination (COD) of .695.

Regression Plot: Mean [l]-[r] Rating by [l]-[r] Distance

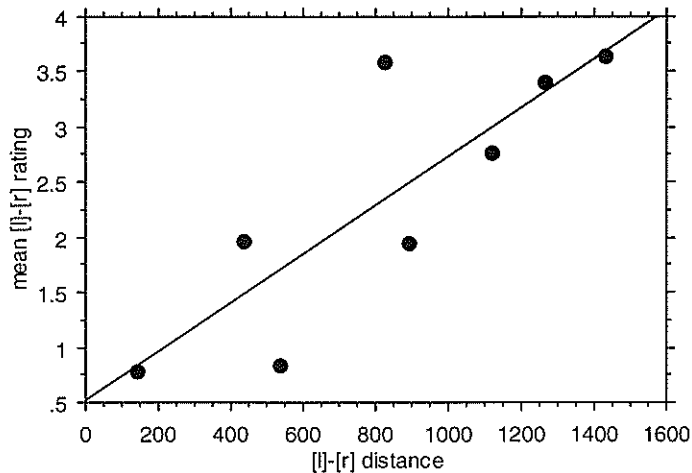


Figure 22. Regression Plot: Mean [l]-[r] Rating by [l]-[r] Distance.

Regression plot illustrating the correlation between mean perception of accentedness ratings across [l]-[r] tokens and the [l]-[r] distances for each subject. The mean ratings are plotted along the y-axis and the [l]-[r] distances in Hertz are plotted along the x-axis.

The following figures illustrate the [l] and [r] distances of each subject. Their mean accentedness ratings and [l]-[r] distance calculations are listed below the diagrams. Figure 23 illustrates the [l]-[r] distances of the male subjects and figure 24 illustrates the [l]-[r] distances of the female subjects (Figures 6 and 7 are repeated here for convenience as Figures 23 and 24).

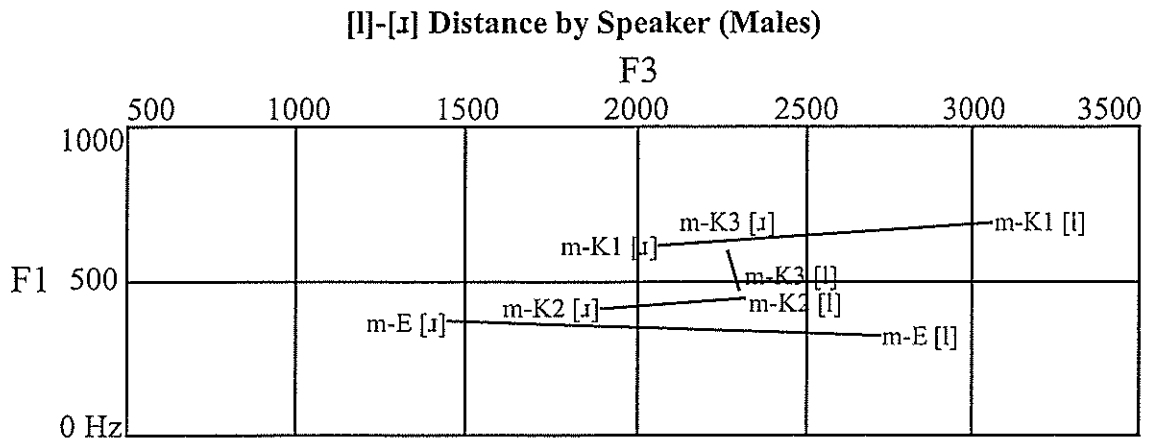


Figure 23. [l]-[ɹ] Distance by Speaker (Males). The [l]-[ɹ] distance for each male speaker is represented by a line connecting each speaker's [l] space to his [ɹ] space. Mean F1 is plotted along the y-axis and mean F3 is plotted along the x-axis.

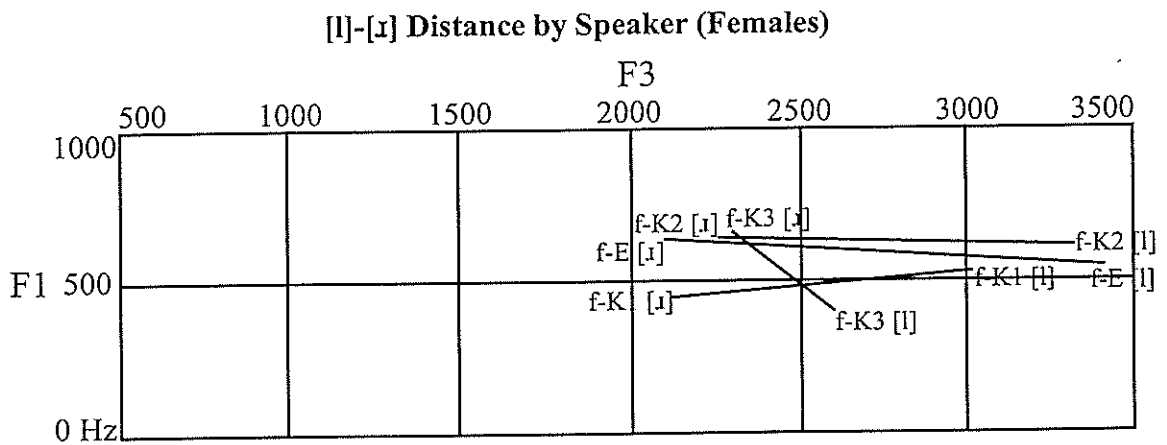


Figure 24. [l]-[ɹ] Distance by Speaker (Females). The [l]-[ɹ] distance for each female speaker is represented by a line connecting each speaker's [l] space to her [ɹ] space. Mean F1 is plotted along the y-axis and mean F3 is plotted along the x-axis.

It is easy to see that the distance between [ɪ] and [ɪ̃] (and therefore the acoustic distinction between them) generally shrinks in accordance with mean ratings of heavier accentedness. It is most observable with the male subjects. The two median female subjects (f-K1, mean rating 3.332, and f-K2, mean rating 2.833), who were rated as “little to no accent” and “some to little accent”, respectively, were actually inverted in terms of their [ɪ]-[ɪ̃] space measurements and their accentedness ratings. The correlation between [ɪ]-[ɪ̃] space and degree of foreign accent is most clear when comparing the native English controls’ [ɪ]-[ɪ̃] space and the [ɪ]-[ɪ̃] space of the two subjects who received the heaviest accentedness ratings. Whereas m-E had an [ɪ]-[ɪ̃] space difference (distance) of 1268, m-K3 only had a distance of 142. Whereas f-E had an [ɪ]-[ɪ̃] distance of 1434, f-K3 only had a distance of 539.

3.332 Vowel tokens

The native speakers produced distinct tense and lax vowels [i] and [ɪ], whereas the subjects who were rated with the heaviest accents showed the smallest distance between these tense and lax variants in terms of vowel space. The following bar chart shows the difference between each speaker’s mean values for [i] and [ɪ]. The native speakers m-E and f-E have very different values from the speakers who were rated with the heaviest accents, but subjects m-K1, m-K2, f-K1, and f-K2 show great variation in their [i]-[ɪ] distances.

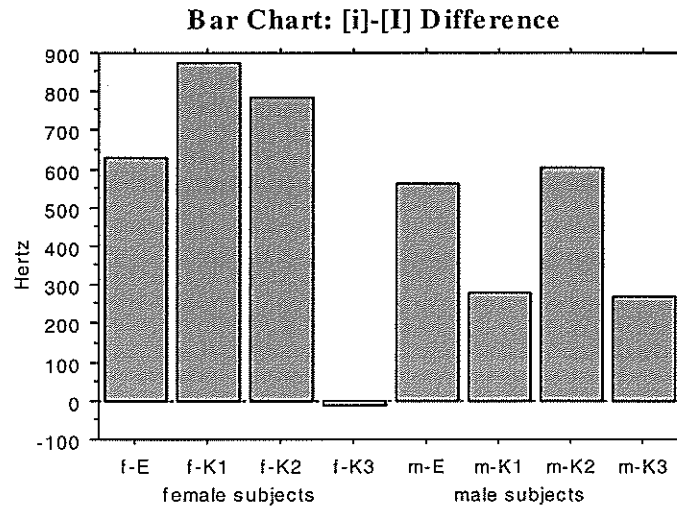


Figure 25. Bar Chart: [i]-[I] Difference. This bar chart shows the differences in [i]-[I] distance among subjects. Subjects are listed along the x-axis and [i]-[I] distances are plotted in Hertz along the y-axis.

The following regression plot illustrates the relationship between the [i]-[I] distances and mean ratings on vowel tokens, and shows a COD of .575. The mean ratings had a stronger relationship with [i]-[I] distances for females than for males (COD=.799 for females; COD=.234 for males).

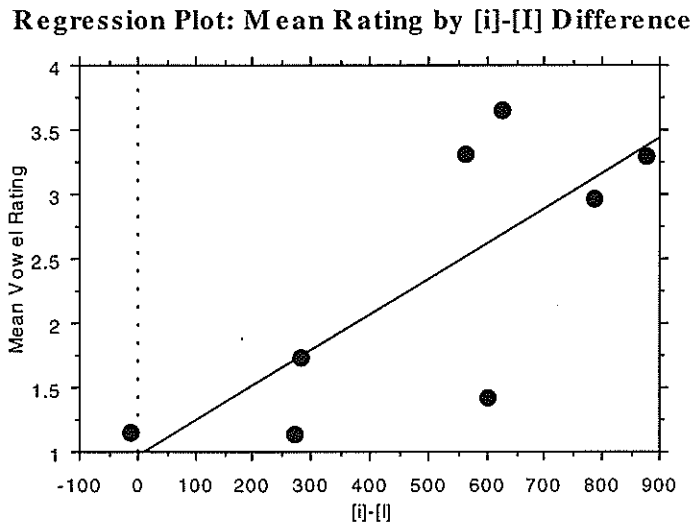


Figure 26. Regression Plot: Mean Rating by [i]-[I] Difference. This linear regression shows the relationship between mean ratings on vowel tokens and the [i]-[I] distances for each subject. The [i]-[I] distances are plotted in Hertz along the x-axis and the ratings are plotted along the y-axis.

A correlation between [e]-[E] distance and mean accentedness ratings was not found. Whereas [i] and [I] are not distinctive in Korean, [e] and [E] are phonemic (Ahn, 1998), so it is expected that the [i]-[I] distance would be correlated with perception of accent while the [e]-[E] distance would not. The following bar chart shows the difference between each speaker's mean values for [e] and [E].

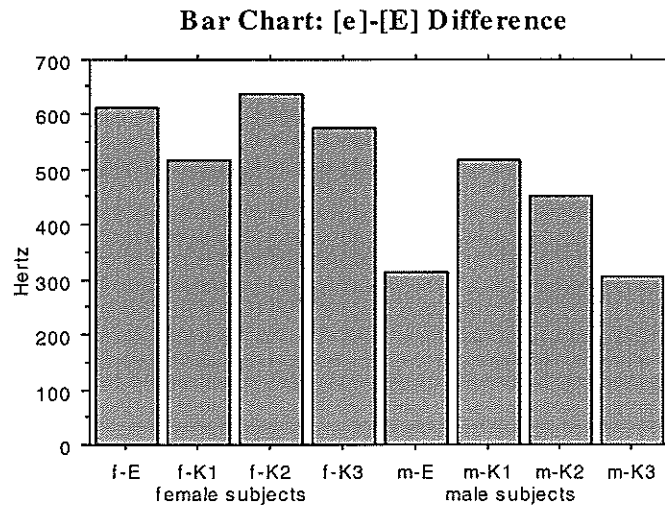


Figure 27. Bar Chart: [e]-[E] Difference. This bar chart shows the differences in [e]-[E] distance among subjects. Subjects are listed along the x-axis and [e]-[E] distances are plotted in Hertz along the y-axis.

The following regression plot illustrates the null relationship between the [e]-[E] distances and mean ratings on vowel tokens, and shows a COD of .071.

Regression Plot: Mean Rating by [e]-[E] Difference

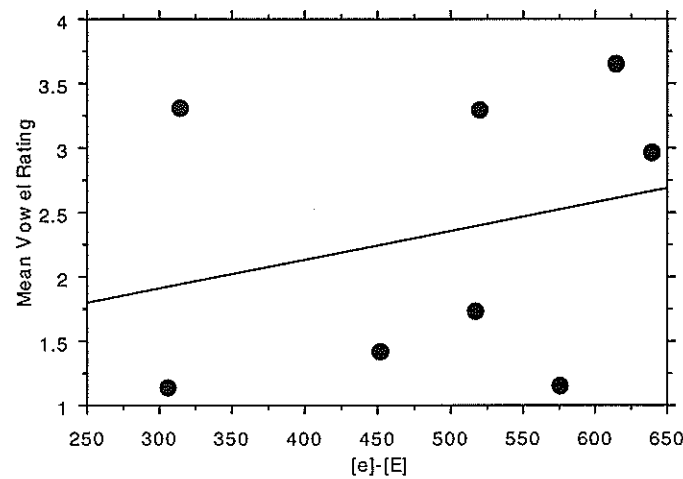


Figure 28. Regression Plot: Mean Rating by [e]-[E] Difference. This linear regression shows the relationship between mean ratings on vowel tokens and the [e]-[E] distances for each subject. The [e]-[E] distances are plotted in Hertz along the x-axis and the ratings are plotted along the y-axis.

3.333 Consonant cluster tokens

A strong connection emerged between the use of consonant cluster avoidance techniques and degree of accent ratings. The cluster avoidance techniques were divided into *weak* (devoicing of one consonant in a voiced cluster) and *strong* (full consonant elision or vowel epenthesis to break up the cluster). Whether considering only strong avoidance or both strong and weak avoidance, subjects who avoided consonant clusters in at least 50% of their productions were consistently rated on those tokens on the heavier half of the accent scale. These subjects received mean ratings below 2.0 (some accent). Comparing the two figures below, it appears that cluster avoidance in general (including both strong and weak types) correlates with perceived degrees of accent. Figure 29 shows the correlation between the use of strong avoidance techniques and mean accent ratings. Figure 30 shows the correlation between the use of strong or weak avoidance techniques

an mean accent ratings. While the correlation in Figure 29 produced a COD of .774, the correlation including both strong and weak avoidance produced a more robust result (COD=.977), indicating that listeners are sensitive to consonant cluster avoidance in both strong and weak ways. The correlation between mean accent ratings and the frequency of use of strong and weak avoidance techniques returned a correlation coefficient of .988 with a p-value of <.0001.

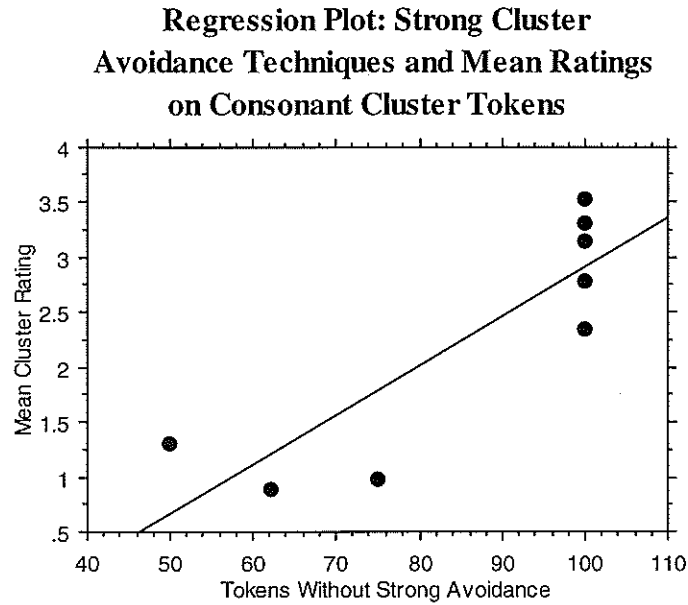


Figure 29. Regression Plot: Strong Cluster Avoidance Techniques and Mean Ratings on Consonant Cluster Tokens. COD=.774. Linear regression.

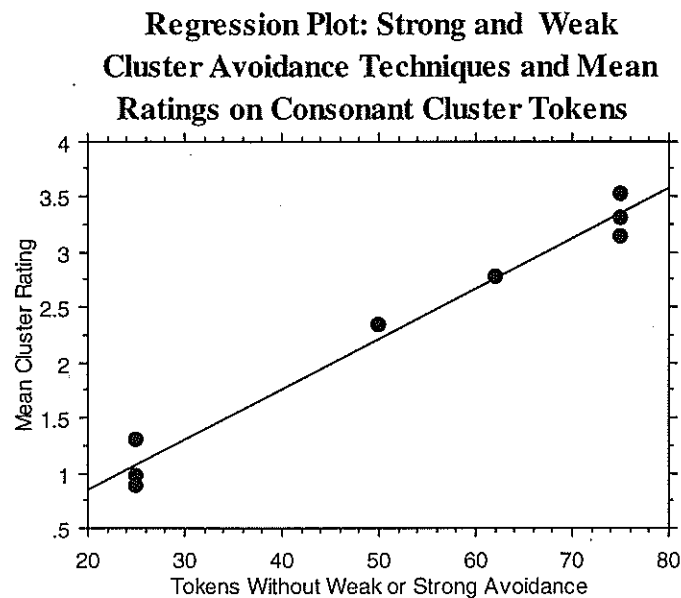


Figure 30. Regression Plot: Strong and Weak Cluster Avoidance Techniques and Mean Ratings on Consonant Cluster Tokens. COD=.977. Linear regression.

3.34 Correlation: Perception-L2 Acquisition Experiences

3.341 Subject-Specific Data

The age of L2 acquisition has been investigated as a correlate to the presence of a foreign accent in L2 learners. Asher and Garcia (1982) claim that L2ers who begin learning their second language after about age 6 will develop a foreign accent. Scovel (1988) claims that L2ers even only 10 years old can be identified as having a foreign accent. Long (1990) said that an L2 is usually spoken without accent if learning begins by the age of 6, with an accent if learning begins after age 12, and with variable degrees of accent if learning begins between ages 6 and 12. Other L2 researchers have made similar conclusions relating age of acquisition and resulting degree of foreign accent. Among the female subjects, the age factors generally comply with previous work on the Critical Period, however, subjects f-K1 and f-K2 showed an inverse relationship between their ratings for accentedness and their L2 acquisition experiences. Subject f-K1 was 11 years old when she began learning and using English. She thus falls into the category where

variability in ultimate L2 ability is expected (approximately ages 6-12 at first exposure to the L2), and she attains a rating of little to no accent. Subject f-K2 began learning and using English at age 4. According to most theories about the connection between age of learning L2 and resulting accent, she would be expected to achieve an ultimate pronunciation with little to no accent, yet she was rated as slightly more accented than f-K1. The same inversion occurred with the male subjects m-K1 and m-K2; m-K2 produced segments that are measurably closer to native English speech, yet he was consistently rated as having a heavier accent than m-K1. Subject m-K1 began learning English at age 13 but didn't consider that he really used English until age 19, whereas subject m-K2 began learning English at age 10 and using it at age 13. The subjects who were rated as having moderately heavy to heavy foreign accents (m-K3, f-K3) began using English at ages 14 and 27 and did not begin living in an L2 immersion environment until ages 24 and 27.

3.342 Age-Related Effects on Degree of Foreign Accent

The type of acquisition experience can also contribute to the resulting degree of accentedness, as the following data show. Critical Period research commonly uses measures such as age of first exposure to or learning of the L2 or age of arrival in the L2 immersion environment in comparison to L2ers' resulting nativeness or non-nativeness. While these measures can provide a general indication of age-related effects in L2 acquisition, a better measure may be the age at which a person first begins to use the L2 naturalistically; that is, outside of the classroom or for genuine communicative purposes. The recent foreign language teaching methodology called *communicative language teaching* relies on the belief that the interpretation, expression, and negotiation of meaning improves learners' skill and ease with the L2 (Lee and VanPatten, 1995). Linguistic phenomena would seem, then, to become better anchored in the learner's mind when the learner uses them purposefully and meaningfully. The age at which a learner begins studying a language in class may or may not be the age at which s/he begins to use the new language in ways which can assist its development. Similarly, the age at which a learner arrives in the L2 immersion environment may or may not be the time at which

s/he integrates into an L2 community and begins to use the new language communicatively. Many cities have large immigrant populations who maintain their L1 as the language of communication and commerce, and who only use the L2 on a very limited basis. Others try to immediately integrate with the surrounding L2 community and use the L2 almost exclusively. With such a variety of L1 and L2 use by immigrants, AOA may not be an appropriate factor for investigating whether a Critical Period exists for L2 acquisition.

The loose clusters around the regression lines in the following figures show a general direction that is supportive of hypotheses such as that by Long and others who have researched the Critical Period. Figure 31 shows that as the age of arrival increases, the overall rating of degree of accentedness decreases (indicating a heavier accent). The same general relationship is shown when accentedness ratings are compared to the age at which the subjects first began learning English (Figure 32) and the age at which they first began to really use English communicatively and outside of the classroom (Figure 33). The age of first learning and AOA figures both contain subjects who lie outside the general relationship of these factors to their mean perception of accent ratings. The figure correlating the age of first naturalistic use of the L2 with the ratings, however, contains all subjects within the pattern of the correlation. There is an observable cutoff point around 12 years of age: subjects who began using the L2 before age 12 all received ratings of 2.833 or higher (3.0 corresponds to "little accent") while subjects who began using the L2 after age 12 all received ratings of 1.991 or lower (2.0 corresponds to "some accent"). Nearly one full rating point on a 5-point scale separates these two groups of L2ers. The correlation between age of first naturalistic use and mean ratings returned a COD slightly higher than the coefficients of the other two regressions. The two groups as determined by their ratings are not separated by a period of years, however; the adjacency of the less-accented and more-accented groups indicates that the age of 12 probably ought not be used as an absolute. Rather, it could indicate that a critical period for speech production ends somewhere around 12, and is likely subject to individual and gender variability.

The following polynomial regression plots compare each subject's overall rating to age-related aspects of his/her L2 acquisition. Figure 31 depicts the correlation between mean rating and age of arrival in an English-speaking environment.

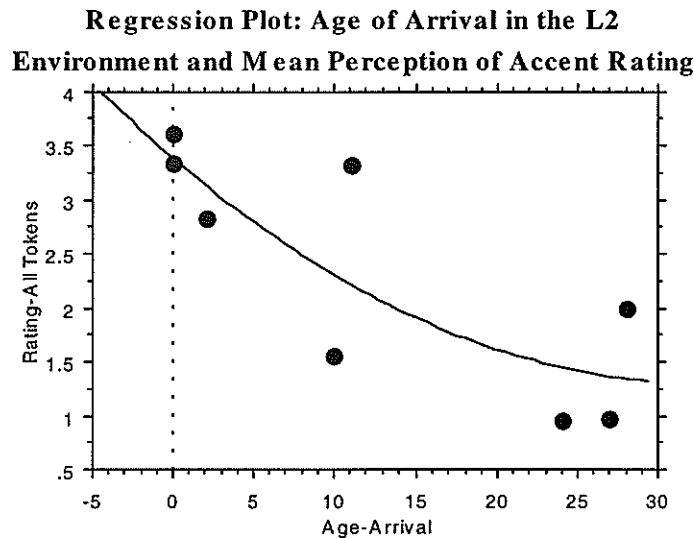


Figure 31. Regression Plot: Age of Arrival in the L2 Environment and Mean Perception of Accent Rating. Subjects tend toward lighter accents if they arrived in the immersion environment at a very young age (<5 years) and toward heavier accents if they arrived in their 20s. Subjects who arrived between those ages showed variable accents: The subject with an AOA of 10 clustered in terms of mean rating with those who arrived in their 20s, and the subject with an AOA of 11 clustered with those who arrived as young children. The age of subjects' first learning of the L2 is plotted along the x-axis, and their mean perception of accent ratings are plotted along the y-axis. COD=.67.

Figure 32 shows the correlation between mean rating and the age at which the subject began to learn English.

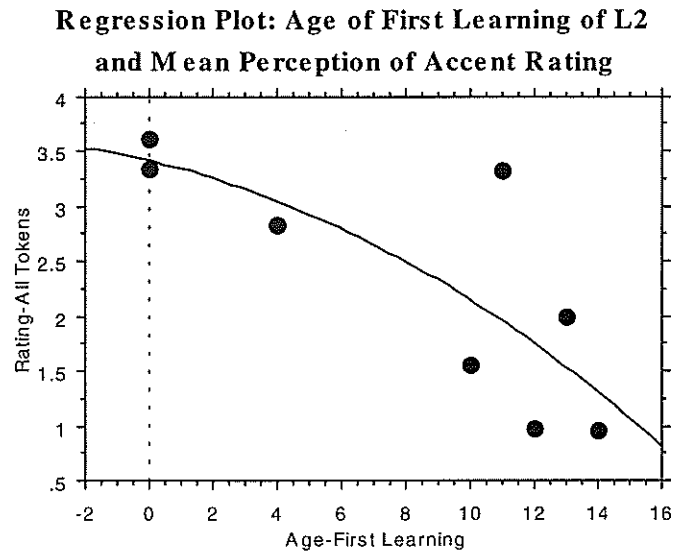


Figure 32. Regression Plot: Age of First Learning of L2 and Mean Perception of Accent Rating. Subjects tend toward heavier accents as their age of first learning increases, but with one notable exception: one subject began learning English at age 11 and received a mean rating of little to no accent (3.332). The age of subjects' first learning of the L2 is plotted along the x-axis, and their mean perception of accent ratings are plotted along the y-axis. $COD=.608$.

Figure 33 shows the correlation between mean rating and the age at which the subject began to really use English for communicative purposes, and outside of the classroom.

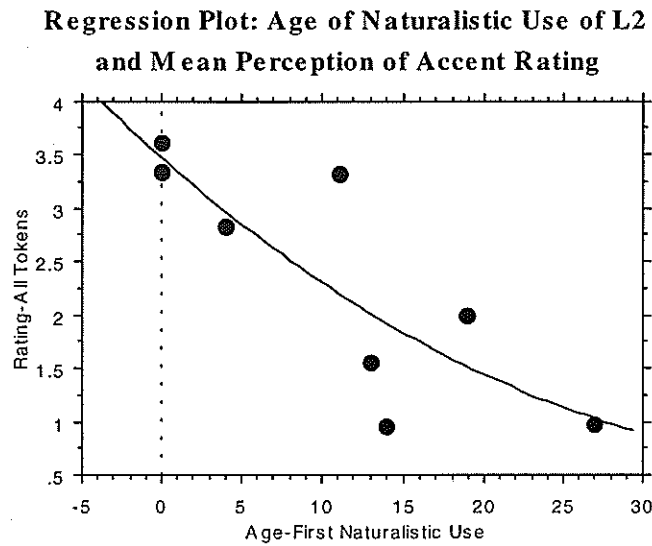


Figure 33. Regression Plot: Age of Naturalistic Use of L2 and Mean Perception of Accent Rating. A shift toward heavier accent ratings around age 12 can be seen in this polynomial regression. The age of subjects' first naturalistic use of the L2 is plotted along the x-axis, and their mean perception of accent ratings are plotted along the y-axis. Coefficient of determination=.678.

4.0 Discussion

Native listeners appear to be sensitive to measurable variances in the acoustic signal at the level of the production of each segment. The correlation relationships shown in this study corroborate the hypothesis that listeners make decisions about how accented another's speech in accordance with their perceptions of intra-factor variability. As the degree of accent assigned to subjects increased, their pronunciations deviated from native speaker norms in a consistent and measurable fashion.

4.1 Native Speaker Judgments

The results raise some questions about the validity of native speaker intuition. As Sorace and other researchers have pointed out, respondents may make judgments based

on factors other than those anticipated or controlled by the experimenter. While the results of this study indicate that intra-factor fluctuations contribute to perception of foreign accent, the results also indicate that the acoustic signal is rich with information and that many factors commingle when we listen to speech. Since the purpose of this study was to see whether a correlation exists between perception of foreign accent and intra-factor variability, the tokens were constructed to isolate the factors being measured as much as possible. The tokens were all monosyllabic words to reduce the influence of prosodic factors such as lexical stress and intonation contour. In spite of using only word-level stimuli to reduce the effects of prosody on perception of foreign accent as much as possible, it seems that word-level prosodic information contributed to respondents' judgments. The f_0 contour is the strongest acoustic cue for lexical and phrasal stress (Borden, Harris, and Raphael, 1994), and suprasegmental factors such as lexical and phrasal stress consistently contribute to listeners' perceptions of foreign accentedness (Magen, 1998). Subjects m-K2 and f-K2 both present as extremely fluent English speakers in casual conversation, and possibly native speakers, however, both were rated as more accented than m-K1 and f-K1, who sound more accented than m-K2 and f-K2 in casual conversation. Notably, both m-K2 and f-K2 produced the tokens with nearly flat f_0 contours at the word level. Pitch track results show that subjects m-K1 and f-K1 produced word-level prosodic contours comparable to the English controls' production, whereas m-K2 and f-K2 showed a marked deviation from the English controls, particularly m-K2. Previous research on the influence of prosodic information on perception of accentedness begs the question of just how powerful the cues it contains are: Can these aspects of the acoustic signal be so rich in information that they can override other acoustic information (such as native-like articulation of consonant clusters) which would otherwise indicate that a speaker had little or no foreign accent?

4.11 Ratings of Native Speakers

Second language experiments often use native speakers as informants who make judgments of whether a subject sounds native or non-native. Using this tool in this way presumes that native speakers have some innate ability to distinguish native speakers of

their own matrix language from those who acquired the language as an L2. Based on the problematic factors of native speaker intuition as discussed previously, I am not convinced that this tool is so well defined or consistent enough to be relied upon in isolation. If native speakers could always identify native speakers, I would expect the native speaking controls to have received consistent ratings of “no accent”. In fact, the respondent group in this study assigned almost identical mean ratings below the midpoint between “no accent” and “little accent” to the male native English speaker (3.340) and one of the female Korean speakers (3.332). This could indicate that the respondents considered both or neither of them to be native speakers. In either case, it means the respondents couldn’t discriminate between them in terms of the degree of accent they perceived. This calls for a reexamination of the use of native speaker judgment of native and non-native status in second language research.

4.12 Native Speaker Judgment Consistency

Although the respondents did not seem to be able to completely separate the native speakers from the non-natives, they were very sensitive to the degrees of variation they heard. There was strong inter-rater consistency, with the smallest standard deviation in ratings on the native controls, providing reliable evidence that there is validity to native speaker perception of varying degrees of foreign accent.

4.2 Correlation: Perception-Production

The results of this study indicate that of the factors measured, subjects’ pronunciation of consonant clusters was most strongly correlated with their perceived accentedness, followed by their production of [l] and [ɹ], and then by their production of tense and lax vowels. These results concur with those found by Magen in her study on perception of foreign accent using Spanish as the L1 and English as the L2. Of the factors she measured which were similar to the factors measured in this study, consonant cluster avoidance by vowel epenthesis had the greatest effect on perceived accentedness, followed by cluster avoidance by consonant elision and then the pronunciation of tense

and lax vowels. While it is clear that the factors measured in this study specifically contributed to the perception of foreign accent, it is also clear that certain factors affect judgments more than others. Sorace (1996) describes a *determinate core* grammar and an *indeterminate periphery* for syntax. It may be the case that for phonetics and phonology, too, certain factors have a dramatic impact on perception of foreign accent while other factors are part of an indeterminate phonological periphery. In particular, it is important to reiterate that aspects of prosody, such as the f0 contour, may be a core element of perception of foreign accent.

4.3 Correlation: Perception-Age Effects in L2 Acquisition

The ages at which certain events and processes occur in L2 acquisition appear to be correlates of the resulting degree of foreign accent. The age at which naturalistic, communicative use of the L2 began was the strongest correlate, followed by the age of arrival in the L2 immersion environment and then the age of first exposure to the L2. Age of arrival and age of first exposure have long been studied for their impact on L2 success; further study of variations of these measures, such as the age of the beginning of naturalistic use, can help define the maturational and experiential factors which advance or hinder L2 acquisition.

5.0 Conclusion

The data presented in this paper indicate that objective acoustic intra-factor variability measurements can be correlated with subjective perceptions of degree of foreign accent. In particular, the amount of consonant cluster avoidance and the steady decline of [l] and [ɹ] space in accordance with ratings for higher degrees of foreign accent were remarkable findings. Further studies with larger and more diverse subject pools could better constrain and define this connection. The next steps of this research are to begin to postulate measurable intra-factor *ranges* of variability that native listeners would associate with the degrees of accent assigned to native speakers; and to better understand the role of prosodic information in foreign accent perception, since its influence is clearly

present and strong even at the word level. The implications of this kind of work include improving models of speech perception and innovations in foreign language teaching such as using perception and production training to help L2ers achieve pronunciation within these ranges (Bradlow, Pisoni, Akahane-Yamada, Tohkura, 1995).

Respondents perceived degrees of foreign accent in subjects which correlated with subjects' L2 acquisition experiences, thus reinforcing previous research indicating some kind of maturational effect for phonetic and phonological acquisition. In particular, subjects whose first naturalistic use of English was after the age of 12 were rated as having much greater degrees of foreign accent than those who began using the L2 before age 12. Other factors need to be considered along with age-related events to determine the power of maturation on L2 acquisition success. Affective factors such as aptitude, motivation, social and psychological distance, and anxiety on acquisition (Nunan, 1996), considered along with maturational effects, may proffer keys to understanding L2 learners' variable success.

Bibliography

- Ahn, Sang-Cheol. (1998). *An Introduction to Korean Phonology*. Seoul, Korea: Hanshin Publishing Company.
- Archibald, John. (1997). The acquisition of second language phrasal stress: a pilot study. In Hannahs, S.J. and Young-Scholten, Martha (Eds.) *Focus on Phonological Acquisition*. Philadelphia, PA: John Benjamins.
- Asher, James and Garcia, Ramiro. (1982). The optimal age to learn a foreign language. In Krashen, Stephen, Scarcella, Robin and Long, Michael (Eds.) *Child-Adult Differences in Second Language Acquisition*. Rowley, MA: Newbury.
- Best, Catherine T. and Strange, Winifred. (1992). Effects of phonological and phonetic factors on cross-language perception of approximants. *Journal of Phonetics*, **20**, 305-330.
- Bialystok, Ellen and Hakuta, Kenji. (1999). Confounded age: linguistic and cognitive factors in age differences for second language acquisition. In Birdsong, David (Ed.) *Second Language Acquisition and the Critical Period Hypothesis*. Mahwah, NJ: Erlbaum Assoc.
- Birdsong, David. (1989). *Metalinguistic performance and interlinguistic competence*. New York: Springer-Verlag.
- Bongaerts, Theo. (1999). Ultimate attainment in L2 pronunciation: the case of very advanced late L2 learners. In Birdsong, David (Ed.) *Second Language Acquisition and the Critical Period Hypothesis*. Mahwah, NJ: Erlbaum Assoc.
- Bongaerts, Theo, van Summeren, Chantal, Planken, Brigitte and Schils, Erik. (1997). Age and ultimate attainment in the pronunciation of a foreign language. *Studies in Second Language Acquisition*, **19**, 447-465.
- Borden, G. J., Harris, K. S. and Raphael, L. J. (1994). *Speech science primer physiology, acoustics, and perception of speech*. Philadelphia, PA: Williams and Wilkins.
- Bradlow, Ann R., Pisoni, David B., Akahane-Yamada, Reiko and Tohkura, Yoh'ichi. (1995). Training Japanese listeners to identify English /r/ and /l/: some effects of perceptual learning on speech production. *Research on Spoken Language Processing: Progress Report No. 20 (1995)*. Indiana University.
- Braine, Martin D. S. (1974). On what might constitute learnable phonology. *Language*, **50** (2), 270-299.

- Brown, H. D. (1980). The optimal distance model of second language acquisition. *TESOL Quarterly*, **14**, 57-164.
- Cutler, A., Dahan, D. and van Donselaar, W. (1997). Prosody in the comprehension of spoken language: a literature review. *Language and Speech*, **40** (2), 141-201.
- Flege, James E. (1999). Age of learning and second language speech. In Birdsong, David (Ed.) *Second Language Acquisition and the Critical Period Hypothesis*. Mahwah, NJ: Erlbaum Assoc.
- Flege, James E., Bohn, Ocke-Schwen and Jang, Sunyoung. (1997). Effects of experience on non-native speakers' production and perception of English vowels. *Journal of Phonetics*, **25** (4), 437-470.
- Flege, James E., Munro, M. and MacKay, I. (1995). Factors affecting degree of perceived foreign accent in a second language. *Journal of the Acoustical Society of America*, **97**, 3125-3134.
- Gass, Susan. (1996). Second language acquisition and linguistic theory: the role of language transfer. In Ritchie, William C. and Bhatia, Tej K. (Eds.) *Handbook of Second Language Acquisition*. San Diego, CA: Academic Press, Inc.
- Gass, Susan, and Selinker, Larry. (1994). *Second language acquisition: an introductory course*. Hillsdale, NJ: Erlbaum Assoc.
- Greenbaum, S., and Quirk, R. (1970). *Elicitation experiments in English: linguistic studies in use and attitude*. London: Longman.
- Hagiwara, Robert. (1995). Acoustic realizations of American /r/ as produced by women and men. *UCLA Working Papers in Phonetics*, **90**, 1-187.
- Iverson, Paul and Kuhl, Patricia K. (1996). Influences of phonetic identification and category goodness on American listeners' perception of /r/ and /l/. *Journal of the Acoustical Society of America*, **99** (2), 1130-1140.
- Johnson, Keith, Flemming, Edward, and Wright, Richard. (1993). The hyperspace effect: phonetic targets are hyperarticulated. *Language*, **69** (3), 505-528.
- Kim-Renaud, Young-Key. (1986). *Studies in Korean Linguistics*. Seoul, Korea: Hanshin Publishing Company.
- Klatt, Dennis H. (1989). Review of selected models of speech perception. In Marlsen-Wilson, W. (Ed.) *Lexical Representation and Process*. Cambridge, MA: MIT Press.

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Production, and Acquisition*

- Labov, William. (1996). When intuitions fail. In McNair, L., Singer, K., Dolbrin, L. and Aucon, L. (Eds.) *Papers from the Parasession on Theory and Data in Linguistics*. Chicago Linguistic Society, **32**, 77-106.
- Lado, R. (1957). *Linguistics Across Cultures*. Ann Arbor: University of Michigan Press.
- Leather, Jonathan and James, Allen. (1996). Second language speech. In Ritchie, William C. and Bhatia, Tej K. (Eds.) *Handbook of Second Language Acquisition*. San Diego, CA: Academic Press, Inc.
- Lee, J. and Van Patten, B. (1995). *Making Communicative Language Teaching Happen*. New York: McGraw-Hill, Inc.
- Lenneberg, Eric. (1967). *Biological foundations of language*. New York: Wiley.
- Lively, S. E., Pisoni, D. B. and Goldinger, S. D. (1994). Spoken word recognition: research and theory. In Gernsbacher-Morton, Ann (Ed.) *Handbook of Psycholinguistics*. San Diego: Academic Press, Inc.
- Long, Michael. (1990). Maturation constraints on language development. *Studies in Second Language Acquisition*, **12**, 251-285.
- Magen, Harriet S. (1998). The perception of foreign-accented speech. *Journal of Phonetics*, **26**, 381-400.
- Nunan, David. (1996). Issues in second language acquisition research: examining substance and procedure. In Ritchie, William C. and Bhatia, Tej K. (Eds.) *Handbook of Second Language Acquisition*. San Diego, CA: Academic Press, Inc.
- Patkowski, M. (1990). Age and accent in a second language: a reply to James Emil Flege. *Applied Linguistics*, **11**, 73-89.
- Peterson, G. and Barney, H. (1952). Control methods used in a study of vowels. *Journal of the Acoustical Society of America*, **24**, 175-184.
- Purcell, E. T. and Suter, R. W. (1980). Predictors of pronunciation accuracy: a re-examination. *Language Learning*, **30**, 271-288.
- Schmidt, Anna Marie. (1996). Cross-language identification of consonants. Part 1. Korean perception of English. *Journal of the Acoustical Society of America*, **99** (5), 3201-3211.
- Scovel, Thomas. (1998). *A Time to Speak: A Psycholinguistic Inquiry into the Critical Period for Human Speech*. Cambridge, MA: Newbury House.

- Sorace, Antonella. (1996). The use of acceptability judgments in second language acquisition research. In Ritchie, William C. and Bhatia, Tej K. (Eds.) *Handbook of Second Language Acquisition*. San Diego, CA: Academic Press, Inc.
- Stevens, Kenneth N. and Blumstein, Sheila E. (1981). The search for invariant acoustic correlates of phonetic features. In Eimas, P. D. and Miller, J. L. (Eds.) *Perspectives on the Study of Speech*. Hillsdale, NJ: Erlbaum Assoc.
- Syrdal, Ann K. and Gopal, H. S. (1986). A perceptual model of vowel recognition based on the auditory representation of American English vowels. *Journal of the Acoustical Society of America*, **79**, 4, 1086-1100.
- Wexler, Kenneth. (1990). Innateness and maturation in linguistic development. *Developmental Psychobiology*, **23** (3), 645-660.
- Wode, Henning. (1994). Nature, nurture, and age in language acquisition. *Studies in Second Language Acquisition*, **16**, 325-345.

Appendix A: Biographical Questionnaire

This questionnaire will gather information about your language experiences throughout your life. Feel free to elaborate on anything you think is important. All responses are confidential. Your name, telephone number, and email address are requested so that I may contact you if I need follow up information. Thank you again for your participation!

Today's date: _____
 Name: _____
 Age: _____
 Gender: (circle) M F
 Email address: _____
 Telephone number: _____

1. Where were you born (city, country)?
2. Where did you attend elementary school?
3. Where did you attend secondary school?
4. Where did you attend college?
5. What is (are) your native language(s)?
6. Did you grow up with your parents? Y N
 If so, what are your parents' native languages?
 Mother: _____
 Father: _____
 If you grew up with other guardians, what are their native languages?
 Guardian 1: _____
 Guardian 2: _____
7. At what age did you first start learning English? _____
 In what kind of learning environment? (please describe: at school, at home, with friends, etc.)
8. At what age did you start using English? (outside of just English class) _____
9. At what age did you move to the United States? _____
10. How long have you lived in the United States (or other English-speaking countries)?
 (List each place and how long you lived there, e.g. "I lived in Dallas, Texas from June, 1994 to August, 1998. I lived in Seattle, Washington from August, 1998 until now.")
11. Do you have a job? Y N
 What language do you usually speak at work?
12. Are you a student? Y N
 What language do you usually speak at school?
13. Who do you live with? (e.g., friends, husband/wife, parents, etc.)
 What language do you usually speak at home?
14. What language do you usually speak with your friends?
15. What language do you usually speak with your family?
16. How often do you speak with your family?
17. Overall, how much of your speaking each day is English? (give a percentage) _____

18. Circle the percent (%) of each language you use in the following environments (each category should add up to 100%, e.g., "at home each day, I speak English 40% of the time, Korean 50% of the time, and French 10% of the time = 100%"):

HOME:

English:	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Korean:	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Other (specify):	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

SCHOOL:

English:	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Korean:	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Other (specify):	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

WORK:

English:	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Korean:	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Other (specify):	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

WITH FRIENDS:

English:	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Korean:	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Other (specify):	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

WITH FAMILY:

English:	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Korean:	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Other (specify):	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

ELSEWHERE:

English:	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Korean:	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Other (specify):	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

19. How "native" do you think you sound in the languages you know? (circle the appropriate response)

	Heavily accented		Some accent			No accent (native)	
English:	5	4	3	2	1		
Korean:	5	4	3	2	1		
Other (specify):	5	4	3	2	1		

20. How important is it to you to sound like a native speaker of American English?

Extremely important (I want to have an American-English accent)	Somewhat important (I would like my speech to be less foreign- accented)	Not important (It is not important to me to have an American- English accent)
5	4	3
		2
		1

21. Please provide any other comments or information that you think would help me understand your language experience and use.

Appendix B: Token Lists

List 1	List 2	List 3
(rate)	(late)	(rate)
date	debt	ball
right	picked	debts
ball	date	begged
picked	bead	light
debts	right	bid
bead	bid	debt
begged	begged	bar
debt	debts	bids
light	bids	picked
bids	ball	date
bar	light	bead
bid	bar	right
(bait)	(bait)	(late)

An Acoustic Analysis of Vowel Formants in Pharyngeal and Glottal Contexts in Nuu-chah-nulth*

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1.0 Introduction

In this paper we study some of the acoustic effects the glottal stop /ʔ/ and the “pharyngealized glottal stop” /ʕ/ have on neighbouring vowels in Nuu-chah-nulth (Nootka), a Wakashan language spoken on the west coast of Vancouver Island. Previous descriptions of these two sounds reveal that they are very similar, and indeed they are often difficult for the non-native ear to distinguish. Our aims are primarily to document and describe precisely the acoustic effects these sounds have on adjacent vowels, with the assumption that such effects are a primary cue to their differentiation. As the pharyngeal is the rarer of the two sounds, our discussion focuses on its properties.

2.0 Background

Although written with the same symbol normally used for a pharyngeal fricative/approximant, this is not an adequate characterization of /ʕ/. This sound has been described in the past by Sapir and Swadesh (1939: 13) as “a glottal stop pronounced with the pharyngeal passage narrowed by the retraction of the tongue toward the back of the pharyngeal wall”, by Swadesh (1939: 78) as a “glottal stop with pharyngeal constriction” and by Jacobsen (1969: 126) as a “pharyngealized glottal stop”. Rose (1981: 15) gives a somewhat more detailed description:

* We would like to thank our research consultant for sharing her language with us. We would also like to thank Henry Davis, Bryan Gick and Guy Carden for much useful discussion. Support for this research was provided by SSHRCC grant # 410-95-1519 to Henry Davis. Unless otherwise noted, all data in this paper come from our own field notes.

ʕ consists of a pharyngealized glottal closure which [...] is accompanied by a raised larynx and a retracted tongue root. *ʕ* is like a resonant in having no release burst (i.e. a stop release). However, associated laryngealization, perceived as a series of 'cracks', gives the impression of a series of stop bursts.

The strong laryngeal character of /ʕ/ is manifested in various ways in the phonology. First of all, /ʕ/ patterns with the glottalized sounds phonotactically. In Nuu-chah-nulth, glottalized elements are banned from the syllable coda. This includes /ʔ/, /h/, glottalized stops (p', t', ts', tʃ', tʃ', k', k'ʷ), glottalized resonants (m', n', w', j') and /ʕ/. This is noteworthy, because the pharyngeal fricative /ħ/ is freely permitted in the coda, indicating the coda prohibition is restricted to truly glottal elements, including /ʕ/, and not more broadly to sounds which are 'guttural' (cf. McCarthy 1994).

The glottal nature of /ʕ/ is also evident in the phonological alternation called *glottalization*. Nuu-chah-nulth has a class of lexical and grammatical suffixes called glottalizing suffixes which cause glottalization of the preceding consonant, resulting in stops becoming ejectives and fricatives becoming glottalized glides. Interestingly, when the uvular stops /q/ and /qʷ/ are glottalized, they become the pharyngeal /ʕ/. This reflects the historical evolution of /ʕ/ from /q/ and /qʷ/ in the proto-language (Jacobsen, 1969). A few examples of the synchronic process of glottalization are given below.

(1) *Glottalization before glottalizing suffixes (a-d, Rose 1976: 58-59)*

- | | | | |
|----|---------------|--------------|--|
| a. | /hupt-'atʃ/ | [hup.t'atʃ] | <i>they hid</i> |
| b. | /wik-'as/ | [wi.k'as] | <i>not outside</i> |
| c. | /hiʃ-'atʃ/ | [hi.j'atʃ] | <i>Inside</i> |
| d. | /ts'axʷ-'atʃ/ | [ts'a.w'atʃ] | <i>speared inside</i> |
| e. | /ts'uq-'aqtʃ/ | [ts'u.ʕaqtʃ] | <i>stabbed inside (eg. knife left in a fish)</i> |
| f. | /t'iqʷ-'as/ | [t'i.ʕas] | <i>sitting on the ground</i> |

Although in isolation both /ʔ/ and /ʕ/ have largely the same auditory profile, there is a dramatic difference in their effect on neighbouring vowels. Whereas /ʔ/ often adds

creakiness, /ʎ/ adds not only creakiness, but adjacent vowels are normally somewhat pharyngealized and high vowels are regularly lowered to mid vowels. Note, however, that contrary to Rose (1981: 16), who was working on the Kyuquot dialect, we have not found that the low vowel /a/ is retracted to /ɑ/ in this environment in the Ahousaht dialect.

(2) ʎ lowering vowels

a.	/ʎi:ʃ.n'u:/	[ʎɛ:ʃ.n'u:]	<i>bullhead fish</i>
b.	/ʎitʃ.ʃitʃ/	[ʎɛʃ.ʃitʃ]	<i>to become rotten</i>
c.	/ʎu.j'i/	[ʎo.j'i]	<i>to augment, worsen</i>
d.	/ʎu:kʷitʃ/	[ʎo:kʷitʃ]	<i>to augment, worsen</i>
e.	/ʎa:ɦu:s/	[ʎa:ɦəws]	<i>place name</i>
f.	/ʎa:tʃ.ʎa:tʃa/	[ʎa:tʃ.ʎa:tʃa]	<i>soften grass</i>

(3) ʎ not affecting vowels

a.	/ʎin.ku.w'iʃ/	[ʎin.ku.w'iʃ]	<i>smoke house</i>
b.	/ʎi:ts.kʷin/	[ʎi:ts.kʷin]	<i>mouse</i>
c.	/ʎu.ʎa:ɦuk/	[ʎu.ʎa:ɦuk]	<i>to look after</i>
d.	/ʎu:kʷitʃ/	[ʎu:kʷitʃ]	<i>to</i>
e.	/ʎas.xʷa:/	[ʎas.xʷa:]	<i>to ask for something</i>
f.	/ʎap.pi:/	[ʎap.pi:]	<i>back</i>

This study aims to capture the difference between /ʎ/ and /ʎ/ by analyzing the formant values of vowels following these consonants.

3.0 Acoustic Study

Formants are the resonant frequencies of one's vocal tract during speech production. They can be very informative, revealing much about such things as vowel height, lip rounding and pharyngealization. Generally, F1 corresponds to a vowel's height. The higher the vowel, the lower F1. Similarly, F2 generally corresponds to the backness of a vowel. The farther back the vowel, the lower F2 (Kent & Read, 1992: 92). Thus by constricting the vocal tract in various places with the tongue or other muscles, one changes the formant frequencies.

In a pharyngeal environment, F1, F2 and F3 all undergo some change. Pickett (1999: 42) notes that pharyngealization can be observed as a rise in F1 and a drop in F2 on neighbouring vowels. Likewise, Ladefoged & Maddieson (1996: 307) cite a

manuscript by Catford, who reports F3 is markedly lower in pharyngealized vowels. This contrasts with glottal stop, where adjacent vowels are not associated with a marked formant transition (Kent & Read, 1992: 143).

Al-Ani (1970: 59-63) studies the effect of these sounds on the formant values of adjacent vowels in Arabic. He finds that /ʔ/ has almost no effect. The pharyngeal /ʕ/, which he analyzes as a voiceless stop¹, has a much greater effect on the formants. He observes that for /i/, the pharyngeal raises F1 by 100 Hz, and lowers F2 by 500 Hz. For /u/ he finds the greatest difference being a slight rise in F2 of 150 Hz, and for /a/ a lowering of 50-100 Hz. Al-Ani concludes that these formant effects, especially F2, are the greatest distinguishing factor between /ʕ/ and /ʔ/. Similar results are reported for Arabic by Alwan (1986) and Butcher & Ahmad (1987).

Alwan (1989) studies onset F1 frequency of /a:/ in Arabic after three different articulatory gestures: uvular, pharyngeal, and glottal. He finds that F1 is higher after things perceived as pharyngeals, intermediate after things perceived as glottals and lower after things perceived as uvulars. Kent & Read (1992: 120) call for further studies to “establish the generality of this acoustic-perceptual relationship”. Our paper will look for correlates to these findings in Nuu-chah-nulth, examining F1-F3.

3.1 *Method*

All of the data used in this paper was elicited from an adult female native speaker of the Ahousaht dialect of Nuu-chah-nulth. The data included for analysis in this paper was elicited over a four-month period during biweekly elicitation sessions. Most of the data was recorded using various analog cassette recorders such as the Marantz PMD430. Data was digitized on an iMac computer sampling at 44kHz. Then acoustic analysis was performed using *Praat 3.8.64*, a shareware program developed by Paul Boersma and David Weenink at the Phonetic Sciences department of the University of Amsterdam.²

Formant averages for each of the three vowels (/a/, /i/, and /u/) were calculated in nine different contexts: a long vowel after each of C, /ʔ/, and /ʕ/; a short vowel in an open

¹ But cf. Laufer 1996.

² For information see <<http://www.fon.hum.uva.nl/praat/>>.

syllable after each of C, /ʔ/, and /ʕ/; and a short vowel in a closed syllable after each of C, /ʔ/, and /ʕ/. Note that in these contexts we use the symbol C to represent any non-guttural voiceless stop (i.e. not uvular, pharyngeal, laryngeal or glottalized). Although formants differ somewhat depending on the place of articulation of a particular stop, we are confident that formants for vowels after C represent an average value for non-guttural stops.

Results of the formant analysis are shown in Appendix 1. The number of tokens included in the calculation of the averages varies from 0 to 8 and this number can be seen in parentheses. The data in Appendix 1 can be read more easily as the bar graphs of Figures 1-3. Here, the values for all of the tokens from the three different syllable contexts (long vowel and 2 short vowel contexts) in Appendix 1 were averaged together. Figure 1 shows the F1 values for /i/, /u/, and /a/ for each of three different preceding consonants: C, /ʕ/ (phar) and /ʔ/ (glot). Figure 2 and Figure 3 show the corresponding values for F2 and F3 respectively.

To minimize confounding variables, the analysis was limited to vowels in word-initial syllables that were not immediately followed by a guttural consonant. Also, whenever possible, the second of three repetitions of a particular token was used for analysis. All formants were calculated at the 25% mark of the vowel.

3.2 *Results*

As can be seen in Figure 1, the effect of the pharyngeal on F1 is consistent across all vowels, causing an unmistakable rise. The rising is most pronounced in the vowels /a/ and /i/, where it is 231 Hz and 206 Hz respectively, but F1 also rises 69 Hz in /u/.

Figure 1

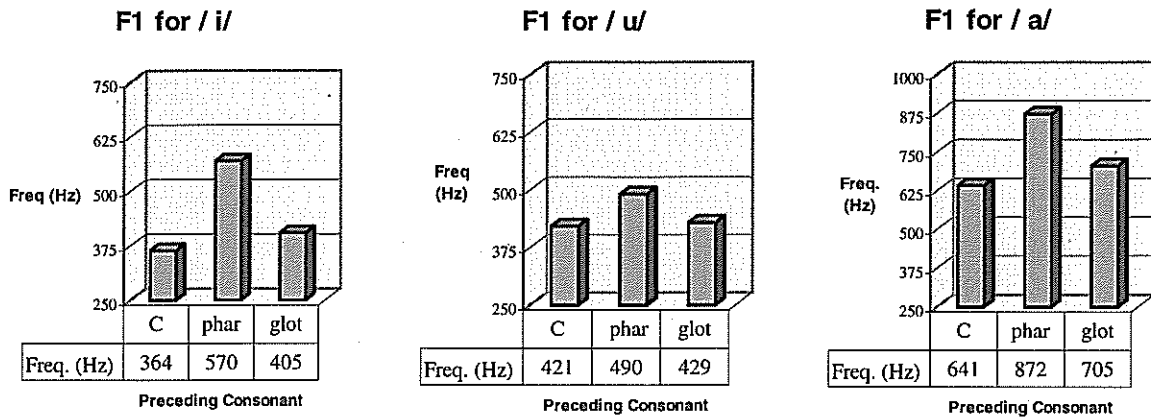


Figure 2

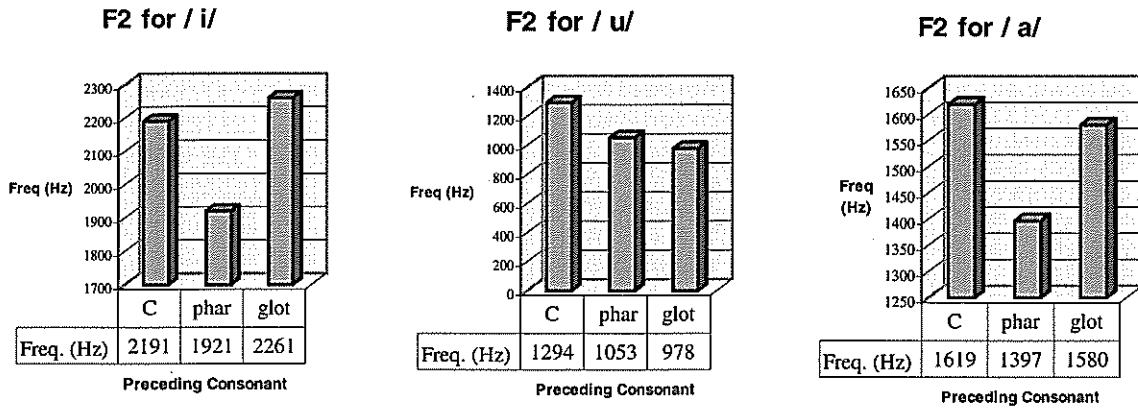
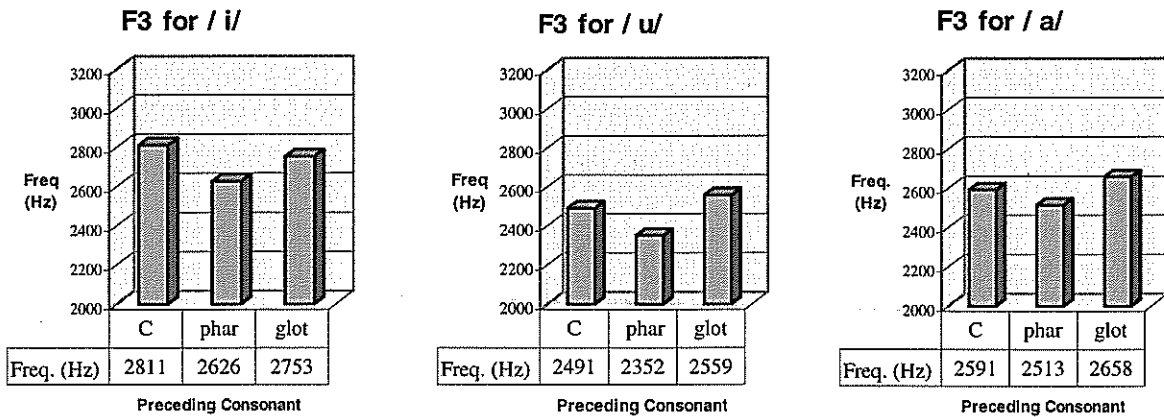


Figure 3



/ʔ/ also shows a rise in F1 across all vowels compared to the standard. However,

the effect of /ʔ/ on F1 is far less salient than the effect of /ʕ/. Though much reduced, once again this rising effect is strongest in /a/ and /i/: 64 Hz and 41 Hz. The rise in F1 in /u/ is marginal, only 8 Hz.

The results for F2 are given in Figure 2. Once again, one observes quite an effect on the formant values after /ʕ/, but in this case, the formants are falling. Unlike the F1 results, the drop in F2 is relatively similar for /a/, /i/ and /u/: 222 Hz, 270 Hz, and 241 Hz respectively.

The results after /ʔ/ are somewhat more irregular. Whereas for /i/, the second formant is 70 Hz higher after the glottal stop than after the standard consonant, for /a/ F2 is 39 Hz lower than the standard. Interestingly, F2 drops for /u/ after /ʔ/ to an even greater degree (316 Hz) than after the pharyngeal (241 Hz).

In Figure 3, one finds the results for F3. For all vowels, there is a drop of the third formant after /ʕ/, most dramatically seen in /i/ (185 Hz) and least in /a/ (78 Hz). However, in the case of the glottal stop, F3 drops only 58 Hz for /i/ but rises 67 Hz for /a/ and 68 Hz for /u/ as compared to the formant values of these vowels after C.

4.0 Discussion

Of the results to note in the data, one interesting finding is the degree of pharyngealization on /a/ following /ʕ/. Since it is not noticeably retracted or lowered, one might expect that the effects of pharyngealization on the formants might be rather subtle. In fact, we found that the formant values of /a/ showed strong effects of pharyngealization.

One can draw a parallel between the results of our own study and Alwan's findings for /a:/. That is, pharyngeals cause the highest rise in F1, and laryngeals an intermediate rise in F1. Although uvulars are outside the scope of this paper, in Shank & Wilson (2000) support is given for the fact that uvulars cause less of a rise in F1 for /a/ than laryngeals do in Nuu-chah-nulth. Our results also establish that the same is true for /i/, and less dramatically so for /u/.

Contrary to work done on Arabic (Al-Ani 1970, Alwan 1986, Butcher & Ahmad 1987) and on Caucasian languages (Catford 1977) we did not find F2 rose for /u/ after the pharyngeal. However, Catford (294) states that a rise in F2 is difficult to explain since one might expect it to fall due to vowel retraction. In this light our results better match our theoretical expectations, but even in this case the lowering effect was much weaker on /u/ than for /i/ and /a/. Given the weaker effects found in F2 of /u/, we are inclined to say that F1 and F3 are clearer, more consistent cues to pharyngealization, contrary to the claim made by Al-Ani for Arabic.

As expected, we have not found that the glottal stop has a great effect on neighbouring vowels. Again, the one exception is F2 for /u/, where /ʔ/ appears to drop the formant to an even greater extent than the pharyngeal. At this time, an explanation is not yet forthcoming for this result.

5.0 Conclusion

To conclude, we have found that the formant values of vowels are significantly different adjacent to the plain glottal stop /ʔ/ as compared to the “pharyngealized glottal stop” /ʕ/ in Nuu-chah-nulth. The pharyngeal causes a greater rise in F1 and a more substantial drop in F3 than the glottal stop. This is a positive result, for the most part correlating well with the findings of researchers concentrating on Semitic and Caucasian languages.

Appendix 1: F1/F2/F3 by Syllable/Consonant Type

		F1	F2	F3
i	Cii (5)	360.2	2258.4	2832.6
	phar ii (1)	632.3	1835.2	2602.8
	glot ii (1)	399.6	2267.3	2789.8
u	Cuu (4)	401.4	1184.1	2453.3
	phar uu (2)	514.3	975.5	2120.0
	glot uu (2)	375.7	940.4	2444.4
a	Caa (6)	746.2	1548.1	2496.9
	phar aa (5)	898.8	1413.4	2620.9
	glot aa (2)	872.7	1586.5	3032.5
		F1	F2	F3
i	Ci]σ (3)	373.0	2141.2	2747.0
	phar i]σ (1)	597.1	1849.4	2618.8
	glot i]σ (1)	372.1	1790.0	2648.9
u	Cu]σ (2)	404.5	1608.2	2351.3
	phar u]σ (5)	480.0	1083.3	2444.3
	glot u]σ (5)	446.2	997.7	2550.6
a	Ca]σ (3)	614.9	1760.6	2603.5
	phar a]σ (1)	913.4	1393.2	2039.9
	glot a]σ (2)	750.5	1621.5	2637.4
		F1	F2	F3
i	CiC]σ (1)	353.8	2007.2	2895.4
	phar iC]σ (1)	481.6	2078.9	2657.8
	glot iC]σ (6)	411.2	2338.6	2763.7
u	CuC]σ (4)	449.1	1245.9	2597.4
	phar uC]σ (0)	<i>no examples in corpus</i>		
	glot uC]σ (6)	432.3	973.8	2603.9
a	CaC]σ (8)	572.5	1619.2	2655.9
	phar aC]σ (1)	698.3	1321.4	2446.4
	glot aC]σ (7)	643.7	1565.5	2556.8

References

- Al-Ani, S.H. 1970. *Arabic Phonology: An Acoustical and Physiological Investigation* (*Janua Linguarum* 61). The Hague: Mouton.
- Alwan, A. 1986. *Acoustic and perceptual correlates of pharyngeal and uvular consonants*. SM thesis. MIT.
- Alwan, A. 1989. Perceptual cues for place of articulation for the voiced pharyngeal and uvular consonants. *JASA*. 86: 549-556.
- Butcher, A. & K. Ahmad. 1987. Some acoustics and aerodynamic characteristics of pharyngeal consonants in Iraqi Arabic. *Phonetica*. 44: 156-172.
- Catford, J.C. 1977. Mountain of tongues: The languages of the Caucasus. *Annual Review of Anthropology*. 6: 283-314.
- Kent, R.D. and C. Read. 1992. *The Acoustic Analysis of Speech*. San Diego: Singular Publishing.
- Ladefoged, P. & I. Maddieson. 1996. *The sounds of the World's languages*. Cambridge, Mass: Blackwell.
- Laufer, A. 1996. The common [ʕ] is an approximant not a fricative. *JIPA*. 26: 113-117.
- McCarthy, J. 1994. The Phonetics and Phonology of Semitic Pharyngeals. In Keating, P. (ed.), *Phonological Structure and Phonetic Form: Papers in Laboratory Phonetics III*. Cambridge, Mass: Cambridge.
- Jacobsen, W. 1969. Origin of the Nootka Pharyngeals. *IJAL*, 35: 125-53.
- Pickett, J.M. 1998. *Acoustics of Speech Communication: The fundamentals, speech perception theory and technology*. Toronto: Allyn & Bacon.
- Rose, S. 1976. *Lenition and Glottalization in Nootka*. MA thesis. University of Victoria.
- Rose, S. 1981. *Kyuquot Grammar*. PhD dissertation. University of Victoria.
- Sapir, E and M. Swadesh. 1939. *Nootka Texts: Tales and Ethnological Narratives with Grammatical Notes and Lexical Materials*. Philadelphia: Linguistic Society of America.
- Shank, S. & I. Wilson. 2000. *The phonetics/phonology of Nuu-chah-nulth post-velars*. Ms. University of British Columbia.
- Swadesh, M. 1939. Nootka Internal Syntax. *IJAL*, 9, 77-102.

A prosodic constraint on rightward displacement rules in English*

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1.0 Introduction

As its name shows, the acceptability of Heavy NP Shift (HNPS) in English largely depends on whether an NP is “heavy” enough to be shifted or not.

- (1) a. He threw [the letter from the principle decoder] into the wastebasket.
b. He threw - into the wastebasket [the letter from the principle decoder].
- (2) a. He threw [the letter] into the wastebasket.
b. *He threw - into the wastebasket [the letter]. (Zec and Inkelas 1990:376)

In the framework of generative transformational grammar, the (b) sentences are considered to be derived from the respective (a) sentences via the operation of HNPS. HNPS is optional in the sense that both (1a) and (1b) are possible depending on the context. The characteristic property of the alternation between (a) and (b) is that the shifted NP must be of some minimal size, as the difference in acceptability between (1b) and (2b) shows. The following section sums up two different approaches to HNPS and points out their problems: one is a prosodic approach proposed by Zec and Inkelas (1990), and the other is a processing approach, namely the principle of Early Immediate Constituents (EIC), proposed by Hawkins (1990,1994). Section 3 presents an alternative analysis of HNPS, a prosodic version of EIC, which combines

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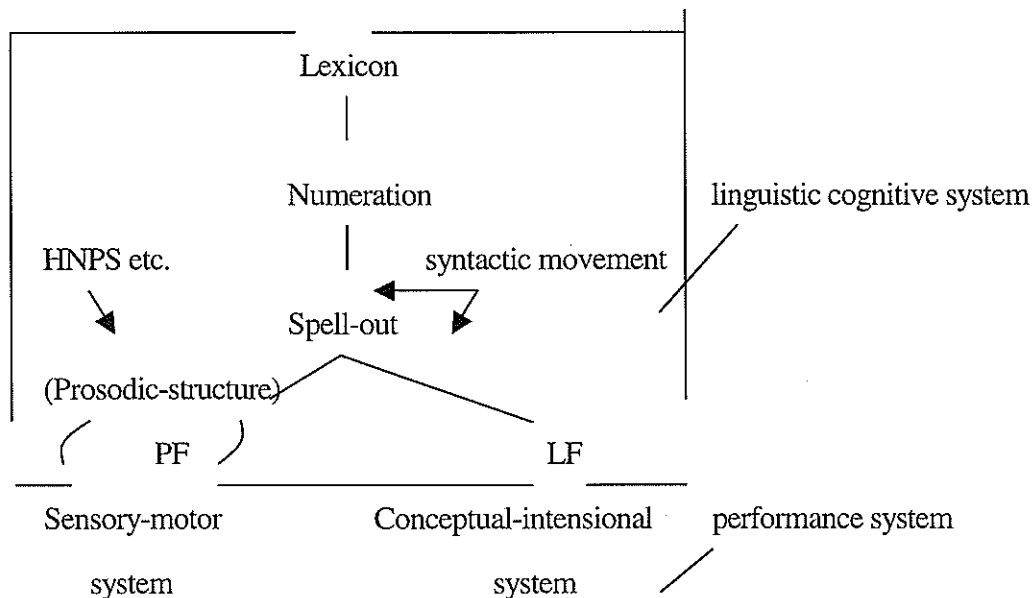
good points from the two approaches.

2.0 Previous analyses

2.1. Theoretical status of optional displacement rules

Before looking at previous studies of Heavy NP Shift (HNPS), let us briefly consider the theoretical status of optional displacement rules or rearrangement rules in general. In the tradition of Generative Grammar, optional displacements such as HNPS have been distinguished from movements in the syntactic component of the grammar which are driven by morpho-syntactic requirements (i.e. feature checking). For example, in the Minimalist Program advocated by Chomsky (1995,1998), it is suggested that rearrangement rules apply at some level(s) in the phonological component, ‘postmorphology but prephonetic, accessed at the interface with PF and LF’ (Chomsky 1995:220), say, the prosodic-structure:

(3)



In the following two subsections, I will examine the prosodic constraint on HNPS that applies at the prosodic-structure (2.2), and then the processing principle which is a manifestation of the language-external requirements in the sense that it is a principle that concerns the performance system (2.3).

2.2. *Zec and Inkelas 1990*

Zec and Inkelas' (1990) (Z&I) approach to HNPS fits into this theoretical framework in (3) since they argue that the "heaviness" of a shifted NP should be captured in prosodic terms. They hypothesize the generalization in (4):

- (4) The shifted NP is licensed when it contains at least two phonological phrases (PPh), that is, it consists of a branching Intonational Phrase (IP). (cf. Z&I 1990:377)

The constraint in (4) is based on the prosodic hierarchy in (5):

- (5) Prosodic hierarchy (Selkirk 1986)

Utterance
 Intonational Phrase (IP)
 Phonological Phrase (PPh)
 Prosodic Word (PWd)
 Foot (Ft)
 Syllable (σ)

This constraint seems to successfully describe the different acceptability in (1b) and (2b) by

saying that the shifted NP in (1b) consists of two PPhs while that in (2b) consists of one PPh. The crucial example for (4) is the following:

- (6) a. Mary gave - to Sue [[that report]_{PPh} [on Dukakis]_{PPh}]_{IP}.
 b. *Mary gave - to Sue [[that report on him]_{PPh}]_{IP}. (Inkelas 1989:17-18)

Z&I say that unemphasized object pronouns such as *him* in (6b) are always enclitics in English and they do not constitute phonological words on their own. Accordingly, the shifted NP in (6a) consists of two PPhs and the sentence is acceptable whereas the shifted NP in (6b) consists of one PPh and the sentence is ruled out by the prosodic constraint in (4).¹

There are at least three problems with the prosodic constraint in (4). First, independent evidence for the different phonological phrasing patterns of shifted NPs in (6) is not provided in Z&I and therefore the argument seems to be circular (e.g. The shifted NP in (6b) consists of one PPh because the sentence is unacceptable, and the whole sentence is unacceptable because the shifted NP consists of one PPh). Secondly, the constraint in (4) refers to the absolute size of a shifted NP. However, the heaviness of the element which is shifted around by an NP is also relevant to the acceptability of the sentence (cf. Hawkins 1990, 1994, Tokizaki 1990):

- (7) a. Max showed - to John [some letters from Paris].
 b. *Max showed - to the man who was sitting next to him [some letters from Paris].
 (Tokizaki 1999)
- (8) a. Mary presented - yesterday morning [the report on Elizabeth].
 b. Mary presented - at the teacher's meeting [the report on Elizabeth].
 c. ?Mary presented - at the teacher's meeting yesterday morning [the report on Elizabeth].

¹ Notice that it is *not impossible* to distinguish between a proper name and a pronoun in syntactic terms. Wiltschko (1999), for example, reduces the different binding possibilities exhibited by nouns to different syntactic categories assigned to them (e.g. AgrP vs. DP).

As long as the constraint in (4) rules in the sentence in (7a), (8a) and (8b), it does not explain the unacceptability of (7b) and (8c) because the sentences in (7) and (8) respectively contain the same shifted NP.

The third problem, which is both theoretical and empirical, is that the constraint in (4) is construction-specific and cannot apply to any other constructions. This is an empirical problem because another construction in English which has been analyzed as involving rightward displacement,² Extraposition from NP (EXNP), exhibits the same type of “heaviness” effect as HNPS:

- (9) a. Heavy NP Shift: Mary gave - to Sue [that report on Dukakis/ ??him/ HIM].
 b. Extraposition from NP: A book - came out yesterday [by Dukakis/ ??him/ ?HIM].

The degrading pattern in (9b) is clearly related to the content of the extraposed phrase and a constraint which predicts the degradation in both (9a) and (9b) is theoretically more welcome than an HNPS-particular constraint like (4).

2.3. *Hawkins 1990,1994*

We have just seen that Extraposition from NP (EXNP) shows the same degrading pattern as HNPS. The property characteristic of the two constructions is that a phrase appears in sentence-final position that is not the canonical position for the phrase. It is reasonable to consider that these constructions are motivated by processing considerations which favor a well-balanced sentence by achieving “End-weight” (Quirk et al. 1985:1398). Under this assumption, Hawkins (1990,1994) gives a processing account of the rearrangement rules in general, not only in English

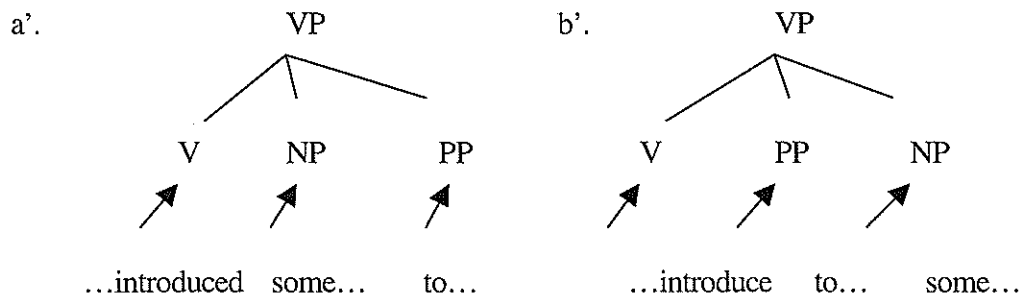
but also in many other languages. He proposes the principle of Early Immediate Constituents (EIC) which predicts that a rearrangement rule will apply only to those grammatical categories and only in that direction (leftward or rightward) that will potentially increase the processing ease of the relevant constituents:

(10) Early Immediate Constituents (EIC)

The human parser prefers to maximize the left-to-right IC-to-word ratios of the phrasal nodes that it constructs. (Hawkins 1990:233)

Instead of going into the technical details of the principle, let us look at the HNPS example in (11) to see roughly how EIC works:

- (11) a. I [VP introduced [NP some friends that John has brought to the party] [PP to Mary]].
 1 2 3 4 5 6 7 8 9 10 11
 b. I [VP introduced [PP to Mary] [NP some friends that John has brought to the party]].
 1 2 3 4



The relevant constituent in the alternation in (11) is VP. In (11a), the parser needs to process 11 words, from the verb *introduce* that signals the first immediate constituent (IC) of VP

² See Culicover and Rochement (1990) and Shiobara (1997) among others for nontransformational approach to EXNP.

(=V) to the preposition *to* that signals the last IC of VP (= PP) in order to recognize the constituent VP. On the other hand, in (11b) only four words must be processed, from the verb to the quantifier *some* that signals the last IC of VP (=NP, in this case).³ The EIC correctly predicts that the HNPS sentence in (11b) is allowed because the operation applies to NP, in the rightward direction, which makes the recognition of VP earlier and easier.

The EIC is better than the prosodic constraint in (4) in that it is sensitive to the *relative* heaviness of the shifted NP, and it can be generalized to other displacement rules including EXNP.⁴ However, the obvious problem with the EIC is in its word-counting system. It does not account for the difference between (6a) and (6b) where the sentences have the same number of words. In the next section, I will sketch out an alternative account of rightward displacement rules, which modifies the EIC into a principle that refers to prosodic structure.

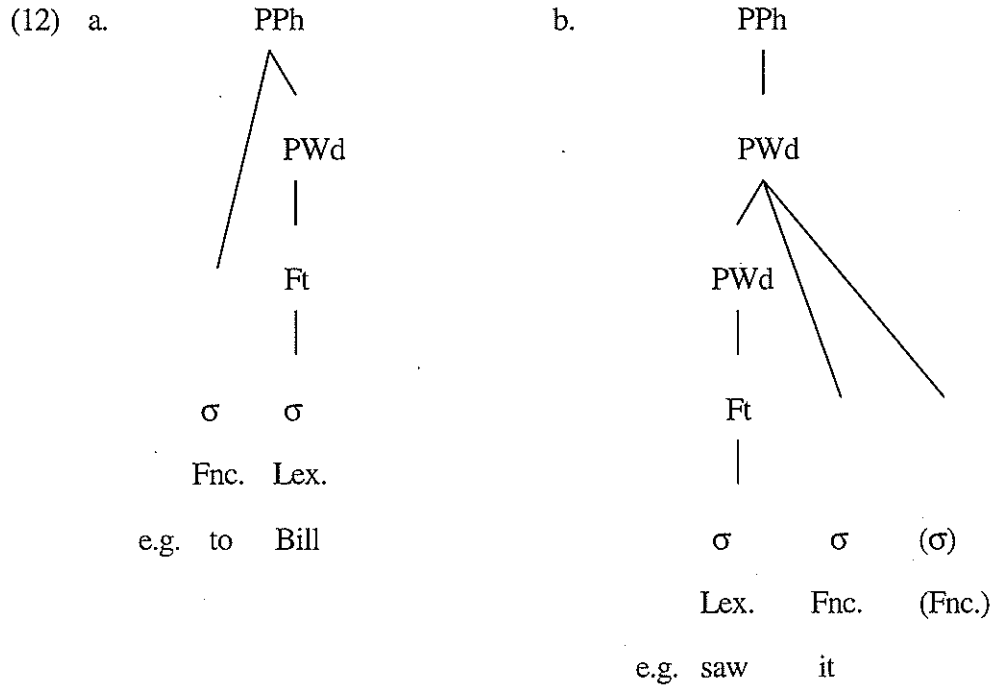
3. Prosodic Version of EIC

As an alternative analysis of HNPS or optional displacement rules in general, I propose a prosodic version of Early Immediate Constituents (EIC). That is, I propose that it is prosodic words, not morphological words, that the EIC counts.

Regarding the structure of prosodic words, I adopt Selkirk 1996,1999, illustrated in (12):

³ In Hawkins (1994), the way of calculating the EIC ratio is altered. Particularly, the EIC refers to not only immediate constituents, but intermediate constituents. I intentionally adopt Hawkins (1990) version of EIC because this version makes more precise predictions than the 1994 version in the case where the two versions make different predictions. (cf. Hawkins 1994:83. I thank Gabe Webster and Masaki Ohno for reminding me of this point.)

⁴ See Hawkins (1994) for the application of the EIC to German EXNP examples, and Shiobara (1997), for English EXNP examples.



The structure in (12a) is for the sequence of a 1-syllable function word and a 1-syllable lexical word, and the structure in (12b) is for the sequence of a 1-syllable lexical word and a 1-syllable functional word. Notice that a functional word does not construct a prosodic word on its own. Rather, a functional word constructs a prosodic word with a preceding lexical word and a recursive structure is assumed in this case. These structures are independently motivated by phonological facts.⁵

Now we are ready to see how the prosodic version of the EIC works for the examples in (6):

⁵ Evidence for (12a) comes from the fact that (i) the stresslessness of the functional word indicates that it is not a prosodic word itself, and (ii) the functional word displays no prosodic word-initial behavior, for example, it may be followed by a stressless syllable. The structure in (12b) is motivated by the fact that both the functional word and the preceding lexical word display prosodic word-final behavior, for example, the appearance of intrusive *r*. See Selkirk (1996,1999) which provides the Optimality theoretic analysis of these structures.

(6) a. Mary [VP gave [NP the report on Dukakis] [PP to Sue]].

[] ... [] ... [] ... []]_{PWD}
 1 2 3 4

a'. Mary [VP gave [PP to Sue] [NP the report on Dukakis]].

[] ... [] ... [] ... []]_{PWD}
 1 2 3

b. Mary [VP gave [NP the report on him] [PP to Sue]].

[] ... [[]] ... []]_{PWD}
 1 2 3

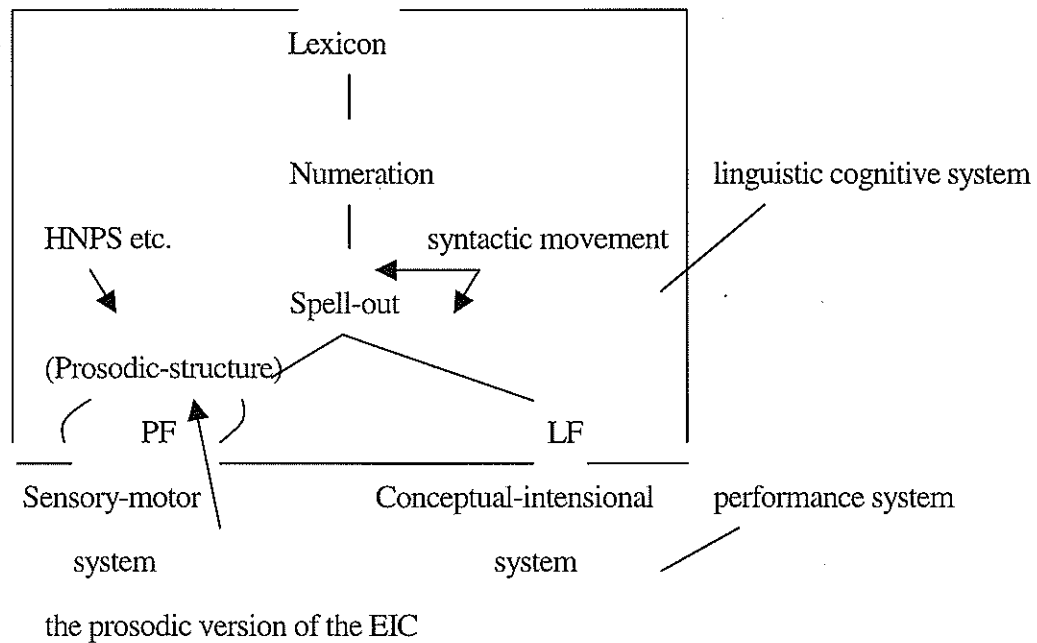
b'. *Mary [VP gave [PP to Sue] [NP the report on him]].

[] ... [] ... [[]]]_{PWD}
 1 2 3

In (6a) the prosodic version of EIC correctly predicts that Heavy NP Shift (HNPS) is possible because it decreases the number of words that must be processed to recognize the VP (from 4 to 3). It also accounts for the unacceptability of (6b'). The prediction is that HNPS cannot apply to (6b) because it *does not decrease* the number of words to be processed (from 3 to 3). Thus, the EIC that counts prosodic words successfully accounts for the different acceptability between (6a') and (6b').

As for the theoretical status of the prosodic version of the EIC, the EIC can be regarded as a principle in the performance system that accesses the prosodic structure.

(13)



However it still needs to refer to the syntactic structures like (11a') and (11b') when it defines the relevant constituent(s) the prosodic words of which should be counted. Then it should be further examined and refined whether the syntactic structure is totally replaced by the prosodic structure as a domain where EIC applies, in terms of syntax-phonology interface.

4.0 Remaining issue

In this paper, I focused on the phonological part of the rightward displacement rules in English. However, it has been agreed that rightward displacements are semantically motivated as well. For example, Quirk et al. (1985:1398) points out that motivations for rightward displacement rules in English are two-fold: one motivation is to achieve End-weight (cf. p.4), and

the other is to achieve an information climax with “End-focus”. In fact, the sentence in (1b) improves when the shifted NP carries a contrastive focus:

(14) Q: Did he throw away the notebook in the wastebasket?

A: No. He threw – into the wastebasket [the LETTER].

I leave the issue of the interaction of phonological and semantic properties of rightward displacement for future research.

REFERENCES

- Chomsky, Noam. 1995. *The minimalist program*. Cambridge, Mass: MIT Press.
- Chomsky, Noam. 1998. Minimalist inquiries: the framework. *MIT occasional papers in linguistics* 15.
- Culicover, Peter and Michael Rochemont. 1990. Extraposition and the complement principle. *Linguistic Inquiry* 21. 23-47.
- Hawkins, John A. 1990. A parsing theory of word order universals. *Linguistic Inquiry* 21. 223-261.
- Hawkins, John A. 1994. *A performance theory of order and constituency*. Cambridge: Cambridge University Press.
- Inkelas, Sharon 1989. *Prosodic constituency in the lexicon*. Doctoral thesis, Stanford University.
- Quirk, Randolph, Sydney Greenbaum, Geoffrey Leech and Jan Svartvik. 1985. *A comprehensive grammar of the English language*. London: Longman.
- Selkirk, Elizabeth 1996. The prosodic structure of function words. *Signals to syntax: bootstrapping from speech to grammar in early acquisition*. ed. by James L. Morgan and Katherine Demuth, 187-213. LEA.
- Selkirk, Elizabeth. 1999. Some basics of Optimality Theory. Handout distributed at the talk at Sophia University, Tokyo, Japan.
- Shiobara, Kayono 1997 *Extraposition from NP as a sentence processing strategy*. MA thesis, University of Tokyo.
- Tokizaki, Hisao 1999. Prosodic Phrasing and the Length of Constituents. Handout distributed at the 17th conference of the English Linguistic Society of Japan, Tokyo, Japan.
- Wiltschko, Martina. 1999. The syntax of pronouns and determiners, a cross-linguistic study. *UBCWPL* 1, 293-320.
- Zec, Draga and Sharon Inkelas 1990. Prosodically constrained syntax. *The phonology-syntax connection*. ed. by Sharon Inkelas and Draga Zec, 365-397. Chicago: University of Chicago Press.

Scrambling and Wh-Movement in Korean

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1.0 Introduction

Korean DPs and wh-phrases have a characteristic of being able to be fronted in syntax, and this property has drawn a lot of interest among Korean linguists. In the Principles and Parameters (Henceforth, P & P) framework, the object DPs in Korean were analyzed as being optionally scrambled, and the wh-phrases in Korean were assumed to be optionally moved. Optionality in computational operations, however, is no more permitted in the Minimalist framework.

In this paper, I will make an analysis of these in-situ and scrambled phrases in Korean consistent with the Minimalist spirit. In section 2, I will introduce the Conditions of local economy proposed by Collins (1997) upon which the analysis presented in this paper is grounded. In section 3.1.1, I will first critically review an IP-adjunction analysis of the scrambled DPs in Korean in the Minimalist framework. In section 3.2.1-2, I will critically review previous analyses of Wh-Movement in Korean, and show the optional movement analysis and Moon's analysis untenable or incomplete under Minimalist assumptions.

Then, in sections 3.1.2 and 3.2.3, I will make an analysis of the scrambled DPs and wh-phrases in Korean under local economy, claiming that the scrambled DP and wh-phrase raise to the Spec FocP in overt syntax while the in-situ phrase remains in its place according to the distinct Numerations.

The following theoretical and empirical advantages follow from the proposal made in this paper. First, the proposal made here correctly characterizes the semantic properties of a scrambled DP and a scrambled wh-phrase in Korean, i.e., the semantic aspects that a preposed DP/ wh-phrase becomes the focus of a sentence in which it occurs, i.e., the scrambled phrase gets focalized in the sentence. Second, the proposal made here is shown to be motivated on general empirical grounds. Korean shows the existence of multiple FocPs and a single TopP in a clause taken under the proposal made

in this paper, which is applicable to Japanese. Furthermore, several languages show the existence of Topic and Focus constructions.

Overall, the occurrences of the moved vs. in-situ DPs and wh-phrases in Korean are to be accommodated under the proposal made in this paper within the Minimalist framework, and the proposal is shown to be theoretically and empirically adequate.

2.0 Local Economy

2.1 Local Economy

Any theory of grammar will include three essential components: a lexicon, PF and LF. Since LF and PF representations are composed of items drawn from the lexicon, it is adequate to assume that the derivation takes items from the lexicon and combines them in certain ways. Chomsky (1991, 1995) postulated that the grammatical derivation is constrained by economy conditions requiring that derivations be minimal. Under these conditions of global economy, the shorter derivation blocks the longer one in case they have the same Numeration.

Collins (1997) in his *Local Economy* favors local economy as the sole conditions for grammatical derivations and part of UG, whose definition is given below.

- (1) Given a set of syntactic objects Σ which is part of derivation D, the decision about whether an operation OP may apply to Σ (as part of an optimal derivation) is made only on the basis of information available in Σ .

He postulates that there are only two local economy conditions, Last Resort and Minimality.

- (2) Last Resort – An operation OP involving α may apply only if some property of α is satisfied.
- (3) Minimality – An operation OP (satisfying Last Resort) may apply only if there is no smaller operation OP' (satisfying Last Resort).

He claims that there are a number of reasons why local economy is superior to global economy. First, it is empirically superior, as the analyses of locative and quotative inversion show. Second, it tends to allow a more natural analysis of optionality. Third, local economy is conceptually superior to global economy. Global economy chooses the derivation with fewest steps, but this kind of comparison does not seem to occur in other parts of the grammar.

He further assumes that local economy places a strong constraint on possible economy conditions. He cites examples of locative and quotative inversion in English where the inverted derivation has more steps than the non-inverted one. Under global economy, then, the inverted derivation should be blocked, which is not the case. Under local economy, however, all the movements involved in both the derivations satisfy Last Resort and Minimality, hence both are allowed. He thus favors local economy over global economy in the cases of locative and quotative inversion, and tries to extend the application of local economy to more linguistic phenomena.

I agree with him in that local economy is conceptually superior to global economy. I assume that a human's brain tends to favor simpler operations in grammatical computation, thus disfavors comparison of derivations based on the same Numeration. A Human mind might be inclined towards economic operations in computation, thus favors simpler economic conditions in computational derivations such as Last Resort and Minimality. Local economy is adopted by Chomsky in his *Minimalist Inquiries* (1998)¹.

2. 2 Epstein's Examples under Local Economy

In this section, I will analyze some examples in Epstein (1992) in terms of Local Economy Collins (1997) adopted in the analyses of locative and quotative inversion cases in English. The following is the first example Epstein uses in his article.

(4) [_{CP} who_i [_{TP} t_i wonders [_{CP} where_j [_{TP} we bought what t_j]]]]

¹ This paper is written in the framework of *The Minimalist Program*. A research on scrambling and focus in Korean and Japanese in the framework of *Minimalist Inquiries* could be my next research project.

(5) [CP[[where]_j] who_i] [TP t_i wonders [CP (t_j) [TP we bought what t_j]]]]

(6) [CP[[where]_j] who_i] [TP t_i wonders [CP what_k [TP we bought t_k t_j]]]]

(4) is the S-structure representation, and (5-6) are its ill-formed LF counterpart. In (5), *where* has moved from the embedded Spec CP to the matrix Spec CP, and in (6) *what* has additionally moved into the embedded Spec CP. Here, it is assumed that a trace in Comp is only optionally left by movement. The well-formed LF structure for (4) should be the same as its S-structure.

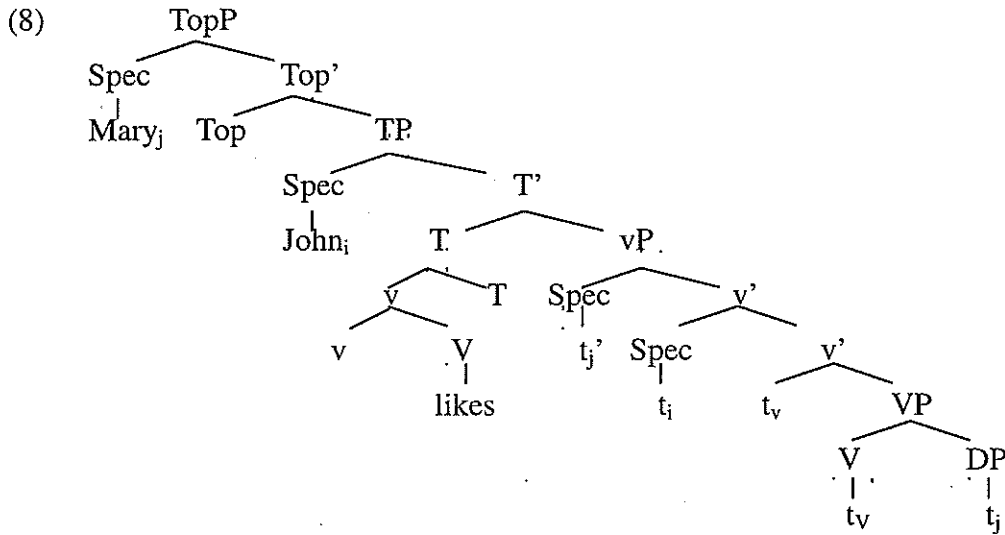
The ill-formedness of LF structures of (5) and (6) follow from Conditions in local economy. In the overt syntax, *who* has moved from the matrix Spec TP to the matrix Spec CP to check the [+wh] feature of the matrix C, and *where* has moved from within the embedded TP to the embedded Spec CP to check the [+wh] feature of the embedded C. Both movements satisfy Last Resort and Minimality, and both wh-phrases will not move any further. In (5-6), *where* does not have any further motivation to move into the matrix Spec CP. Therefore, the movement of *where* in (5) and (6) violates Last Resort, and (5) and (6) are judged ungrammatical. In (6), the [+wh] feature of the embedded C has already been checked off. There is no motivation for *what* to move into the embedded Spec CP, so the movement of *what* in (6) is in violation of local economy.

On the other hand, the well-formed LF structure for (4) is the same as its S-structure. Within the Minimalist framework, in the LF structure for (4), if *what* has a wide scope, *who* unselectively binds its trace and *what*; if *what* has a narrow scope, *who* binds its trace, and *where* binds its trace and *what*. This unselective binding in the Minimalist framework replaces Wh-Movement at LF in the P & P framework.

- (7) a. [CP who_i [TP t_i said [CP that [TP John likes Mary]]]]
 b. [CP who_i [TP t_i said [CP that [_{TopP}² Mary_j [TP John likes t_j]]]]]
 c. [CP who_i [TP t_i said [CP that [TP John likes who]]]]
 d. *[CP who_i [TP t_i said [CP that [_{TopP} who_j [TP John likes t_j]]]]]

The sentence (7d) exemplifies the nontopicalizability of wh-phrases.

The facts observed in (7) follow naturally from Local Economy. In (7b), *Mary* raises to the embedded Spec TopP to check off the topic feature of the embedded Top, and this movement satisfies Last Resort and Minimality.



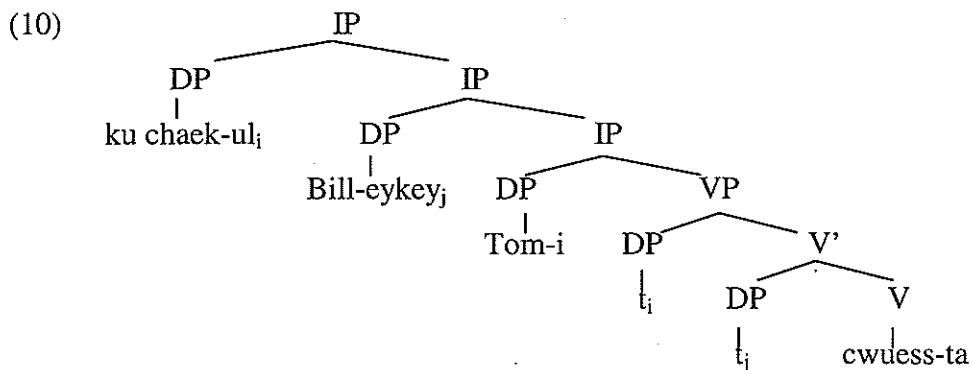
(8) is the partial LF structure for (7b). In essence, the subject *John* does not have a topic feature selected in transition from Lexicon to the Numeration, thus might not constitute a closer candidate for the topic movement. *Mary*, being the only DP with a topic feature, can safely raise overtly to the embedded Spec TopP in conformity with Minimality requirements for movement under local economy.

In (7d), *who* raises to the embedded Spec TopP, but this movement is in violation of Last Resort, since a Wh-phrase does not have a topic feature, and thus the topic feature of Top can only be checked off by the topic feature of an ordinary [-wh] DP. This explains why (7d) is ungrammatical. All the movements in the sentences in Epstein

- d. *ku chaek-ul_i Bill-eykey_j Tom-i t_i t_j cwu-ess-ta*
 the book-Acc -Dat -Nom give-Past-Dec
 ‘The book to Bill, John gave.’
 ‘It was the book to Bill that John gave.’ [focus]

- e. *ku chaek-ul_i Bill-eykey_j Tom-un t_i t_j cwu-ess-ta*
 the book-Acc -Dat -Top give-Past-Dec
 ‘As for Tom, the book to Bill, he gave.’
 ‘As for Tom, it was the book to Bill that he gave.’ [focus]

Korean exhibits the phenomenon of scrambling which fronts the object DPs. (9a) is the regular declarative sentence in Korean where the word order is typically SO(O)V. In the P & P framework, the direct object *ku chaek-ul* in (9b-e) was assumed to be adjoined to IP by several Korean syntacticians, including Yang (1989). The indirect object *Bill-eykey* in (9d-e) was also assumed to be adjoined to IP in the same manner.



In (10), the objects *ku chaek-ul* and *Bill-eykey* c-command their traces respectively, hence this kind of structure was compatible with the P & P tenets. In the Minimalist framework, however, movement is driven by a need to satisfy some morphological requirement, i.e., feature checking. Collins (1997) assumes further that all operations involving Merge and Move take place to satisfy economy conditions, Minimality and Last Resort under his Local Economy.

- c. ku chaek-ul_i Tom-un t_i Bill-eykey cwu-ess-ta
 the book-Acc -Top -Dat give-Past-Dec
 ‘As for Tom, the book, he gave to Bill.’
 ‘As for Tom, it was the book that he gave to Bill’ [focus]
- d. ku chaek-ul_i Bill-eykey_j Tom-i t_i t_j cwu-ess-ta
 the book-Acc -Dat -Nom give-Past-Dec
 ‘The book to Bill, John gave.’
 ‘It was the book to Bill that John gave.’ [focus]
- e. ku chaek-ul_i Bill-eykey_j Tom-un t_i t_j cwu-ess-ta
 the book-Acc -Dat -Top give-Past-Dec
 ‘As for Tom, the book to Bill, he gave.’
 ‘As for Tom, it was the book to Bill that he gave.’ [focus]

The entire sentence (11a) in which the object DPs appear in the base positions conveys a piece of new information and get a presentational reading while the sentences (11b-e) in which the object DP or DPs are scrambled get a focus³ reading in that the object DP comes out as new or highlighted information.

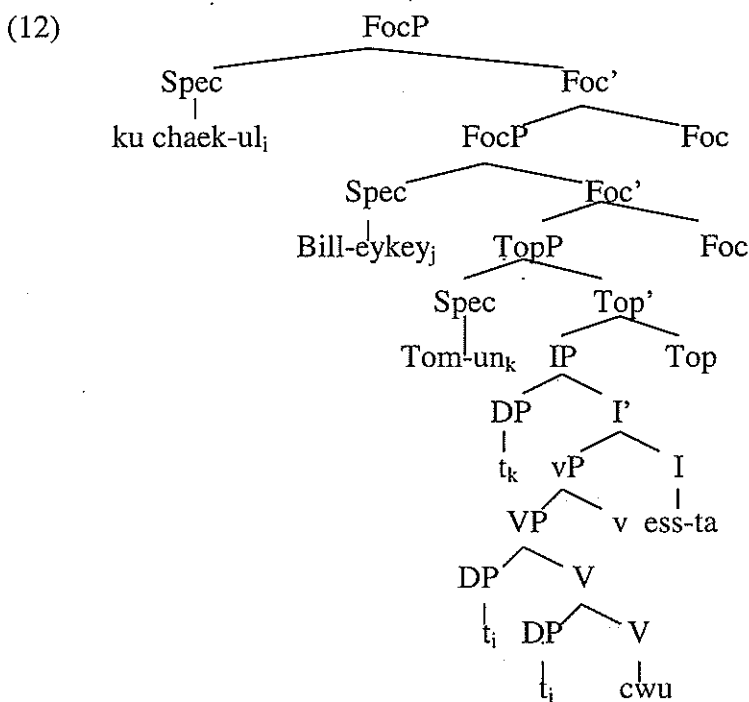
I assume the focus reading assigned to the (11b-e) sentences above in which the object DP is scrambled is consistent with native speaker intuitions in that the native speaker of Korean uses the object-scrambled sentences when that person wants to try to have the information associated with the object DP focused or highlighted.

The presentational reading assigned to (11a) above is also assumed to be consistent with native speaker intuitions in the sense that the native speaker of Korean uses the non-scrambled sentences of ordinary word order when that person tries to say plainly about one thing or a piece of information without the intention of having any information associated with any element in the sentence focused or highlighted.

³ The notion ‘focus’ has not been uncontroversial in the literature. For the present purposes, I assume that the concept ‘focus’ taken in this paper is comparable to existential and exhaustive presuppositions or Kuno’s (1973) ‘exhaustive listing’.

Thus I claim that the focus effect in Korean is driven by scrambling, which is also assumed to hold for Japanese.

To accommodate the occurrences of the scrambled DPs under the Minimalist framework, I claim that the so-called scrambled DPs occur in the Specs FocPs, which are in the left periphery of IP. I claim that the Numeration for the sentence where the DP(s) is to be moved has a functional head Foc, and that the DP selects a focus feature in transition from Lexicon to the Numeration. Accordingly, the DP raises to the Spec FocP overtly to enter into a checking relation with the focus feature of the functional head Foc, and checks off the focus feature of the head Foc. The Numeration for the sentence where the DP remains in-situ, on the other hand, does not involve a functional head Foc, and the in-situ DP does not have a focus feature selected in transition from Lexicon to the Numeration. Consequently, the in-situ DP has no motivation to raise whatsoever, and it remains in its place. Thus, it is assumed that the focus feature is strong and the focus feature of a DP is interpretable.



ku chaek-ul in (11b-e) has raised to the Spec FocP in overt syntax, where the focus feature of *ku chaek-ul* enters into a checking relation with the focus feature of the

functional category Foc. In (11e), the object DPs have raised overtly to the distinct Specs of FocPs to check off the focus features of the functional heads Focs, and the topicalized subject DP has raised overtly to the Spec TopP in the left periphery of IP to check off the topic feature of the functional head Top.

I assume that at LF, the level of interpretation, semantic interpretation principles apply to the scrambled DP and its sister constituent, yielding a focus reading presented above. The current analysis of the preposed DPs in Korean presented here is compatible with the Minimalist tenets. Let us consider the following sentences.

(13) a. Bill-i [John-i ku chaek-ul Mary-eykey cwu-ess-ta-ko] saengkakha-n-ta
 -Nom -Nom the book-Acc -Dat give-past-Dec-Comp think-pres-Dec
 ‘Bill thinks that John gave the book to Mary.’ [presentational]

b. ku chaek-ul_j Bill-un_i t_i [John-i t_j Mary-eykey cwu-ess-ta-ko] saengkakha-
 n-ta
 the book-Acc -Top -Nom -Dat give-Past-Dec-Comp think-Pres-
 Dec
 ‘The book, Bill thinks that John gave to Mary.’
 ‘It is the book that Bill thinks that John gave to Mary.’ [focus]

c. Bill-i [[_{FocP} ku chaek-ul_i] [_{FocP} Mary-eykey_j] John-i t_i t_j cwu-ess-ta-ko]
 -Nom the book-Acc -Dat -Nom give-Past-Dec-Comp
 saengkakha-n-ta
 think-Pres-Dec
 ‘Bill thinks that the book to Mary, John gave.’
 ‘Bill thinks that it was the book to Mary that John gave.’ [focus]

In (13b), the direct object of the embedded verb has raised to the matrix Spec FocP⁴ where it checks off the focus feature of the head Foc. This movement satisfies Last Resort and Minimality under local economy proposed by Collins.

It satisfies Last Resort, since the focus feature of the direct object DP enters into a checking relation with that of the head Foc, thereby checking off the focus feature of the head Foc. That movement satisfies Minimality since there is no operation satisfying Last Resort moving another DP to the Spec FocP. The Numeration for the sentence (13b) has the focus feature available only to the direct object DP, which means no other lexical DP has the focus feature in the Numeration for the sentence. Thus, no other DPs can count as a closer candidate for the movement target, the matrix Spec FocP, and *ku chaek-ul* raises to the matrix Spec FocP in conformity with Minimality requirements for movement. In (13c), the embedded direct and indirect object DPs have raised to the distinct embedded Specs FocPs to check off the focus features of the heads Focs.

Thus, all the movements of the DPs presented in (11) and (13) follow straightforwardly from the current proposal.

As for the interpretation of the sentences (13b-c), I assume as before that semantic interpretation principles⁵ apply to the scrambled DP and its sister constituent at LF to yield a focus reading. Let us consider the following sentences.

(14) John-i ttoktokha-ta.

Nom clever-dec

'JOHN is clever.' = 'It is John who is clever.' [focus]

(15) John-i ttuy-ko iss-ta

Nom run Prog dec

'John is running' [presentational]

'JOHN is running.' = 'It is John who is running.' [focus]

⁴ Choe (1995: 298-9) notes that Focus Movement applies irrespective of the position of wh-scope markers and does not show strong and weak wh-island effects.

⁵ The semantic interpretation principles that apply to the scrambled DP and its sister constituent at LF to render a focus reading might be an extended version of type-shifting principles put forth by Ogihara (1987). But, I will not specifically address the nature of these principles here. It could be included in my next research.

It has been noted in the literature (e.g. Kuroda 1965, Kuno 1973, Kim 1990) that the nominative-marked subject of an individual-level predicate can only get a focus reading, while the nominative-marked subject of a stage-level predicate⁶ can, but does not have to get a focus reading in Korean and Japanese.

I claim that the focused in-situ DP in Korean and virtually in other languages selects an empty operator (Op) with a focus feature in transition from Lexicon to the Numeration, and the strong focus feature of the head Foc is checked by raising of the empty focus operator to the Spec FocP in overt syntax⁷.

The result is shown in (16).

- (16) a. [_{FocP} Op_[John-i] [_{IP} John-i ttoktokha-ta]]
 b. [_{FocP} Op_[JOHN-I] [_{IP} JOHN-I ttuy-ko iss-ta]]

We could handle the focus effect observed in English in the same manner as is illustrated in (17).

- (17) a. John likes MARY.
 (=‘It is Mary who John likes.’)
 a’ [_{FocP} Op_[MARY] [_{IP} John likes MARY]]

- (18) a. Mary-lul_i John-i t_i coahanta.
 Acc Nom likes
 ‘Mary, John likes’ = ‘It is Mary who John likes.’
 b. John-i MARY-LUL coahanta.
 ‘It is Mary who John likes.’

⁶ The concepts ‘individual-level predicates’ and ‘stage-level predicates’ are from Carlson (1977). Individual-level predicates are property-denoting predicates such as ‘boring, intelligent, clever, orange, fat, etc’ and stage-level predicates are state-descriptive predicates such as ‘sick, tired, hungry, drunk, open, walking along the road, etc.’

⁷ The postulation of an empty wh-operator or an empty focus operator might not be very well-motivated in any theoretic framework. The theoretic model has changed in *Minimalist Inquiries* (Chomsky 1998), and in that framework, Chomsky assumes that feature checking/Agree is largely independent of movement. It is assumed that language variation for XP-movement is formulated in terms of requirements of the target that are independent of feature checking. For our present purposes, we could informally assume in the framework of *Minimalist Inquiries* that the focused scrambled DP in Korean and Japanese raises to the Spec FocP in overt syntax while the focused in-situ DP raises to the Spec FocP at LF to be licensed as focus and get a focused interpretation.

a' [_{FocP} Mary-lul_i [_{IP} John-i t_i coahanta]

b' [_{FocP} OP_[MARY-LUL] [_{IP} John-i MARY-LUL coahanta]]

In (18a), the object DP selects a focus feature in transition from Lexicon to the Numeration, and the DP raises to the Spec FocP overtly to check the strong focus feature of the head Foc as is shown in (18a'), while in (17a) and (18b) the object DP has an empty focus operator selected in the Numeration, and the empty focus operator raises overtly to check the strong focus feature of the head Foc as is illustrated in (17a') and (18b'). At LF semantic interpretation principles apply to these constructions to render a focus reading assigned to them.

Let's shift our attention to the case checking of the scrambled object DP here. Kitahara (1992) suggests that at LF, the trace of the object raises to the Spec Agr_o where the checking of [+Acc] features may be done. But, as Chomsky (1995) suggests in his *Minimalist Program*, a trace is a copy of the moved element that gets deleted in the phonological component, but remains present at LF for the purpose of interpretation.

Thus, I claim that at LF, there remains a copy of the moved element in its original position and the copy raises to the outer Spec vP where it checks off the accusative case feature of v, and its case feature also deletes, being uninterpretable. Then, a chain is formed in this context, a three-membered chain whose members have the same form.

I further claim that if a feature of one member of a chain is checked, the same feature of the other members of that chain is also checked automatically. The case checking of the scrambled DPs takes place this way.

3. 2 Wh-Scrambling in Korean

In this section, I will be concerned with Wh-Movement in Korean which, within the P & P framework, was assumed to show optionality in its operations. I will first critically review an optional movement analysis of the wh-phrases in Korean under Minimalist assumptions. Then, I will review Moon's (1996) analysis of Wh-Movement in Korean and address some problems for her analysis.

3. 2. 1 An Optional Movement Analysis of the Wh-phrases in Korean

Let's consider the following sentences.

- (19) a. Tom-i nwuku-lul ecey manna-ss-ni?
 -Nom whom-Acc yesterday meet-Past-Q
 'Who did Tom meet yesterday?'
- b. nwuku-lul_i Tom-i t_i ecey manna-ss-ni?
 whom-Acc -Nom yesterday meet-Past-Q
 'Who was it that Tom met yesterday?' [focus]
- c. ku-tul-un_i t_i [_{CP} John-i Mary-eykey mwuess-ul cwuessnun-ci] alko-sipeha-ni?
 They-pl-Top -Nom -Dat what-Acc gave-Q want to know-
 Q
 'Do they want to know what John gave to Mary?'
- d. mwuess-ul_j ku-tul-un_i t_i [_{CP} John-i Mary-eykey t_j cwuessnun-ci] alko-sipeha-ni?
 what-Acc They-pl-Top -Nom -Dat gave-Q want to know-
 Q
 'What do they want to know John gave to Mary?'
 'What is it that they want to know John gave to Mary?' [focus]

(19a) and (19c) are the so-called in-situ wh-questions in Korean, and (19b) and (19d) show another type of Korean wh-questions where the wh-phrases have been moved to the initial position of a sentence. Several Korean syntacticians, within the P & P framework, analyzed these sentences as involving optional Wh-Movement.

Optional movement, however, is, like adjunction, unmotivated under Minimalist assumptions. In the Minimalist framework, movement is driven by a need to satisfy some morphological requirement, i.e., feature checking. If the features involved are strong, the movement should take place in overt syntax before Spell-out, and if the features involved are weak, the movement should be delayed as late as at LF under Minimalist assumptions. If the [+wh] feature of C is strong in Korean, then the wh-phrase should

move in overt syntax. If it is weak in Korean, then the wh-phrase remains in-situ in overt syntax, and it should move at LF to check off the weak [+wh] feature of C. Thus, optional overt movement is untenable under Minimalist tenets.

3. 2. 2 *Moon's analysis*

Moon (1996) adopts Watanabe's (1992) invisible wh-operator movement hypothesis for the analysis of Wh-Movement in Korean. She proposes that a wh-phrase in Korean optionally selects an empty operator (Op) with [+wh] feature, in transition from Lexicon to the Numeration. When an empty wh-operator is inserted into the Numeration, the strong [+wh] feature of C is checked by raising of the empty wh-operator to [Spec, CP] in overt syntax. If the Numeration does not contain an empty wh-operator, a wh-phrase raises to check off the strong [+wh] feature in C. The suggested analysis in Moon claims that Wh-Movement takes place universally prior to Spell-out to check off the strong [+wh] feature in C.

The facts in (19) follow straightforwardly from her proposal. In (19a) and (19c), the in-situ wh-phrases have an empty wh-operator in the Numerations for the sentences, and the strong [+wh] feature of C is checked by raising of the empty wh-operator to [Spec, CP] in overt syntax. As the Numerations for (19b) and (19d) do not involve an empty wh-operator for the wh-phrases, the wh-phrases raise overtly to check off the strong [+wh] feature of C. Thus, under Moon's proposal, the [+wh] feature of C is universally strong, and Wh-Movement takes place universally in overt syntax.

Let us consider the following sentences.

(20) a. John-i mwuess-ul Bill-eykey cwuess-ni?

-Nom what-Acc -Dat gave-Q

'What did John give to Bill?'

b. Bill-eykey_i mwuess-ul_j John-i t_i t_j cwuess-ni?

- Dat what-Acc -Nom gave-Q

'To Bill what was it that John give?'

[focus]

c. John-i wey Bill-eykey ku chaek-ul cwuess-ni?

-Nom why -Dat the book-Acc gave-Q

'Why did John give Bill the book?'

d. Bill-eykey_j wey_i John-i t_i t_j ku chaek-ul cwuess-ni?

-Dat why -Nom the book-Acc gave-Q

'To Bill why was it that John gave the book?' [focus]

e. Bill-eykey_j wey_i ku chaek-ul_k John-i t_i t_j t_k cwuess-ni?

-Dat why the book-Acc -Nom gave-Q

'To Bill why the book was it that John gave?' [focus]

Under Moon's analysis, the empty operator with the [+wh] feature in the wh-phrase in (20a) and (20c) raises in overt syntax to the matrix Spec CP to check off the strong [+wh] feature of C, and this movement satisfies Minimality and Last Resort. In (20b, d, e), the wh-phrases raise overtly to the Spec CP to check off the strong [+wh] feature of C, and these movements also satisfy Last Resort and Minimality.

But, how can the occurrences of the fronted indirect object *Bill-eykey* in (20b, d, e) and the moved direct object *ku chaek-ul* in (20e) be accounted for under her analysis?

The fronted DP *Bill-eykey* should occur before the matrix Spec CP, and it might be proposed that the DP has been raised and adjoined to the Spec CP, but in that case, there is no motivation for that kind of movement, since no feature checking could be involved in that instance. The Spec CP should be occupied by some maximal category with the [+wh] feature, but *Bill-eykey* does not have the [+wh] feature.

The same problem occurs in the movement of the direct object *ku chaek-ul* in (20e). The direct object has raised to some target between CP and IP, but this kind of movement or adjunction cannot be explained under Moon's proposal. Therefore, the structures of the types (20b, d, e) are not to be accommodated under Moon's analysis.

Let us take a look at the sentences (19a-b), repeated here as (21a-b).

(21) a. Tom-i nwuku-lul ecey manna-ss-ni?

-Nom whom-Acc yesterday meet-Past-Q

'Who did Tom meet yesterday?'

- b. *nwuku-lul*; Tom-i t_i ecey manna-ss-ni?
 whom-Acc -Nom yesterday meet-Past-Q
 ‘Who was it that Tom met yesterday?’ [focus]

The fronted wh-phrase *nwukwu-lul* in (21b) gets a focus reading while the in-situ *nwukwu-lul* in (21a) does not. I assume that the focus interpretation assigned to *nwukwu-lul* in (21b) and the non-focus interpretation given to *nwukwu-lul* in (21a) are consistent with native speaker intuitions.

Under Moon’s analysis, however, we cannot predict the fact that the fronted wh-phrase gets focused and that the in-situ wh-phrase in Korean does not. She deals with these wh-questions in terms of movement of a wh-phrase under consideration or of an empty wh-operator related to an in-situ wh-phrase, but does not specifically address the interpretational differences between them.

The third problem for her analysis comes from the non-wh-island effects⁸ observed in the following sentences.

- (22) a. *mwuess-ul*; *ku-tul-un* [_{CP} John-i t_i Mary-eykey *cwuessnun-ci*] *alko-sipeha-ni*?
 what-Acc They-pl-Top -Nom -Dat gave-Q want to know-Q
 ‘What do they want to know John gave to Mary?’
 ‘What is it that they want to know John gave to Mary?’ [focus]
- b. *Nwuku-lul*; *Chelswu-nun* [*nwu-ka* t_i *coaha-nunci*] *kwungkwumhaecha-nayo*?
 who-Acc -Top who-Nom likes-Q wonder-Q
 ‘Whom does Chelswu wonder who likes?’
 ‘Whom is it that Chelswu wonder who likes?’ [focus]

⁸ Choe (1995: 293-299) claims that sentences such as (22a-c) show wh-island effects and thus are ungrammatical. I am in complete disagreement with her and take these sentences to be grammatical. I feel the grammaticality judgments given to these sentences in this paper correctly reflect native speaker intuitions.

- c. Mwues-ul_i nwukwu-eykey_j Chelswu-nun [Yenghi-ka t_i t_j cwuess-nunci]
 what-Acc who-Dat -Top -Nom gave-Q
 kwungkwumhaecha-nayo?
 wonder-Q
 ‘What to whom does Cheswu wonder Yenghi gave?’
 ‘What to whom is it that Chelswu wonder Yenghi gave?’ [focus]

Moon (1996: 381) and Choe (1995: 293-299) claim that wh-preposing in Korean is not simply due to syntactic scrambling or to Focus Movement, and that it must be understood as Wh-Movement, which is triggered by some morphological requirement on C.

However, if wh-preposing in Korean were to be considered Wh-Movement, then it should be expected that wh-preposing in Korean is subject to the wh-island condition. But, this is not the case, as is evidenced by the data in (22). The wh-phrases have extracted from the embedded wh-question clauses in (22a-c), but they are considered grammatical.

Therefore, all these arguments against Moon’s and Choe’s analyses are taken to suggest that wh-preposing in Korean is not, by nature, syntactic Wh-Movement at all.

3. 2. 3 *The Focus Analysis of the Scrambled Wh-phrases in Korean*

I claim in this connection that wh-preposing in Korean is scrambling or Focus Movement of a wh-phrase to the Spec FocP in overt syntax, and that the focus effect in Korean is driven by scrambling. My claim is consistent with the focus effect observed in the above sentences (19b-d), (20b, d, e), (21b), and (22a-c), and is also consistent with the fact that wh-preposing in Korean is not subject to the wh-island condition, which is characteristic of Focus Movement.

To accommodate all these movements in Korean under Minimalist assumptions, I propose that the scrambled wh-phrase raises to the Spec FocP in overt syntax, where the focus feature of the wh-phrase enters into a checking relation with that of the functional head Focus to check off the focus feature of the head Foc. As the focus feature of the wh-

phrase is interpretable, it is not deleted in a checking process. As for the in-situ wh-phrase in Korean, the Numeration for a sentence where the in-situ wh-phrase occurs does not involve the head Focus nor the focus feature for the wh-in-situ. Thus, the in-situ wh-phrase has no motivation to move whatsoever, and it just stays in-situ. Thus, it is assumed that the focus feature is strong and that the focus feature of a wh-phrase is interpretable.

Let's go back to the data in (19) and check what kind of movement there is in (19). The Numerations for (19a) and (19c) do not involve the functional head Focus, and the wh-phrases remain in-situ. The Numerations for (19b) and (19d) include the functional head Focus, and the wh-phrases have a focus feature selected in transition from Lexicon to the Numeration. Accordingly, the wh-phrases raise overtly to the Spec FocP to check off the focus feature of the head Foc.

The same kind of explanation extends to the sentences in (20). The problematic cases for Moon's proposal are handled under the current approach along the following line. The Numerations for (20b), (20d), and (20e) involve the functional heads Focs, and the scrambled wh-phrase and DPs have the focus feature selected in transition from Lexicon to the Numeration. Accordingly, the wh-phrase *wey* raises overtly to the Spec FocP to check off the focus feature of the head Foc, and likewise, the objects *Bill-eykey* and *ku chaek-ul* raise to the distinct Specs FocPs overtly to check off the focus features of the functional heads Focs.

As for the in-situ wh-phrases in (20a) and (20c), the Numerations for those sentences do not involve the functional head Focus, nor have the wh-phrases-in-situ had the focus feature selected in the Numerations. Thus, the in-situ wh-phrases have no motivation to move.

The same kind of explanation extends to the sentences (22a-c) where the wh-phrase raises across the embedded CP to the matrix FocP. The Numerations for the sentences (22a-b) have the focus feature available only to the object wh-phrase in the embedded clause, which means no other lexical DPs can count as a closer candidate for the movement target, the matrix Spec FocP, and the object wh-phrase raises to the matrix Spec FocP overtly in conformity with Minimality requirements for movement. In (22c), both the direct and indirect object wh-phrases have the focus feature selected in the Numeration, and these wh-phrases raise to the distinct Specs FocPs in overt syntax to

check off the focus features of the heads Focs. I assume that at LF, semantic interpretation principles apply to the scrambled wh-phrase and its sister constituent to yield a focus reading.

Therefore, the Focus Movement analysis of the preposed wh-phrases in Korean is taken to characterize correctly the semantic aspect that the scrambled wh-phrase becomes the focus of a sentence it occurs, and the syntactic fact that wh-preposing in Korean is not subject to the wh-island condition.

Let us consider the following sentences.

- (23) a. John-i nwukwu-lul coaha-ni?
 Nom who-Acc likes-Q
 ‘Who does John like?’
- b. nwuku-lul_i John-i t_i coaha-ni?
 who-Acc -Nom like-Q
 ‘Who is it that Tom likes?’ [focus]
- c. John-i NWUKWU-LUL coaha-ni?
 Nom who-Acc likes-Q
 ‘Who is it that John likes?’ [focus]

I assume that the focused wh-in-situ in (23c) has the same kind of interpretation that the scrambled wh-phrase in (23b) has, and thus claim along the line given for (14-18) above that the focused in-situ wh-phrase in Korean select an empty operator (Op) with a focus feature in transition from Lexicon to the Numeration, and that the strong focus feature of the head Foc is checked by raising of the empty focus operator to the Spec FocP in overt syntax, whose result is shown in (24).

- (24) [_{FocP} Op_[NWUKWU-LUL] [_{IP} John-i NWUKWU-LUL coaha-ni]]

Then semantic interpretation principles are assumed to apply to this kind of construction at LF to render a focused interpretation of a scrambled phrase.

I claim that the [+wh] feature is weak in Korean. The wh-phrase with the focus feature raises overtly to the Spec FocP to check off the focus feature of the head Foc. As the [+wh] feature of C is weak in Korean, checking of the [+wh] feature is procrastinated until at LF where the [+wh] feature of the wh-phrase in the Spec FocP raises to the Spec CP in an A'-to-A' movement to enter into a checking relation with the [+wh] feature of C, and checks off the [+wh] feature of C. The [+wh] feature of a wh-phrase is not deleted, being interpretable. The explanation along a similar line can extend to the checking of the [+wh] feature of a wh-in-situ in Korean. The [+wh] feature of the wh-in-situ raises covertly to the Spec CP to check off the weak [+wh] feature of C. Thus a feature movement occurs at LF in the case of Wh-Movement in Korean.

As for the focused in-situ wh-phrase, a null focus operator raises to the Spec FocP in overt syntax to check the strong focus feature of Foc, and at LF, the [+wh] feature of the wh-phrase raises to the Spec CP to check the [+wh] feature of C⁹.

Therefore, all the movements that have occurred in the sentences presented so far are now handled properly under the current proposal.

Let us consider the following sentences.

(25) a. John-un_i t_i Mary-lul coaha-nta. [topic]

-Top -Acc like-dec

'Speaking of John (or As for John), he likes Mary.'

b. Mwues-ul_i nwukwu-eykey_j John-i t_i t_j cwuess-ni? [focus]

what-Acc who-Dat -Nom gave-Q

'What to whom was it that John gave?'

(26) a. Mary_i, John likes t_i. [topic]

b. John introduced MARY to BILL. [focus]

'It was Mary to Bill that John introduced.'

⁹ We could give a straightforward account of the nature of wh-phrases in Korean and Japanese in the *Minimalist Inquires* framework. Under that framework, we could informally assume that the scrambled wh-phrase raises to the Spec FocP in overt syntax to be licensed as focus and get a focus reading at LF, being subject to the relevant semantic interpretation principles before it moves to the Spec CP. As for the focused wh-in-situ, we could assume that it raises to the Spec FocP at LF and gets a focused interpretation before it moves to the Spec CP. In that framework, feature checking/Agree is largely dissociated from movement, and movement is supposed to satisfy (LF)-properties of the phrase the XP moves to.

- (27) a. John-wa_i t_i hasit-te iru. [topic]
 -Top run PROG
 ‘Speaking of John, he is running.’
- b. Mary-o_i Bill-ni_j John-ga t_i t_j sookai sita. [focus]
 -Acc -Dat -Nom introduced
 ‘It was Mary to Bill that John introduced.’
- (28) a. Il libro, a Gianni, domani, glielo daro \exists senz’altro [topic]
 ‘The book, to John, tomorrow, I’ll give it to him for sure.’
- b. NESSUNO ho visto t [focus]
 ‘NOONE I saw.’

I assume that the occurrences of the heads Topic and Focus vary, depending on individual languages, but that in many languages, the Topic head is one in a clause, while there are as many Focuses as are consistent with the arguments and adjuncts in a clause, as is shown by such languages as Korean, English, and Japanese. On the other hand, Italian is assumed to take a unique structural focus position and as many topics as are consistent with the arguments and adjuncts in a clause, as is claimed by Rizzi (1999).

Overall, it follows from the discussions so far that the DP or wh-phrase with a focus feature in Korean is scrambled to the Spec FocP in overt syntax while the empty focus operator of the focused in-situ DP or wh-phrase is scrambled to the Spec FocP in overt syntax, and that the focus effect in Korean is achieved by scrambling. Wh-Movement in Korean is assumed to take place at LF as feature movement.

4.0 Conclusion

Korean shows two kinds of structures for the DPs and the wh-phrases. One kind of structure shows the movement of the DPs and the wh-phrases, and the other kind the in-situ status of the DPs and the wh-phrases. In the P & P framework, an optionality account was given of these moved and in-situ phrases. Optionality in grammatical operations, however, is no more tenable under Minimalist assumptions.

In this paper, I have made an analysis of these moved vs. in-situ phrases consistent with the Minimalist spirit. In section 2, I have addressed the core concepts of local economy put forth by Collins (1997). In sections 3.1.1 and 3.2.1-2, I have critically reviewed the previous analyses of the moved phrases in Korean, and have shown them untenable in the Minimalist framework. I have also shown Moon's analysis incomplete with regard to the nature of the moved non-wh DPs in Korean.

Then, I have claimed that the fronted DP/ wh-phrase in Korean raises overtly to the Spec FocP to check off the focus feature of the functional head Foc. I have made an analysis of the moved vs. in-situ DPs and wh-phrases in terms of different Numerations which is consistent with the Minimalist spirit.

In conclusion, the proposal made in this paper is founded on empirically as well as theoretically firm grounds. Korean data show the existence of multiple FocPs and a single TopP in a clause posited under the proposal made in this paper, which is applicable to Japanese. Furthermore, several languages show the existence of Topic and Focus constructions. Under the proposal made in this paper, semantic properties of the fronted phrases in Korean are correctly characterized in that the scrambled DPs/ wh-phrases in Korean get focalized in the sentences in which they occur.

Overall, preposing of a DP or a wh-phrase in Korean is in fact Focus Movement of a DP or a wh-phrase in overt syntax, and Wh-Movement in Korean takes place at LF as feature movement. Therefore, the focus effect is assumed to be driven by scrambling of a DP or a wh-phrase in Korean.

REFERENCES

- Carlson, Gregory N. (1977) *Reference to Kinds in English*. PhD diss., Umass.
- Choe, H.-S. (1995) "Focus and Topic Movement in Korean and Licensing," in K. E. Kiss, ed., *Discourse Configurational Languages*. New York, Oxford University Press.
- Chomsky, N. (1991) "Some Notes on Economy of Derivation and Representation," in R. Freidin, ed., *Principles and Parameters in Comparative Grammar*. MIT Press.
- _____. (1995) *The Minimalist Program*. MIT Press, Cambridge, Massachusetts.
- _____. (1998) "Minimalist Inquiries: the framework," *MIT Working Papers in Linguistics*.
- Collins, C. (1997) *Local Economy*. Linguistic Inquiry Monograph 29, MIT Press, Cambridge, Massachusetts.
- Epstein, S. (1992) "Derivational Constraints on A'-Chain Formation," *Linguistic Inquiry* 23: 235-260.
- Kim, K.-S. (1990) "Where do the contrastive and focus readings come from?," in H. Hoji, ed., *Japanese/Korean Linguistics*, 395-412.
- Kitahara, H. (1992) "Checking Theory and Scope Interpretation without Quantifier Raising," in *Harvard Working Papers in Linguistics* 1.
- Kuno, S. (1973) *The Structure of the Japanese Language*. Cambridge, MA: MIT Press.
- Kuroda, S.-Y. (1965) *Generative Grammatical Studies in the Japanese Language*. PhD diss. MIT
- Moon, G.-S. (1996) "Syntactic Wh-movement in Korean: Movement of Long-Distance Scrambled Wh-phrases," in H.-D. Ahn et al., eds., *Morphosyntax in Generative Grammar*. Hankuk Publishing Co
- Ogihara, T. (1987) "Obligatory Focus in Japanese and Type-Shifting Principles," in M. Crowhurst, ed., *WCCFL* 6, 213-227, Stanford Linguistics Association.
- Rizzi, L. (1997) "The Fine Structure of the Left Periphery," in L. Haegeman, ed., *Elements of Grammar*. Kluwer.
- Watanabe, A. (1992) "Subjacency and S-structure Movement of WH-IN-SITU." *Journal of East Asian Linguistics* 1: 255-291.
- Yang, D.-W. (1989) *The Basis of the Government-Binding Theory*. Shin-Ah Sa, Seoul.

Laryngeal Neutralisation: The Athapaskan Picture¹

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1 Introduction

Steriade (1997) proposes a cue-based approach to the licensing of laryngeal features. Laryngeal features are typically neutralised in positions where the cues to the relevant contrast are not available, or where additional articulatory measures would be necessary. Laryngeal contrasts are permitted in positions where the scale of perceptibility of these contrasts is high. Howe (1998) has shown that Steriade's analysis is not adequate for characterising certain cases of laryngealisation in Wakashan languages. In the South Wakashan language Nuuchahnulth, glottalised sonorants are strictly prevocalic, and in the North Wakashan language Oowekyala, are preglottalised word-initially but postglottalised word-finally (Howe 1998). Steriade's cue-based approach predicts just the opposite. The aim of this paper is to test glottalisation evidence from the Athapaskan language family against Steriade's hypothesis.

Proto-Athapaskan (PA) is posited to have had a three-way laryngeal distinction between voiceless unaspirated (plain) stops, voiceless aspirated stops and glottalised stops (Leer 1979). These distinctions are maintained in the daughter languages stem-initially. However, stem-final contrasts have been reduced in most languages. PA is posited to have had a two-way contrast between plain and glottalised consonants stem-finally (Leer 1979). In the daughter languages, this two-way laryngeal contrast may be maintained (in languages such as Hupa (Golla 1996)), or the laryngeal distinctions may be neutralised (in languages such as Koyukon (Rice 1994)). In some languages, such as Chipewyan², a diachronic process of spirantisation has occurred. All series of stops in Chipewyan have undergone spirantisation. The spirantisation process is relevant to the discussion of laryngeal neutralisation because while spirantisation involves loss of the

¹ The work presented here was part of my MA thesis (Gessner 1999). Unless otherwise cited, all Chipewyan data was collected through fieldwork with native speaker Max Deranger, to whom I am extremely grateful. I would also like to thank members of my thesis committee, Pat Shaw, Doug Pulleyblank and Henry Davis, for comments and suggestions.

² It should be pointed out that the conventional name "Chipewyan" is considered offensive by some speakers, who prefer the name "Dene". To avoid confusion, however, linguists continue to use "Chipewyan", because there are speakers of *other* Northern Athapaskan languages who refer to their own language as "Dene".

manner feature [stop], it also entails loss of the stop's laryngeal features [spread glottis] or [constricted glottis].

Section 2 will review Steriade's (1997) Licensing by Cue hypothesis in some detail. Section 3 will present data illustrating the glottalisation patterns in Athapaskan languages. Section 4 will present an Optimality Theory (McCarthy and Prince 1993, 1994, Steriade 1997) analysis of the languages which maintain laryngeal distinctions, and of the languages which neutralise laryngeal distinctions stem-finally. Section 5 will present the case of Chipewyan where stem-final laryngeal contrasts are neither preserved nor neutralised; stem-final stop consonants are spirantised. Section 6 will conclude.

2 The Licensing by Cue hypothesis (Steriade 1997)

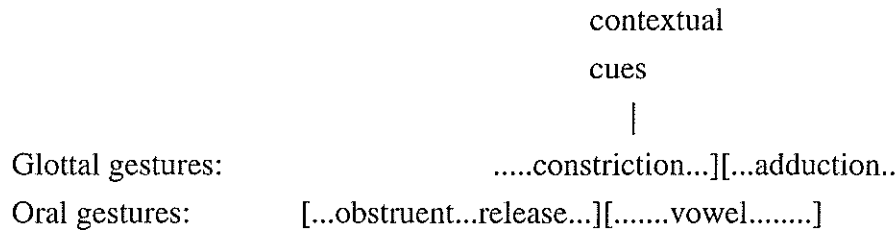
Steriade proposes a cue-based approach to the licensing of laryngeal features. Differing from previous prosodically-based theories that have argued for the licensing of laryngeal features based on syllable position, this hypothesis bases licensing on position of best perceptibility. Laryngeal features are typically neutralised in positions where the cues to the relevant contrast are not available, or where additional articulatory measures would be necessary. Laryngeal contrasts are permitted in positions where the scale of perceptibility of these contrasts is high. Steriade examines a wide variety of languages which provide evidence for this hypothesis.

Regarding glottalisation, Steriade notes that there are two classes affected: sonorants and obstruents. A classification relevant for patterns of glottalisation often involves the sonorant/obstruent distinction. The timing of the glottal closure with respect to the edges of the oral constriction tends to be different for the two classes. "The laryngeal constriction is timed to the onset of the oral closure in sonorants, and to its release in obstruents" (Steriade 1997:77). This may be illustrated as shown in (1) and (2). Square brackets indicate onset and offset of gesture.

- (1) Preferred timing for oral and glottal constriction in glottalised sonorants (Steriade 1997:77)

	contextual cues	internal cues
Glottal gestures:		
Oral gestures:	[.....vowel.....]	[...consonantal sonorant....]

- (2) Preferred timing for oral and glottal constriction in glottalised stops
(Steriade 1997:78)



The hypothesis of Licensing by Cue predicts that the glottalised sonorants will be optimally realised when there is a preceding vowel or sonorant (left-hand cue). Glottalised stops will be optimally realised when followed by a vowel or sonorant (right-hand cue) as shown in the scales in (3) and (4).

- (3) Perceptibility scale for glottalised sonorants (Steriade 1997:81)

[+son]___ > #___, [-son] ___

- (4) Perceptibility scale for glottalised obstruents (Steriade 1997:81)

___[+son] > ___#, ___[-son]

Sonorants are more likely to neutralise in the absence of a preceding vowel or sonorant, whereas obstruents will be most likely to neutralise in the absence of a following vowel or sonorant.

Steriade suggests that the two classes are also differentiated by distinct perceptual realisations: sonorants or preglottalised consonants have "creaky voicing" whereas stops or post-glottalised consonants have explosive or ejective release. She postulates different features for these effects; therefore, glottalised sonorants and glottalised obstruents do not form a natural class.

Different ranking of the perceptibility constraints with faithfulness constraints can produce different grammars. As an example, the constraint ranking for Yokuts is shown in (5). In Yokuts, glottalised sonorants are disallowed after consonants and word-initially, i.e. in environments where context clues are lacking. Ejective stops, however, are allowed in all environments.

- (5) Constraint ranking for Yokuts (Steriade 1997:82)
(Constraints are ranked from top to bottom.)

<u>*creak constraints</u>	<u>faithfulness conditions</u>	<u>*ejection constraints³</u>
	Preserve [ejection]	
*creak/ {[-son], #}____		*ejection/____{[-son], #}
	Preserve [creak]	
*creak/ V____		*ejection/____V

Preserve [ejection] is undominated which ensures that all underlying ejectives are preserved. Preserve [creak] only outranks the bottom creak condition, so the only glottalised sonorants that will surface are those in a post-vocalic environment.

Having presented the theoretical background, we can turn to the Athapaskan data.

3 Data: glottalisation patterns in Athapaskan

Athapaskan languages do not include glottalised sonorants in their inventory, therefore I will focus on the analysis of glottalised stops. Note that in the Athapaskan literature “stem” refers to root plus suffix (if any), and uninflected stems (i.e. stems without any prefixation) are monosyllabic. The Athapaskan stem normally takes the form CV(C) (Krauss and Golla 1996). Therefore, stem-initial may also be considered “onset” and stem-final considered “coda”. Furthermore, phonological processes that target the stem generally only affect continuants, so the phonological environment which precedes the stem does not have any impact on the possibilities of stem realisation of stops. First I will present the stem-initial distribution.

3.1 *Stem-initial distribution*

All modern Athapaskan languages have maintained the three-way distinction between plain, aspirated and glottalised stops in stem-initial position. This is illustrated with examples from Chipewyan, shown in (6). In the examples given, the first consonant of each item is the stem-initial consonant. Stems preceded by a hyphen indicate that

³ I will use the feature [CG] or [constricted glottis] in place of Steriade’s term “ejection”.

prefixation is required. Note that while most of the examples shown are nouns, the same distributional patterns are attested for verbs.

(6) Stem-initial contrasts

Series	Plain	Aspirated	Glottalised
Dental	-dɛl 'blood'	-tá 'father'	-t'áʒé 'back'
Interdental	-dǒér 'it rattles'	tθe 'stone'	tθ'é 'sinew'
	(Li 1933:140)		
Alveolar	dzé 'gum'	tsá 'excrement'	ts'a 'hat'
Lateral	dlúne 'mouse'	tłis 'grease'	tł'ís 'paper'
Palatal	dʒã 'here'	tʃã 'rain'	tʃ'is 'mitts'
Velar	gu 'insect'	kūn 'fire'	k'oθ 'clouds'

3.2 *Stem-final distribution: retention of plain and glottalised stops*

Of the twenty-three Northern Athapaskan languages, stem-final glottalisation has been lost in all languages except Kolchan (Upper Kuskokwim), Tanaina, Ahtna, Tagish, Tsetsaut and Sarcee (Krauss and Golla 1981). To my knowledge, stem-final glottalisation has also been lost in the Apachean subgroup, but has been retained in the Pacific Coast subgroup.

Hupa, the only surviving language of the Pacific Coast subgroup (Golla 1977), is representative of the most conservative type of Athapaskan language, that which maintains both plain and glottalised stops stem-finally. Examples are shown in (7), all cited from Golla (1996).

(7) Stem-final contrasts:

Series	Plain	Glottalised
Dental-	[d] ʔid 'smoke'	[tʰ] mimit' 'my belly'
alveolar	[dz] k'iwididz 'string/rope'	[tsʰ] tits' 'cane'
Alveopalatal	[dʒ] tʃʷidʒ 'firewood'	[tʃʰ] ditʃ' 'valley quail'
Velar	[gʲ] xo:wiligʲ 'story'	[kʲʰ] dinkʲ' 'four'
Back velar	[ŋ] yinaŋ 'upstream'	[qʰ] ʔo:qʰ 'salmon, fish'
Lateral	[dl] <i>not in inventory</i>	[tʃʰ] tʃʰitehsde:tʃʰ 'they went off'

3.3 Stem-final neutralisation

Some Athapaskan languages neutralise the distinction between plain and glottalised consonants stem-finally, with plain stops surfacing. A representative example is Koyukon, with examples shown in (8).

(8) Stem-final neutralisation

Proto-Athapaskan form	Koyukon form	Gloss
*nəqʰ	nəq (perf. stem) ⁴	'swallow' (Leer 1979:54)
*ʔa:tʃʰ	ʔots (perf. stem)	'few go' (Leer 1979:56)
*ʔa:tʃʰ	ʔotʃʰ (perf. stem)	'chew' (Leer 1979:58)

The third pattern, stem-final spirantisation, where both laryngeal and manner features are neutralised, will be presented in section 5. The next section will present an Optimality Theory analysis of the different patterns of glottalisation seen to this point.

⁴ Leer (1979) notes that while in many orthographies final non-glottalised stops are written as voiceless unaspirated (plain) stops, he has chosen to follow the practice of writing voiceless aspirated stops. This is because of citation of data from languages such as Tanacross and Ingalik which have light:heavy final pairs; where the stem ends in an obstruent, the light final is voiceless and the heavy final is voiced.

4 Analysis

4.1 Previous analysis

Rice (1994) presents the problem of laryngeal neutralisation. As we have seen, some Athapaskan languages with syllable-final stops reflect patterns of distribution of Proto-Athapaskan, while many others are more restrictive in terms of which stops, if any, are allowed syllable-finally. This distribution is shown in (9).

(9) Distribution of stops (Rice 1994:112)

	<u>stem-initial</u>	<u>stem-final</u>
plain	√	√
aspirated	√	
glottalised	√	(√)

Rice (1994) proposes the Dual Mechanism Hypothesis to allow for the differences in distribution of stops. The feature geometry showing plain and glottalised stops based on the Dual Mechanism Hypothesis, is shown in (10).

(10) Dual mechanism hypothesis (Rice 1994:115):

Plain stop	Glottalised Stop
ROOT	ROOT
	/ \
[stop]	[stop] Laryngeal
	[CG]

Laryngeal neutralisation involves delinking of the laryngeal node, with the resulting phoneme a plain stop.

4.2 Optimality Theory analysis

Steriade (1997) argues that laryngeal constriction is timed to the release of oral closure in obstruents. Therefore, the hypothesis of Licensing by Cue predicts that the glottalised stops will be optimally realised when followed by a vowel or sonorant (right-hand cue) as shown in the scale in (11), repeated from section 2.

(11) Perceptibility scale for glottalised obstruents (Steriade 1997:81)

___[+son] > ___#, ___[-son]

Obstruents will be most likely to neutralise in the absence of a following vowel or sonorant. This yields the following constraints:

(12) *[CG]/___{[-son], #}: [CG] is dispreferred before a non-sonorant or word-finally.

(13) *[CG]/___V: [CG] is dispreferred before a vowel.

The Licensing by Cue hypothesis suggests that the ranking of constraint (12) over constraint (13) is universal. These perceptibility constraints interact with a faithfulness constraint.

(14) Preserve [CG]: Underlying [CG] must be preserved as such.

The first tableau shows the cases of stem-initial obstruents where glottalisation is preserved.

Tableau 1: Stem-initial ejection
Chipewyan t'έθ 'coal' (cf. PA *t'ex^w? 'charcoal' (Krauss 1964:127))

t'έθ	Preserve [CG]	*[CG]/___V
a. dέθ	*!	
b. tέθ	*!	
✓c. t'έθ		*

Ranking of the faithfulness constraint above the cue constraint ensures that underlying ejectives i.e. consonants specified for the feature [CG] in the input surface in the output, as in the optimal candidate (c).

The next tableau shows the case of laryngeal neutralisation illustrated by Koyukon.

Tableau 2: Stem-final neutralisation
Koyukon -nəq (perf. stem) ‘swallow’ (cf. PA *-nəq’) (Leer 1979:54)

-nəq’	*[CG]/___{[-son], #}	Preserve [CG]	*[CG]/___V
√a. -nəq		*	
b. -nəq’	*!		

As can be seen from tableau 2, ranking of the second cue constraint above the faithfulness constraint achieves the desired result: laryngeal distinctions are neutralised word-finally, in an environment where the cues for realising glottalisation are not optimal.

Tableau 3 illustrates the case exemplified by Hupa, where plain and glottalised stops are retained stem-finally. This case poses a challenge for Steriade’s (1997) hypothesis; glottalisation should be dispreferred when the appropriate cues are missing. In this case, glottalisation should be dispreferred word-finally because there is not following vowel to optimise perception. However, Steriade states (1997:78): “This is not to say that ...a following vowel is indispensable for [t’]: but the contexts of optimal perceptibility will clearly be different for the two segment types.” So, while word-final glottalisation is not optimal for perceptibility, is still possible. This is achieved by making the faithfulness constraint the most highly-ranked.

Tableau 3: Stem-final ejection
Hupa ʌimit’ ‘my belly’ (Golla 1996:367)
(cf. PA *-wəd? ‘belly’ (Krauss 1964:126))

ʌimit’	Preserve [CG]	*[CG]/___{[-son], #}	*[CG]/___V
a. ʌimid	*!		
b. ʌimit	*!		
√c. ʌimit’		*	

As shown in tableau 3, the grammar for Hupa has the faithfulness constraint ranked the highest, ensuring that any underlying glottalised consonants are preserved whether stem-initially or stem-finally. The following section will present the case of spirantisation, as exemplified by Chipewyan.

5 Spirantisation

5.1 Background

Leer (1979) has hypothesised that a spirantisation process developed during the transition from Pre-Proto-Athapaskan to Proto-Athapaskan which operated on root-final stops, changing them to fricatives. There were two specific environments for root-final spirantisation: (i) when followed by an obstruent suffix, and (ii) in verb stem-final (i.e. word-final) position where the stem vowel was full. In Chipewyan and several other Athapaskan languages, spirantisation has occurred to a much greater degree. In Chipewyan for example, syllable-final consonants are limited to the fricatives and sonorants shown in (15).

- (15) Syllable-final/coda consonants
- [θ] tʃéθ ‘duck’
 - [ð] xəð ‘boil’ (Li 1933:134)
 - [s] sas ‘bear’
 - [z] ʃéz ‘hiccough’ (Li 1933:146)
 - [ʈ] deʈ ‘crane’ (Li 1933:129)
 - [l] dɛl ‘blood’
 - [ʃ] náteʃ ‘dream/vision’
 - [x] xax ‘playing cards’
 - [ʏ] tʃ’oʏ ‘porcupine quill’ (Li 1933:149)
 - [h] gah ‘rabbit’
 - [n] dzɛn ‘muskrat/rat’
 - [r] bər ‘meat’

Stops (with the exception of glottal stop) in word-final position in Proto-Athapaskan developed into fricatives or sonorants.⁵ Examples are shown in (16).

(16)	Proto-Athapaskan	Chipewyan	Gloss
	*təd	tər	‘smoke’ (Krauss 1978:Table 4)
	*dlaxt’	dlar	‘algae, moss’ (Krauss 1978:Table 3)
	*xen’ts’	ʃiθ	‘wart’ (Krauss 1978:Table 7)
	*tʃi:tʃ’	tsiʃ	‘scab’ (Krauss 1978:Table 3)
	*ts’a:tʃ’	tʃ’al	‘cradle’ (Krauss 1978:Table 3)
	*-ʔa:tʃ’	-ʔál (perf. stem) -ʔáʃ (imp. stem)	‘chew’ (Leer 1979:58) ‘chew’ (Li 1933:126)
	*tədʒ	téz	‘flour’ (Krauss 1978:Table 6)
	*-ʔa:tʃ’	-ʔaz (perf. stem) -ʔás (imp. stem)	‘few go’ (Leer 1979:56) ‘two persons go’ (Li 1933:126)
	*ʃe:q’	sey	‘spit’ (Krauss 1978:Table 3)
	*-nəq’	-náy (perf. stem)	‘swallow’ (Leer 1979:54)
	*-qeʔ	-ké	‘foot’ (Krauss 1978:Table 5a)

5.2 Analysis

The constraints presented so far are not adequate to account for the spirantisation cases, as shown in tableau 4. Stem-final glottalisation can be prevented by the appropriate ranking of Preserve [CG], but the desired candidate with the stem-final fricative is no better than the ones where the stem-final consonant has been neutralised.

Tableau 4: Spirantisation
Chipewyan tsiʃ ‘scab’ (cf. PA *tʃi:tʃ’) (Krauss 1978)

tsiʃ’	*[CG]/__[-son], #}	Preserve [CG]	*[CG]/__V
√a. tsidl		*	
√b. tsiʃ		*	
c. tsiʃ’	*!		
√d. tsiʃ		*	

⁵ Stem-final glottal stop developed into high tone on the preceding vowel in Chipewyan (Krauss 1978, Leer 1979).

While Steriade's (1997) cue-based approach can account for neutralisation of laryngeal features, it does not address cases where manner features are neutralised. I do not know of any research that has shown whether certain cues are relevant for the realisation of particular manner features. Steriade's analysis has focused exclusively on phonetic cues and has specifically argued that syllable structure is not relevant. However, the post-vocalic spirantisation exhibited in Chipewyan seems to suggest that constraints making reference to syllable structure would best explain the process.

Cross-linguistically, spirantisation most typically occurs in a postvocalic context (Kenstowicz 1994:35). For example, in Tiberian Hebrew, oral stops (except for geminates) spirantise postvocally (McCarthy 1981). And, in Dominican Island Carib, an Arawakan language, aspirated /p/ and /k/ spirantise to /f/ and /x/, especially following a loud stressed vowel (Taylor 1978). Nisqa'a reduplication provides a third example (Shaw 1987, 1994).

Based on the cross-linguistic evidence for spirantisation to occur post-vocally, I propose that a constraint expressing the limitation of codas to continuants is justified for Chipewyan. This condition on codas⁶ can be stated as follows:

(17) CODA-COND: *[stop]/___]_σ : [stop] is not licensed in coda position.⁷

Following Rice's (1994) Dual Mechanism Hypothesis, the three types of stops are the only phonemes marked underlyingly for [stop]. These phonemes never occur in coda position; this constraint will ensure that is the case.

The interaction of these constraints is shown in tableau 5.

⁶ For further reference on constraints on codas, see McCarthy and Prince (1994) and see Shaw (1994, 1999) for use of this particular constraint.

⁷ I am using the manner feature [stop] rather than [-cont] but they may be considered to be equivalent.

Tableau 5: Spirantisation (revised)
 Chipewyan *tsitʰ* ‘scab’ (cf. PA **tʃi:tʰ*) (Krauss 1978)

<i>tsitʰ</i>	CODA-COND: *[stop]/___]σ	*[CG]/ ___{[-son], #}	Preserve [CG]	*[CG]/___ V
a. <i>tsidl</i>	*!		*	
b. <i>tsitʰ</i>	*!		*	
c. <i>tsitʰʰ</i>	*!	*		
d. <i>tsitʰʰ</i>		*!		
√e. <i>tsitʰ</i>			*	

The coda condition constraint succeeds in eliminating the first three candidates. Candidate (d), with syllable-final glottalised fricative, is eliminated by the highest-ranked cue constraint. Note that I did not include candidates with syllable-final sonorants; these are possible candidates but additional faithfulness constraints requiring faithfulness to manner of articulation would prevent their emergence as optimal.

6 Conclusion

We have seen that while Proto-Athapaskan was posited to have had a three-way laryngeal distinction between voiceless unaspirated stops, voiceless aspirated stops and glottalised stops stem-initially, and a two-way contrast between plain and glottalised stops stem-finally, three different scenarios play out in the daughter languages as summarised in (18):

(18)	DAUGHTER LANGUAGES	STEM-INITIALLY	STEM-FINALLY
	1) laryngeal contrasts maintained	– all languages	– Hupa
	2) laryngeal contrasts neutralised		– Koyukon
	3) laryngeal contrasts neutralised; manner neutralised (spirantisation)		– Chipewyan

Some of the glottalisation evidence from Athapaskan supports Steriade’s (1997) analysis. Stem-initially, glottalised stops are retained, as exemplified by Chipewyan. This result is predicted from Steriade’s hypothesis: optimal identification of

glottalisation contrasts is dependent on the right-hand context such as a following vowel. Conversely, identification of glottalisation is not optimal when the right-hand context is not a vowel, i.e. the end of the word. This is shown by evidence of laryngeal neutralisation in Koyukon. Evidence from Hupa, however, differs. In Hupa, glottalisation contrasts are maintained word-finally; since there is no following vowel, this is not the optimal context for retention of glottalisation. While this case is less common than the previous ones, Steriade's hypothesis can accommodate this through the relative ranking of constraints; the faithfulness condition Preserve [CG] is undominated, and therefore ranked above the cue constraints.

In several Athapaskan languages including Chipewyan, no stops are maintained in syllable-final condition; a process of spirantisation has occurred. Spirantisation involves neutralisation of manner as well as laryngeal features. Steriade's analysis of laryngeal neutralization contexts does not address cases where manner is neutralised. Spirantisation in Chipewyan can be accounted for within Optimality Theory by resorting to a syllable-sensitive coda condition banning stops in syllable-final position.

References

- Gessner, Suzanne. 1999. Laryngeal processes in Chipewyan and other Athapaskan languages. MA thesis, University of British Columbia.
- Golla, Victor. 1977. A note on Hupa verb stems. *International Journal of American Linguistics* 43: 355-358.
- Golla, Victor. 1996. Sketch of Hupa, an Athapaskan language. In I. Goddard (ed.) *Handbook of North American Indians* V. 17. Washington: Smithsonian Institution, 364-389.
- Howe, Darin. 1998. Markedness-as-faithfulness in the interaction of [constricted glottis] and [sonorant]. Ms., University of British Columbia.
- Kenstowicz, Michael. 1994. *Phonology in Generative Grammar*. Cambridge: Blackwell Publishers Inc.
- Krauss, Michael. 1964. Proto-Athapaskan-Eyak and the problem of Na-Dene: the phonology. *International Journal of American Linguistics* 30: 118-131.
- Krauss, Michael. 1978. Athapaskan tone. Ms., Alaska Native Language Center.
- Krauss, Michael and Victor Golla. 1981. Northern Athapaskan languages. In J. Helm (ed.) *Handbook of North American Indians*. V. 6. Washington: Smithsonian Institution, 67-85.

- Leer, Jeff. 1979. *Proto-Athapaskan Verb Stem Variation, Part One: Phonology*. Fairbanks: Alaska Native Language Center.
- Li, Fang-Kuei. 1933. A list of Chipewyan stems. *International Journal of American Linguistics* 7: 122-151.
- Li, Fang-Kuei. 1946. Chipewyan. In H. Hoijer (ed.) *Linguistic Structures of Native America*. New York: Viking Fund, 398-423.
- McCarthy, John. 1981. The representation of consonant length in Hebrew. *Linguistic Inquiry* 12:322-327.
- McCarthy, John and Alan Prince. 1993. Generalised alignment. In Geert Booij & Jaap van Marle (eds.) *Yearbook of Morphology*. Dordrecht: Kluwer, 79-153.
- McCarthy, John and Alan Prince. 1994. The emergence of the unmarked: Optimality in Prosodic Morphology. *NELS* 24, 333-379.
- McCarthy, John and Alan Prince. 1995. Faithfulness and reduplicative identity. Papers in Optimality Theory, *University of Massachusetts Occasional Papers* 18: 249-384.
- Rice, Keren. 1994. Laryngeal features in Athapaskan languages. *Phonology* 11: 107-147.
- Shaw, Patricia. 1987. Non-conservation of melodic structure in reduplication. In A. Bosch et al. (eds.) *Papers from the Parasession on Autosegmental and Metrical Phonology*. CLS, 291-306.
- Shaw, Patricia. 1994. Minimality and markedness. Paper presented at the Workshop in Prosodic Morphology, Utrecht, Netherlands.
- Shaw, Patricia. 1999. Reduplicative non-identity in Nisqa'a. Paper presented at SSILA summer meeting, Urbana-Champaign, Illinois.
- Steriade, Donca. 1997. Phonetics in phonology: the case of laryngeal neutralisation. Ms., UCLA.
- Taylor, Douglas. 1978. Consonantal patterns in Arawakan. *International Journal of American Linguistics* 44:121-130.

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