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—Stephanie Buchner

THE OCCURRENCE OF GERUNDS IN CP CLAUSES

Marisa Schaer

INTRODUCTION

Stowell (1982), in his discussion of the structural properties of tensed clauses and infinitives versus those of gerunds, states that gerunds lack the COMP position. From this he concludes that there is no gerundive complementizer parallel to *for* or *that*. Stowell provides no structural diagrams to substantiate his claims; thus it is impossible to tell what he considers to be the scope of a gerund, such that it does not include a COMP position. I will show that gerunds do occur in complementizer phrase (CP) clauses with a COMP position, and that these clauses can contain movement. According to Chomsky's derivational theory of grammar, movement relates the sequential occurrence of a constituent in one place at one level of structure with its occurrence at a different place and level of structure (Trask, 1993).

CP CLAUSES WITH MOVEMENT

Stowell gives the following examples to show that WH-movement does not occur with gerunds (5a-c in Stowell 1982):

(1) a. The table on which you should put your coat is in the next room.
 b. The table on which to put your coat is in the next room.
 c. *The table on which putting your coat is in the next room.

I do not consider (1c) to be a satisfactory test of the properties of gerunds. I propose the following sentences as examples of gerunds in CP structures involving movement:

(2) a. The table for putting your coat on is in the next room.
 b. The pot for cooking the soup in is on the top shelf.

Granting that (2a) is cumbersome, (2b) employs the identical structure with more likely semantics.

Examination of the deep structures of (1b) and (2a) will demonstrate this argument (following Holisky, 1996):[1]

(1b) Deep structure:

spec comp

$[_S[_{NP}[_{NP}$The table$][_{CP}$ ___$_i$ 0 $[_S[_{NP}$ e $][_{InfVP}$ to put your coat on $[_{NP}$<u>which table</u> $_i$ $]]]][_{VP}$is in the next room$]]]$

(for) (you)

[1]NP=noun phrase, VP=verb phrase, InfVP=infinitive verb phrase, S=sentence, VPPresPart=present participle verb phrase.

(2a) Deep structure:

spec comp

$[_S[_{NP}[_{NP}$The table$][_{CP}$ ___$_i$ for $[_S[_{NP}$ e $][_{VPPresPart}$ putting your coat on $[_{NP}$ the table $_i]]]][_{VP}$ is in the next room.$]]]$

The theta structure position of the constituent *the table* relative to the verb *put* is the grammatical function indirect object (goal). It is in an argument position, as assigned by the verb *put* <agent, patient, goal>, and as such is eligible for movement.

CP CLAUSES WITHOUT MOVEMENT

Holisky's (1996) analysis of the gerundive as an NP with a potentially empty NP Genitive position denies Stowell's claim that "even phonetically null pronouns cannot appear in the (nonexistent) COMP of a gerund." Consider Stowell's example:

(3) a. *The city (his) visiting is Paris. (his 7c)

Contrast (3a) with:

(3) b. [The city [for e visiting in April]] is Paris.]

A gerundive can also occur as a verb in a CP clause in an S with empty NP and Aux positions:

(4) $[_S[_{NP}$ The important thing$][_{CP}$ when $[_{NP}$ e $][_{VP}$ e traveling$]][_{VP}$is to use caution$]]$
(one) (is)

CONCLUSION

In making the above points regarding gerunds in CPs, I do not refute Stowell's claim that gerunds have no internally determined tense. I have demonstrated that the COMP position does occur in gerundives; thus, any lack of tense cannot be attributed to a missing COMP position. Furthermore, the COMP position provides a landing site for constituent movement.

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VARIANCE IN THEMATIC ROLES PROJECTED BY MIDDLES: A CASE FOR FORMAL ROLE SUBCATEGORIZATION GRIDS

Carol Brouha

INTRODUCTION

The Projection Principle of Chomsky's Universal Grammar requires that thematic roles (i.e. specific semantic roles in the relations among a verb's arguments) be projected onto the syntax. Thematic roles are a significant point of contrast between middle verbs and passive verbs. Levin and Jones (1996) point out that one way Russian middle verbs and passives differ is that middles do not allow "an attendant adjunct NP in Instrumental case." Likewise in English, the absence of a *by* prepositional phrase and the elimination of the external NP are characteristics that distinguish passives from middle verbs:

(1) a. The clay was molded by the sculptor.
b. The clay molds well.

In (1)a the verb's lexical entry is:

mold, V, [____NP], <(1),2>

In (1)b, a typical middle-verb sentence, the lexical entry is:

mold, V, [____], <2>

However, there appears to be an exceptional case in English in which a middle verb has two theta roles:

(2) Left alone, the bread machine starts by itself on the hour.

start, V, [____] <(1), 2>

Notice that in (2), the sentence does not contain a redundancy by containing both "left alone" and "by itself." Semantically *by itself* does not mean "alone." This prepositional phrase means "under its own power," or "by itself as agent." Here we have a case of a middle verb with a suppressed, but not eliminated, subject.

What is it about inclusion of *itself* or its derivative, an affixed *-self*, in a middle-verb sentence that can break the middle-verb rule of not having an adjunct NP and can also make possible a varied projection of theta roles? Consider the following subcategorization:

self-clean, V, [____] <1,(2)>

(4) a. The oven self-cleans quickly.

The internal argument, somewhat absorbed by the morphology of the verb but still overt, takes the thematic role of patient and yet in its hyphenated form allows <1> to be a theme and not an agent. Because the thematic role grids projected onto the syntax by the middle verbs *start* and *self-clean* differ, middle verb subcategorizations are best expressed in argument grids without thematic consideration. As suggested by Levin and Jones (1996), an approach in which arguments are expressed as formal roles in the subcategorization grid rather than as specific thematic roles is a step towards further minimizing Universal Grammar.

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AN INVESTIGATION OF SONORITY DISPERSION IN THAI-ENGLISH INTERLANGUAGE CODAS

Namassawan Patibat and Caroline Cochran

INTRODUCTION

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

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

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

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

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

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

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

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

Table 1. Thai Consonants

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

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

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

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

Table 2. Subjects

Thai Speakers

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

English Speakers

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

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

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

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

These three data gathering instruments are presented in Appendix A.

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

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

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

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

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

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

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

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

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

The full transcriptions of the data appear in Appendix B.

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

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

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

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

RESULTS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

---

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

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

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

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

ANALYSIS

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

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

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

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

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

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

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

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

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

Table 4. Proportions of Correct Productions by Demisyllable Type

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

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

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

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

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

Table 5. Summary of Correct Productions

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

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

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

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

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

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

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

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

Table 6. Factors That Could Affect Production of Clusters

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

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

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

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

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

Table 7. Sonority Changes in Category I

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

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

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

Table 8. Sonority Changes in Category II

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

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

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

CONCLUSION

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

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

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

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

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

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Appendix A: Reading Tasks

Part I: Initial Task

IA: Story Sentences

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

Questions: True or false?

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

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

IB: Unrelated Sentences

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

Part II: Supplemental Reading Task

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

Part III: Supplemental Reading Task

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

Appendix B: Complete Transcriptions

Category IA: Both in Thai Codas

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

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

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

Category IC: Neither in Thai

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

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

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

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

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

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

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

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

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

Single Consonants: Occur in Thai only as Onsets

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

Single Consonants: Do Not Occur in Thai

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

CONSONANT HARMONY: A COMPARISON OF TWO EXPLANATIONS BASED ON UNDERSPECIFICATION THEORY

Stephanie Buchner

INTRODUCTION

As part of a program to develop a theory of phonology based on "substantive universals" rather than "formal algebra," Mohanan (1993) introduces a theory of place assimilation that reformulates the substance of underspecification into a dominance hierarchy for place of articulation. Mohanan's theory makes more extensive and specific predictions than Stoel-Gammon and Stemberger's (1994) underspecification theory of place assimilation in consonant harmony in child speech.

Stoel-Gammon and Stemberger (1994) claim that the underspecification of alveolar for place accounts for their behavior in assimilating to the place of articulation of labials and velars. They claim that "It is more natural for underspecified phonemes to assimilate to specified phonemes than the reverse." "[D]eletion of features [as would be necessary for a labial to assimilate to a velar or vice versa] is not a natural operation." (p. 67) Thus Stoel-Gammon and Stemberger predict the following biases in place assimilation (p. 68):

(1) Stoel-Gammon and Stemberger's predictions:

a. a bias for alveolars, which are unspecified for place, to assimilate to labials and velars
   i. very uncommon for labials or velars to assimilate to alveolar
b. no biases for assimilation between labials and velars because both are specified and assimilations of one to the other are equally complex operations (p. 68)

Instead of focusing only on the coronal place specification as Stoel-Gammon and Stemberger do in their examination of consonant harmony, Mohanan develops a dominance hierarchy for place based on three features. Mohanan observes that, "The substance of the statement that feature value [αF] is specified and [-αF] is unspecified is that [αF] can override [-αF], but not the reverse." (Mohanan 1993: 90) Mohanan notes that most theories of radical underspecification assume" that [+coronal], [+anterior], and [-back] are underspecified and instead proposes that the opposite values for these features, i.e., [-coronal], [-anterior], [+back], be considered dominant. (p. 91) Alveolars have none of the dominant features, velars have all three of the dominant features, and palatals and labials each have two of the dominant features.[1] This leads to the following "dominance scale" (Mohanan 91):

(2)

<u>Least dominant</u>				<u>Most dominant</u>
alveolar	<	palatal labial	<	velar

[1] Mohanan does not discuss the fact that in this scheme, the alveopalatals [ʃ] and [ʒ] have one dominant feature, [-anterior], placing them between labials and alveolars on the dominance scale. Having none of the dominant features, the affricates [tʃ] and [dʒ] are alveolars in this scheme. My decision to treat alveopalatals as alveolars is discussed below.

Mohanan views assimilation in terms of the "strength of assimilatory force," which is greatest when the trigger is most dominant and the undergoer is least dominant. Although this theory is not completely incompatible with Stoel-Gammon and Stemberger's assertion that alveolars are the most likely undergoers of assimilation, it makes further and more specific predictions than the Stoel-Gammon and Stemberger theory (p. 91).

(3) Mohanan's predictions:

a. if labials, palatals, or velars undergo place assimilation, then alveolars will also undergo assimilation
b. if velars undergo place assimilation, then labials and palatals will also undergo place assimilation
c. if alveolars trigger place assimilation, then labials, palatals, and velars will also trigger place assimilation
d. if palatals or labials trigger place assimilation, then velars will also trigger place assimilation
e. no bias for assimilation between labials and palatals

Note that the substance of prediction 3a is similar to Stoel-Gammon and Stemberger's prediction 1a: alveolars will be the most common undergoers. However, where Stoel-Gammon and Stemberger assert only the general likelihood of alveolar as undergoers and unlikelihood of alveolar as triggers, the dominance hierarchy goes further to also assert the likelihood of velars as triggers and an implicational hierarchy for undergoers and triggers. Further, where Stoel-Gammon and Stemberger predict no biases in assimilation between labials and velars, the dominance hierarchy implies a bias for labials to assimilate to velars, and predicts that there would instead be no bias between labials and palatals.

Direction of Assimilation. Stoel-Gammon and Stemberger do not explicitly address the issue of direction of assimilation, progressive or regressive. Their theory implies that either direction is equally likely; a segment underspecified for place will tend to assimilate to the place of a specified segment. Stoel-Gammon and Stemberger's view has nothing to say about which direction assimilation would occur in among labials and velars.

Mohanan's overall program is to identify UG principles and parameters in phonology, and his theory of place assimilation focuses on the place assimilation observed between adjacent consonants in many languages. Mohanan theorizes that these assimilation processes are instantiations of a UG principle, and that individual languages specify the domain in which the principle holds (p. 79):

(4) In the sequence [+stop][+cons], the two consonants must share a single place node.

His theory also treats direction of assimilation as a UG principle (p. 81):

(5) The trigger for (4) is the following segment.

However, Mohanan proposes the UG principle in (5) specifically regarding the phenomenon of contiguous place assimilation in adult language. By this principle, Mohanan's theory would predict regressive assimilation only. Although regressive assimilation is more common in child harmony than progressive, certainly such a strict principle such as (5) cannot be said to apply in child harmony. Thus, this prediction will not be attributed to Mohanan regarding direction. Yet it seems that some principle must underlie the prevalence of regressive assimilation in child harmony. One possible principle will be discussed in the Analysis section below. To a point, Mohanan's theory implies that direction will be a function of the assimilatory force as a function of the dominance of the consonants involved. However, since Mohanan allows for the possibility of a more dominant segment assimilating to a less dominant one (given a sufficiently strong assimilatory force), relative dominance of segments cannot be used to straightforwardly predict direction of assimilation. We might, however, tentatively predict that given a principle making regressive assimilation more likely than progressive, and assuming in Mohanan's framework that this contributes to the overall assimilatory force, i.e., that the assimilatory force is stronger in the regressive direction, that more dominant segments will not assimilate to less dominant ones in the progressive direction.

OBJECTIVES AND METHODOLOGY

This study examines the consonant harmony data for individual children in Smith (1973) (1 child, English) Vihman (1978) (2 subjects*[2] speaking Estonian and Czech), Berg (1992) (1 child, German), and Cruttenden (1978) (1 child, English) to see whether the assimilation patterns conform to Mohanan's dominance hierarchy of place assimilation and/or whether these data support the assertions of Stoel-Gammon and Stemberger. The questions addressed in this research are:

1. What are the patterns of place assimilation for these individual subjects?

    a. Do these patterns support Stoel-Gammon and Stemberger's general prediction that alveolar will be the most common undergoers, and will only very rarely be triggers?
    b. Do these patterns reflect Mohanan's implicational hierarchy?

2. What are the patterns for direction of assimilation? Although there is much data that regressive harmony is more common than progressive (Berg 1992: 232), what are the patterns for individuals? How does the direction of assimilation relate to the assertions of Stoel-Gammon and Stemberger and Mohanan?

Although Mohanan's theory of place assimilation focuses on a common phenomenon of adult languages, the dominance hierarchy is presented as a general principle which could be considered to apply to the place assimilation seen in consonant harmony in child language. Mohanan predicts that in a given language, and by implication, in a given child's developing grammar, the patterns of place assimilation must follow the implicational hierarchy for place assimilation based on the dominance scale. Therefore, for example, if in a given child's developing language velars undergo assimilation, then labials and palatals must also undergo place assimilation. A guiding assumption of this research, and the view that Mohanan would probably adopt in light of his larger theory, is that each child's developing language is in a sense a language unto itself. Therefore, Mohanan's predictions must be tested against harmony data for individuals, which Stoel-Gammon and Stemberger do not present. In fact, Stoel-Gammon and Stemberger comment that "...the single-subject type of study...[is] inconclusive about the issues raised here" because of the variability between children (pp. 64-65).

The Data. The data are presented in Appendix A. A weakness in the data is that there are no palatals by which to test Mohanan's claims regarding the equal dominance factors of labials and palatals.

It was difficult to determine how to treat alveopalatals. Though it would be interesting to examine whether the single dominant feature of alveopalatals, [-anterior], placed them between labials

[2] Vihman 1978 includes 13 subjects, but only presents sufficient individual data for 3 subjects, and one of those is from Smith 1973.

and alveolars in their likelihood to undergo and trigger assimilation, it is more reasonable to treat these as alveolars given their status in the grammars of children this age. For three of the five subjects, the author notes a rule fronting alveopalatals (see notes following each data set in Appendix A). Because children as young as the subjects in this study (0;7-2;11) have not acquired the alveopalatals or palatals, which do not emerge until around 3;6 (Vihman 1996: 219), I have opted to treat the alveopalatals as alveolars for all five subjects. Of course, in Stoel-Gammon and Stemberger's theory, which considers underspecification for coronal place of articulation alone, there is no reason to distinguish among coronals.

A more theoretically crucial decision to the outcome of this study is the decision to exclude tokens that were identified by the researchers as harmony involving velars assimilating to alveolars because there is considerable reason to believe that these are actually cases of the common process of fronting. Most notably, for Subject 3, I have excluded 20 such tokens that Vihman (1978) identified as harmony. Vihman notes that there is a rule substituting [t] for [k] which occurred "for over half of this early period" (Vihman 1978: 309). Vihman identifies tokens as harmony where [k] emerges as an alveolar in the neighborhood of [s]: /kIsu/→ši·šu ~ti·tu. However, it seems more consistent to treat the emergence of [k] as an alveolar consistently as fronting, especially taking into account how young this subject was during the study (0;10-1;10). Velar fronting can be understood to occur because velars appear later (around 2;0) than alveolars or labials in every word position (Vihman 1996: 219; Stoel-Gammon 1985: 508). Thus, we will generalize that up to a certain age velars are often fronted to become alveolars, and that this is the process that underlies any apparent assimilation of a velar to an alveolar. Note that since there are many velars left in subject 3's data, we have to generalize in the absence of age data for specific tokens that the tokens in which velars survive were gathered later than the others. Subject 2, another very young subject (0;10-1;8 during the study), provides complex data suggesting that velars can be fronted in some instances and yet survive and trigger assimilation in the same word in other instances: tužka→tušta~kuška. Why can't we just say that in the one alternation the alveolar is the trigger and in the other the velar is the trigger?

Adopting underspecification as the paradigm in which to understand harmony necessitates finding another explanation for what appears to be harmony triggered by an alveolar. If harmony involves the spreading of the place specification from one segment to another, and the prevalence of alveolar undergoers is a function of their underspecification for place, as both Mohanan and Stoel-Gammon and Stemberger propose, the existence of alveolar triggers absolutely contradicts these terms, and we have to say something very special about it. Stoel-Gammon and Stemberger broach the possibility of alveolar triggers as "very uncommon" (p. 68), while Mohanan makes room for them as the least likely trigger, without offering any principled explanation of how alveolar triggers could exist at all.

Identifying these tokens as instances of fronting rather than harmony is a principled explanation. Aside from the numerous tokens excluded from Subject 3's data, three tokens from Subject 2 and one from Subject 4's data are excluded on this basis, and are mentioned in the notes following the data in Appendix A.

In addition, certain other tokens from the original sources have been excluded for various reasons, as explained in the notes following each data set.

ANALYSIS

Predictions regarding most likely undergoer and trigger. Table 1 identifies the number of tokens of each assimilation pattern for each subject. As asserted before, because of the process of fronting common in children this young whereby palatals are produced as alveolars, we cannot use this data to test Mohanan's claims about the hierarchy where palatals are concerned. However, I have presented the patterns involving palatals to fully portray Mohanan's hierarchy. These patterns are italicized to indicate that the data was insufficient for palatals and that tokens involving alveopalatals are counted among the patterns involving alveolars. Where there is a gap in the hierarchy for a particular pattern, this symbol appears: O with the number of the prediction that is contradicted by the gap.

Mohanan's overall theory of place assimilation actually implies more specific predictions than those listed in (3) above. Because the relative status of both undergoer and trigger determine the strength of the force of assimilation (where there is an assimilation process in the grammar, of course) the theory predicts not just the presence of segments of a particular place of articulation as undergoers or triggers overall, but also the presence of the trigger relative to the strength of the undergoer and vice versa. So, for example, if in a given subject's grammar we find tokens where alveolars assimilate to velars and palatals assimilate to labials, if there are words in that subjects grammar containing palatals and velars, those palatals *should* assimilate to those velars, and if there are words containing alveolars and labials, those alveolars *should* assimilate to those labials. The predictions in (3) simply say that if there are labial triggers, there must be velar triggers. Table 1 tests the presence of a particular trigger for each place of articulation.

Mohanan's hierarchy is evidenced here to a good extent. Note that many of the gaps involve the absence of palatals as triggers. This raises a separate problematic issue regarding palatals because these gaps could reflect accidental gaps in the child's vocabulary.

Subject 5 exhibits the most glaring contradiction of Mohanan's predictions because of the absence of velar triggers. Because this subject's harmony pattern involves labial triggers strictly, it seems that we should consider whether something other than or in addition to level of specification drives this process.

Table 1 also clearly demonstrates the prevalence of alveolars as undergoers. This result is predicted by both Stoel-Gammon and Stemberger's and Mohanan's theories.

Table 1. Mohanan's Implicational Hierarchy

Predicted pattern: If 3 then 2 and 1 If 2 then 1 Undergoer→Trigger	Subject Exhibits Assimilation Pattern 1	2	3	4	5
Alveolars					
1. alveolar→velar	18	3	10	9	O-3d
2a. alveolar→labial*	8	4	15	17	35
2b. *alveolar→palatal*					
Labials					
1. labial→velar		1	2	1	
2. *labial→palatal*			O-3c		O-3b
3. labial→alveolar			1		
Palatals					
1. *palatal→velar*					
2. *palatal→labial*					
3. *palatal→alveolar*					

Velars					
1a. velar→labial* 1b. *velar→palatal* 2. velar→alveolar		1	3	3	20

*In Mohanan's theory, a and b are equally likely.

The tables below present a statistical analysis of the occurrence of the various places of articulation as undergoer and trigger, overall and broken down by direction of assimilation for each subject.

Subject 1				Overall			
Total Tokens: 26				Undergoer	# / %	Trigger	# / %
Progressive: 8 (31%)				alveolar	26 /100	alveolar	
Regressive: 18 (69%)				labial		labial	8 / 31
				velar		velar	18 / 69
Progressive				Regressive			
Undergoer	# / %	Trigger	# / %	Undergoer	# / %	Trigger	# / %
alveolar	8 / 100	alveolar		alveolar	18 /100	alveolar	
labial		labial	1 / 13	labial		labial	7 / 39
velar		velar	7 / 87	velar		velar	11 / 61

Subject 2				Overall			
Total Tokens: 9				Undergoer	# / %	Trigger	# / %
Progressive: 3 (33%)				alveolar	7 / 78	alveolar	
Regressive: 6 (67%)				labial	1 / 11	labial	5 / 56
				velar	1 / 11	velar	4 / 44
Progressive				Regressive			
Undergoer	# / %	Trigger	# / %	Undergoer	# / %	Trigger	# / %
alveolar	2 / 67	alveolar		alveolar	5 / 83	alveolar	
labial	1 / 33	labial	1 / 33	labial		labial	4 / 67
velar		velar	2 / 67	velar	1 / 17	velar	2 / 33

Subject 3

Total Tokens: 31

Progressive: 12 (39%)

Regressive: 19 (61%)

Overall			
Undergoer	# / %	Trigger	# / %
alveolar	25 / 81	alveolar	1 / 3
labial	3 / 9.5	labial	18 / 58
velar	3 / 9.5	velar	12 / 39

Progressive			
Undergoer	# / %	Trigger	# / %
alveolar	11 / 92	alveolar	
labial	1 / 8	labial	6 / 50
velar		velar	6 / 50

Regressive			
Undergoer	# / %	Trigger	# / %
alveolar	14 / 74	alveolar	1 / 5
labial	2 / 10	labial	12 / 63
velar	3 / 16	velar	6 / 32

Subject 4

Total Tokens: 30

Progressive: 19 (63%)

Regressive: 11 (37%)

Overall			
Undergoer	# / %	Trigger	# / %
alveolar	25 / 83	alveolar	
labial	2 / 7	labial	20 / 67
velar	3 / 10	velar	10 / 33

Progressive			
Undergoer	# / %	Trigger	# / %
alveolar	16 / 84	alveolar	
labial	1 / 5	labial	15 / 79
velar	2 / 11	velar	4 / 21

Regressive			
Undergoer	# / %	Trigger	# / %
alveolar	10 / 91	alveolar	
labial		labial	5 / 45
velar	1 / 9	velar	6 / 55

Subject 5

Total Tokens: 55

Progressive: 1 (2%)

Regressive: 54 (98%)

Overall			
Undergoer	# / %	Trigger	# / %
alveolar	35 / 64	alveolar	
labial		labial	55 /100
velar	20 / 36	velar	

Progressive			
Undergoer	# / %	Trigger	# / %
alveolar	1 / 100	alveolar	
labial		labial	1 / 100
velar		velar	

Regressive			
Undergoer	# / %	Trigger	# / %
alveolar	34 / 63	alveolar	
labial		labial	54 /100
velar	20 / 37	velar	

Table 2 examines the predictions of Stoel-Gammon and Stemberger and Mohanan against the data above. As discussed previously, because of the lack of palatals in the data and because children this young produce alveopalatals as alveolars, we cannot fairly test Mohanan's claims with regard to palatals against this data.

Table 2. Evidence for Predictions

Stoel-Gammon and Stemberger	
Predictions	Evidence in Data
1a. bias for alveolars to assimilate to labials and velars	Strongly supported by subjects 1, 2, and 4 Less strongly supported by subjects 3 and 5
i. very uncommon for labials or velars to assimilate to alveolars	Strongly supported by subjects 1, 3, 4, and 5 Less strongly supported by subject 2
1b. no biases for assimilation between labials and velars	velar→labial 7 tokens (excluding 20 tokens from subject 5) labial→velar 4 tokens

Mohanan	
Predictions	Evidence in Data
3a. if labials, palatals, or velars undergo place assimilation, then alveolars will also undergo assimilation	Supported by all data
3b. if velars undergo place assimilation, then labials and palatals will also undergo place assimilation	Supported by all data
3c. if alveolar trigger place assimilation, then labials, palatals, and velars will also trigger place assimilation	Prediction is supported by overall data, but is not supported specifically for labial undergoers in subject 3's data, where there is no instance of a labial assimilating to a palatal though there is a token of a labial assimilating to an alveolar (accidental gap?)
3d. if palatals or labials trigger place assimilation, then velars will also trigger place assimilation.	Prediction is supported by overall data, but is not supported specifically for palatal undergoers in subject 2's data, where there is no instance of a labial assimilating to a palatal though there is a token of a labial assimilating to an alveolar (accidental gap?)
3e. no bias for assimilation between labials and palatals.	Insufficient data

Table 3 shows that the data do not reflect the prevalence of velars as triggers which follows from Mohanan's predictions, even excluding Subject 5's data.

Table 3. Prevalence of Velar vs. Labial Triggers

Triggers (percentage of tokens)	Subject				
	1	2	3	4	5
Velar	69	44	39	55	
Labial	31	56	58	45	100

Direction of assimilation. Regressive assimilation is more common than progressive for all but one of the subjects (for whom the usual tendency seems to be reversed), as shown in Table 4.

Table 4. Direction of Assimilation

Direction (percentage of tokens)	Subject				
	1	2	3	4	5
Progressive	31	33	39	63	
Regressive	69	67	61	37	100

The data tables for individual subjects above show clear evidence for the prediction that arises out of Stoel-Gammon and Stemberger's theory, i.e., that underspecified segments (alveolars) will assimilate to specified segments (labials and velars) regardless of direction; but this does not explain why regressive assimilation is still most common.

Table 5. Assimilation Patterns According to Direction of Assimilation

Progressive	Subject					Regressive	Subject				
Under.→Trigger	1	2	3	4	5	Under.→Trigger	1	2	3	4	5
alveolar→velar	7	1	5	3		alveolar→velar	11	2	5	6	20
alveolar→labial	1	1	6	13	1	alveolar→labial	7	3	9	4	34
labial→velar		1	1	1		labial→velar			1		
labial→alveolar						labial→alveolar			1		
velar→labial				2		velar→labial		1	3	1	

The tentative prediction that more dominant segments would not assimilate to the place of less dominant segments in the progressive direction is contradicted by two such tokens in Subject 4's data. (But Subject 4 also contradicts the usual pattern of the prevalence of regressive assimilation.)

Berg suggests that the overwhelming predominance of regressive assimilation in his subject (Subject 5) owes to word initial position being more difficult than word medial position. (Berg 1992: 232) Vihman reports that there is evidence to suggest that the "word or the syllable is the earliest contrasting unit of linguistic perception." (Vihman 1996: 155) Vihman suggests that harmony involves a child producing a word using a template, and that the spreading we observe as harmony occurs as a strategy to fill the template when the child is confused. (Vihman 1996: 225) We could combine all of these observations to suggest a principle which would account for the prevalence of regressive assimilation while allowing for progressive assimilation, by saying simply that the word is the primary unit of perception, and that word medial position is generally more perceptually salient than word initial position.[3]

CONCLUSIONS

The data unambiguously support the claim of Stoel-Gammon and Stemberger that alveolars, which are underspecified for place of articulation, will be the most common undergoers of place assimilation and will very rarely be triggers. A statistically insignificant number of tokens contradict Stoel-Gammon and Stemberger's prediction that there would be no bias for assimilation between labials and velars (7 velar→labial tokens, 4 labial→velar tokens out; 11 out of a total of 153 tokens).

Table 1 reveals overall support for Mohanan's dominance hierarchy, with the notable exception of the absence of velar triggers for Subject 5. Mohanan's hierarchy cannot be assessed with regard to palatals using this data. Child data is not appropriate for this because of the tendency to front palatals. The implication of Mohanan's hierarchy that velars should be more common as triggers than labials is not born out by the data.

Regarding direction of assimilation, the data again supports the implications of Stoel-Gammon and Stemberger's simple claim: alveolars are the predominant undergoers regardless of the direction of assimilation.

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[3] Stoel-Gammon (1985) reports that segments generally appear in word initial position before word final position, which would make word final position the least salient of all. (p. 508) This study does not examine the emergence of phones in word medial position.

Appendix A

Subject 1. Amahl, 2;2, English, from Smith 1973

Assimilations	Undergoer	Trigger	Direction
cloth→ġɔk	alveolar	velar	progressive
glasses→ġa:gi:	alveolar	velar	progressive
kiss→ġik	alveolar	velar	progressive
biscuit→bigik	alveolar	velar	progressive
good (night)→ġug (nait)	alveolar	velar	progressive
whistle→wibu*	alveolar	labial	progressive
dark→ġa:k	alveolar	velar	regressive
drink→ġik	alveolar	velar	regressive
leg→ġɛk	alveolar	velar	regressive
ring→ġiŋ	alveolar	velar	regressive
singing→ġiŋiŋ	alveolar	velar	regressive
snake→ŋe:k	alveolar	velar	regressive
stuck→ġʌk	alveolar	velar	regressive
taxi→ġɛgi:	alveolar	velar	regressive
motor-car→mu:ġəġa:	alveolar	velar	regressive
knife→maip	alveolar	velar	regressive
nipple→mibu	alveolar	labial	regressive
stop→bɔp**	alveolar	labial	regressive
table→be:bu	alveolar	labial	regressive
room→wum	alveolar	labial	regressive
rubber→bʌbə	alveolar	labial	regressive
zebra→wi:bə	alveolar	labial	regressive
shopping→wɔbin	alveolar†	labial	regressive
kitchen→ġigən	alveolar†	velar	progressive
coach→ġo:k	alveolar†	velar	progressive
chockie (chocolate) →ġɔgi:	alveolar†	velar	regressive

*Smith excludes labial triggers from rule 17 (non-nasal alveolar and palato-alveolar consonants harmonise to the preceding velar point of articulation) because of fragmentary data (p. 19). For our purposes this token is included as an instance of harmony.

**This rule is optional for labial triggers.
stop →dʌp
stamp →dɛp
drum →dʌm

†By rule 23, all alveopalatal consonants are neutralized as |d| (p. 21).
church →dət
It is not clear whether these segments are processed in the harmony rule as alveolars or whether rule 23 applies after harmony. However, I will assume that rule 23 has applied and that the harmony process treats these as alveolars.

Subject 2. Jiři, 0;10-1;8, Czech, from Vihman 1978.

Assimilation	Undergoer	Trigger	Direction
tužka→kuška	alveolar	velar	regressive
taška→kašku (1;7,15)	alveolar	velar	regressive
balon→babo:nek**	alveolar	labial	progressive
knoflik→koki:kek†	alveolar	velar	progressive
gramofon			
→kakofon (1;7,20)	labial	velar	progressive
→gagafo:n (1;8,20)	not counted		
žaba→ba:ba	alveolar*	labial	regressive
koupat→po:pat	velar	labial	regressive
čap→pap	alveolar*	labial	regressive
sova→fofa	alveolar	labial	regressive

I have omitted certain tokens which Vihman identifies as harmony which are not straightforward, such as makap→mamak, which may involve other processes.

The following tokens have been excluded as instances of velar fronting:
kolečko→tolešto
tužka→tušta
taška→tašta (1;6,13)

As with subject 1, I will assume a fronting rule and count alveopalatals as alveolars.

**Vihman notes that harmony did not occur when this word was first attempted at 1;2. The form above was produced at (1;7,19) (p. 306)

† Knoflik was produced one day before this both as noti:k and nofik, making it difficult to determine whether the undergoer in the harmonized form koki:kek should be considered the alveolar or the labial. (p. 306)

Subject 3. Virve, 0;7-1;10, Estonian, from Vihman 1978.			
Assimilation	Undergoer	Trigger	Direction
/karu/→kaɣu	alveolar	velar	progressive
/kivi/→kiki	labial	velar	progressive
/ma.hla/→mahma	alveolar	labial	progressive
/priLit/→pi·pi	alveolar	labial	progressive
/paL/→pap	alveolar	labial	progressive
/pati/→papi	alveolar	labial	progressive
/læhme/→mæhme	alveolar	labial	regressive
/lamP/→pamp	alveolar	labial	regressive
/putel/→pupa	alveolar	labial	progressive
/muna/→nuna	labial	alveolar	regressive
/tops/→pops	alveolar	labial	regressive
/tu.pa/→pupa	alveolar	labial	regressive
/su.Pi/→fup:i	alveolar	labial	regressive
/napa/→papa	alveolar	labial	regressive
/sEme/→fe·me	alveolar	labial	regressive
/sÖ.ma/→fö:ma	alveolar	labial	regressive
/nImO.ti/→mi·mona	alveolar	labial	regressive
/minema/→mimema	alveolar	labial	regressive
/prüki/→küki	labial	velar	regressive
book*→pʊp	velar	labial	progressive
/kaM/→pam:	velar	labial	regressive
/krE.mi/→pe·mi	velar	labial	regressive
/aKen/→akɛŋ	alveolar	velar	progressive
/kena/→keŋa	alveolar	velar	progressive
/kaNap/→kaŋ.ak	alveolar	velar	progressive
/koN/→koŋ:	alveolar	velar	progressive
/tütruK/→kiuk	alveolar	velar	regressive
/teKi a.La/→kek·i al:a	alveolar	velar	regressive
/tü.Ki/→kük:i	alveolar	velar	regressive
/teki/→keki	alveolar	velar	regressive
thankyou→kæŋku	alveolar	velar	regressive

*Vihman presents book and a few other English words Virve spoke in English orthography.

/veT/→tɛt: has been excluded assuming that v→t reflects stopping.

Subject 4. English, 1;6-2;2, from Cruttenden 1977

Assimilation	Undergoer	Trigger	Direction
chocolate→kaki	alveolar*	velar	regressive
duck→kaka	alveolar	velar	regressive
dog→gɑgi	alveolar	velar	regressive
pudding→pʊgɩŋ	alveolar	velar	regressive
chicken→kɩki	alveolar*	velar	regressive
shopping→pɒpɩn	alveolar*	labial	regressive
rhubarb→bubɑ	alveolar	labial	regressive
rabbit→babi	alveolar	labial	regressive
sleeping→fifɩŋ	alveolar	labial	regressive
glasses→gɑgi	alveolar	velar	progressive
cuddle→kʌku	alveolar	velar	progressive
pudding→pʊpɩŋ	alveolar	labial	progressive
man→mam	alveolar	labial	progressive
spoon→bum	alveolar	labial	progressive
birdie→bə:bi	alveolar	labial	progressive
pen→pɛm	alveolar	labial	progressive
Ribena→bimə	alveolar	labial	progressive
pencil→pupu	alveolar	labial	progressive
bunnie→bʌmi	alveolar	labial	progressive
parcel→papə	alveolar	labial	progressive
button→bʌpə	alveolar	labial	progressive
good→gʊk	alveolar	velar	progressive
water→wɔwə	alveolar	labial	progressive
crispies→pipi	velar	labial	regressive
gooseberry→bubi	alveolar	labial	progressive
piggy→pɩpi	velar	labial	progressive
bacon→beɩbən	velar	labial	progressive
apple→papa	alveolar	labial	progressive
all gone→gɒgɒn	alveolar	velar	regressive
grampa→gɑgə	labial	velar	progressive

* Alveopalatals are treated as alveolars

One token was excluded as an instance of velar fronting rather than harmony: cup of tea→tʌpəti. Given the predominance of labial triggers, the more likely output if this were harmony would be pʌpəti.

Subject 5. Melanie, 2;7,15-2;11, German, from Berg 1992

Assimilation	Undergoer	Trigger	Direction
ka:mi→pa:mi	velar	labial	regressive
li:p→bi:p	alveolar	labial	regressive
kɔmt→pɔmt	velar	labial	regressive
tsimɛr→pimɛr	alveolar	labial	regressive
angəʃupst→anəpups	alveolar*	labial	regressive
tsa:npasta→pa:npata	alveolar	labial	regressive
kɛmən→pɛmən	velar	labial	regressive
turnbɔitəl→purnbɔitəl	alveolar	labial	regressive
trɔməl→pɔməl	alveolar	labial	regressive
ʃi:bən→b i:bən	alveolar*	labial	regressive
zaubɛr→baubɛr	alveolar	labial	regressive
ʃupən→pupən	alveolar	labial	regressive
hu:pʃraubɛr→pu:pbaubɛr	alveolar*	labial	regressive
gra:bən→ba:bən	velar	labial	regressive
kre:mə→pe:mə	velar	labial	regressive
ainkre:m→ainpe:m	velar	labial	regressive
umgəkipt→uməpipt	velar	labial	regressive
kam→pam	velar	labial	regressive
zilbɛr→bilbɛr	alveolar	labial	regressive
padəl→papəl	alveolar	labial	progressive
kɛlbɛr→pɛlbɛr	velar	labial	regressive
kle:pt→pe:pt	velar	labial	regressive
kle:bən→pe:bən	velar	labial	regressive
ʃtɔp→bɔp	alveolar*	labial	regressive
gɛlp→bɛlp	velar	labial	regressive
gru:bə→bu:bə	velar	labial	regressive
ʃtrympfə→bymfə	alveolar*	labial	regressive
gumi:→bumi:	velar	labial	regressive
treɛpə→pɛpə	alveolar	labial	regressive
ga:bəl→ba:bəl	velar	labial	regressive
na:mən→ma:mən	alveolar	labial	regressive
vɛkgə**n**ɔmən →dɛkgə**m**ɔmən**	alveolar	labial	regressive
le:bɛr→be:bɛr	alveolar	labial	regressive
ko:miʃ→po:mis	velar	labial	regressive
zupə→bupə	alveolar	labial	regressive
ʃlapɛrt→papɛrt	alveolar*	labial	regressive
lampə→bampə	alveolar	labial	regressive
to:mas→po:mas	alveolar	labial	regressive
gɛlbə→bɛlbə	velar	labial	regressive
zɔmɛr→bɔmɛr	alveolar	labial	regressive

dry:bən→by:bən	alveolar	labial	regressive
do:m→bo:m	alveolar	labial	regressive
ga:bi:→ba:bi:	velar	labial	regressive
ʃtro:man→bo:man	alveolar*	labial	regressive
zu:per→bu:per	alveolar	labial	regressive
ne:mən→me:mən	alveolar	labial	regressive
zɛlber→bɛlber	alveolar	labial	regressive
ʃi:bən→pi:bən	alveolar*	labial	regressive
fɛrgaməlt→baməlt	alveolar	labial	regressive
ne:bəl→me:bəl	alveolar	labial	regressive
rainkɔmən→ainpɔmən	velar	labial	regressive
lapən→bapən	alveolar	labial	regressive
tsu:zamən→bamən	alveolar	labial	regressive
ange:bɛr→anbe:bɛr	velar	labial	regressive
bauxna:bəl→bauxma:bəl	alveolar	labial	regressive

The subject has a rule making bilabial fricatives alveolar stops: f→t and v→d. Six tokens from Berg's data (10, 25, 32, 34, 46, 53) have been omitted here because it is unclear whether these could be instances of place harmony or manner harmony, depending on whether or not the stopping rule above applies before harmony. Three other tokens (2, 15, 31) were excluded because the undergoer was the glottal /h/. Finally, one more token (42) was omitted because it is difficult to characterize: Luftbalɔŋ→bukabɔŋ

*The subject has not mastered [ʃ] and regularly replaces it with [t]. (p. 229) As with subjects 1 and 2, I will treat these as alveolars.

**The glottal→labial harmony evidenced here will not be counted for statistical purposes.