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ABSTRACT

This issue contains the following articles: "Was Mir Wisse: A Review of the Literature on the Languages of the Pennsylvania Germans" (David Bowie); "Tigrinya Root Consonants and the OCP" (Eugene Buckley); "Duration of Onset Consonants in Gay Male Stereotyped Speech" (Sean Crist); "PRO, the EPP and Nominative Case: Evidence from Irish Infinitivals" (Heidi Harley, Andrew Carnie); "Palatalization and Umlaut in Korean" (Soonhyun Hong); "Exceptional Case Marking in the Xtag System" (Seth Kulick); "Functional and Pair-List Embedded Questions" (Yael Sharvit); and "The Perfect, Contingency, and Temporal Subordination" (Beverly Spejewski). (KFT)

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Clarissa Surek-Clark and Alexander Williams

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This volume presents a cross-section of current work in linguistics at the University of Pennsylvania. On behalf of both the editors and the authors whose work appears in this volume, we wish to thank the reviewers of these papers for their important contribution.

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Was Mir Wisse: A Review of the Literature on the Languages of the Pennsylvania Germans[1]

David Bowie

1. Introduction

In North America—and particularly in the United States—minority languages generally die out rather quickly to make way for the surrounding language. Certain pockets of immigrant languages, however, can still be found; one of the best known of these is the language that has become known variously as Pennsylvania Dutch, Pennsylfawnisch, and Pennsylvania German (the preferred term in the scholarly literature, hereafter abbreviated PG), a dialect of German which has been spoken continuously in North America[2] since the end of the seventeenth century by a group of people which have come to be known as the Pennsylvania Germans.[3]

PG is spoken by various groups of people, primarily by Anabaptist "plain people"—that is, the conservative Amish, Mennonite, and Hutterite groups. (While the language was spoken by other groups of German origin as recently as fifty years ago, it is only rarely heard now among those populations.) The area in which the language is spoken covers a roughly diamond-shaped area with corners in southern Ontario, southeastern Pennsylvania, southern Maryland, and at the Indiana-Illinois border, and throughout the area PG is in some degree of contact with North American English. This has given rise to what is generally described as a stable

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[1] This paper is the initial printed result of an ongoing effort to develop a bibliography of linguistic treatments of Pennsylvania German; the Pennsylvania German in the title means "What we know." I would be remiss without giving thanks to the many people whose help has led in some way to this paper, among them particularly Gillian Sankoff, Hikyoung Lee, Zsuzsanna Fagyal, and an anonymous reviewer.

[2] The other main surviving North American German languages are generally called Mennonite Low German, Texas German, and Wisconsin German, with some disagreement over whether Wisconsin German is actually separate from PG. Mennonite Low, Texas, and Wisconsin German deserve treatment separate from PG, and therefore will not be dealt with in this paper. Reed (1971) has suggested the blanket term "American colonial German" to cover all of these languages, a term which (unfortunately, in my opinion) has not gained widespread acceptance.

[3] This is actually a somewhat inexact usage; technically, one must not be a speaker of PG to be called a Pennsylvania German. The correlation is close enough, however, for present purposes, although as will be seen, some of the studies described in this paper do not hold to such a definition.

bilingual situation, with all or nearly all speakers of PG being fluent in North American English; therefore, studies of PG speakers do not have to be limited to PG, but can also look at the English spoken by PG speakers, comparative fluency in the two languages, etc.

This paper will attempt to give an overview of the research which has been done on the languages of the Pennsylvania Germans over the past 125 years. To accomplish this end, the paper will look at the evolution of the field of study, starting with the studies of PG made in the late nineteenth century, followed by the dialectological surveys of PG and the Pennsylvania Germans done in the first half of the twentieth century as reflected primarily in articles published in *American speech* at that time, followed by studies done since the time of the 1968 Tenth Germanic Languages Symposium at the University of Texas at Austin, which focused in great part on the German languages spoken in North America and how to maintain their presence. These divisions will allow a glimpse of the way in which the study of the languages of the Pennsylvania Germans has developed, from a focus on structural description to dialectology to language death and language maintenance; they also allow highlights of the field and its development to be presented, as the numbers of studies which have been published is much larger than the number that could even begin to fit into a paper of this length.

2. The Nineteenth Century

The nineteenth century saw the end of the Anabaptist migration to North America (in about 1860), and the first widespread realization that a large group of people in North America were maintaining their German language. The first records we have of this are occasional entries in the travel journals of German-speaking tourists and occasional general-interest books published about PG (Yoder 1971); these are, however, not very important for present purposes, whereas the scholarly literature on PG that began to appear in the last quarter of the nineteenth century is.

The two main scholarly works on PG to come out of the nineteenth century are Haldeman's *Pennsylvania Dutch: A dialect of south German with an infusion of English* (1872) and Learned's *The Pennsylvania German dialect* (1889). These works are now most useful because they offer a snapshot of the condition of PG in the late nineteenth century; they also give no hint that non-Anabaptist PG speakers were in any danger of losing their proficiency in PG. It thus seems that that started to happen sometime in the late nineteenth or early twentieth centuries, as dialectologists were already reporting on that phenomenon in the 1930s.

3. Twentieth-Century Dialectologists

PG and the area populated by PG-speaking people have been of great interest to dialectologists. In the first half of the twentieth century this interest focused on two issues, each of which will be dealt with separately—the structure of PG itself, and the English spoken by Pennsylvania Germans as well as non-Pennsylvania Germans living in areas with large numbers of PG speakers. As the question of PG itself received more attention, it will be dealt with first.

3.1. Twentieth-Century Studies of PG

The study of PG by dialectologists began to appear in the scholarly press in the 1920s with books and articles by various authors, most notably Lambert (1924), who worked on developing dictionaries of PG. Other PG dictionaries and grammars followed; the field of study, however, flowered particularly brightly in the pages of *American speech* around the time of the Great Depression and World War II. The first article in *American speech* on PG (Follin 1929) identified PG as a "southern German" dialect, echoing the conclusion that Haldeman (1872) had reached half a century earlier. A quick response came from Bickel (1930), who noted that Follin (1929) had identified PG as a Palatinate German dialect. Bickel also noted that the use of PG was fading, but it retained a strong hold in certain counties of Pennsylvania;[4] this may be a reflection of the shift of the non-Anabaptist Pennsylvania Germans away from speaking PG and toward speaking English in areas where the PG-speaking populations were not concentrated enough to hold out against the encroachment of English.

A favorite study of dialectologists studying PG has been the borrowing of English words into PG. Haldeman (1872) and Learned (1889) had both made note of large numbers of English borrowings, but comprehensive dialectological studies of these borrowing were not done until the issue was taken up by such people as Werner (1931), Buffington (1941), Frey (1942), Reed (1942,1948), and Schach (1948,1949,1952,1954); in addition, Schach (1951) looked at semantic borrowing from English into PG. These studies often made it seem that the German of PG was simply being

[4] Interestingly, the Pennsylvania counties listed were Lehigh, Berks, and Lebanon Counties; Lancaster County, now thought of as the heart of PG, was not included. A likely reason for this is that the three counties listed in the article held a large number of *non*-Anabaptist PG-speakers, and many dialectological studies of the time tended to ignore the Anabaptist PG-speakers (see, for example, the opening maps in Reed and Seifert 1954).

replaced by English words, but some researchers pointed out that what had happened was only that certain high-frequency words had been borrowed, giving the appearance that PG was being overwhelmed by American English, when in fact most of the words in PG are clearly German in origin.

Studies of PG from this time period that focused on its character as a German language were rarer, but still existed; representative of these are the studies by Buffington (1937,1939,1948) and Frey (1941,1943). These sorts of studies were important for various reasons, but two of them are worthy of particular note. In his study of the diphthong *oi*, Frey (1943) demonstrated that the differences between PG and European German were actually the result of regular historical processes much like, for example, those differentiating northern and southern varieties of European German. Buffington's (1939) study of Pennsylvania German in relation to other German dialects also focused on historical processes, but looked at which dialect of European German PG is most closely related to; Buffington's finding was that PG is most closely related to Palatinate German (as had already been concluded by several researchers), and that it is most closely related to eastern Palatinate rather than western Palatinate. This came as a surprise, as most of the early German settlers in the present PG area came from the western Palatinate region; however, Buffington's evidence is most compelling, and provided a useful tool for further historical studies of PG and its development.

3.2. Twentieth-Century Studies of PG-Influenced English

Some of the dialectologists working at this time chose to focus on the English spoken in PG-speaking areas; these studies include those done by Struble (1935), Page (1937), Frey (1945), Wilson (1948), and Ashcom (1953). As each of these studies is important for a different reason, the following paragraphs will deal quickly with each of them in turn.

3.2.1. Struble (1935)

Struble's (1935) report of the English of PG speakers concluded that speakers of PG speak English with a particular accent, affirming the conventional wisdom of both that time and the present. Struble listed various features of PG-accented English (such as exchanging *w* and *v*, devoicing of English *j*, etc.), and claimed further that these features were stable, or in other words that one could expect all Pennsylvania Germans to exhibit them when speaking English.

3.2.2. Page (1937)

Page's (1937) study of the English of PG speakers built on Struble's (1935) study. Page noted that Struble had looked at a variety of PG-influenced English that was very divergent from Standard American English; Page looked at PG-influenced English varieties which more closely approached the standard.[5] This study is most valuable for two reasons: first because it pointed out that there was a continuum (or at least a multi-tiered hierarchy) of levels of PG influence on the English of PG speakers, and second because it pointed out the inverse relationship between literacy in English and the use of PG-influenced forms in English.

3.2.3. Frey (1945)

Frey (1945), in one of the most-referenced articles on the subject of PG-influenced English, looked at the languages spoken by the Old Order Amish (OOA) and concluded that the OOA of Lancaster County, Pennsylvania are trilingual (in PG, a German dialect more closely approaching written European German called Amish High German, and PG-influenced English). This remains a controversial conclusion, which some, such as Meister Ferré (1991), reject, concluding that even if Frey was correct about the situation in 1945, it was only ever the case in Lancaster County and is no longer the case (that is, that the OOA are now balanced PG-American English bilinguals). Others, such as the members of the Essen-Delaware Amish Project Team (Enninger *et al* 1984), accept Frey's conclusions and hold that the OOA remain trilingual.[6]

3.2.4. Wilson (1948)

Wilson (1948) conducted a fairly cursory study of words used by PG speakers when speaking English, and concluded that much of what strikes speakers of other varieties of American English as odd about PG-influenced English stems from an "attempt to speak English as a literal translation of the

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[5] For example, Struble (1935) offered such items as the switching of [w] and [v] (*Wicar of Vakefield* 'Vicar of Wakefield') and some non-standard syntactic constructions (*He climbed the fence over* 'He climbed over the fence'); Page's (1937) study noted such things as some differences in lexical usage (*machine* 'car') and certain intonational patterns, but nothing at the same level as what Struble reported.

[6] Others challenge Frey's (1945) conclusions in other ways, for example questioning whether PG and Amish High German should be considered separate languages. For a short but thorough overview of the controversy see Rein 1977.

German idiom" (p. 236). Unfortunately, all that is then given is a description of particular items, without any mention of how often and when they were used or what sort of support exists for the claim that PG interference is the result of such "literal translation."

3.2.5. Ashcom (1953)

Ashcom's (1953) study of the English of central Pennsylvania does not deal directly with any of the languages of the Pennsylvania Germans, but it is significant in that it points out that PG has had an influence on the English of certain regions even among non-Pennsylvania Germans. Ashcom included with the article a short list of lexical variants found among all speakers in the PG-speaking region; among these are PG-influenced items such as *smearcase* 'cottage cheese' and simple regionalisms such as *onion snow* 'a late, short-lived snow in the spring.'

4. Recent Studies

A linguistic atlas of Pennsylvania German (Reed and Seifert) was published in 1954 as the culmination of the dialectological work which had been done in the preceding years in the PG-speaking region of eastern Pennsylvania. After this point, interestingly, dialectological studies of the Pennsylvania Germans were still occasionally conducted (see, for example, Seifert 1971 and Shields 1985), but the focus on PG and the languages of the Pennsylvania Germans seems to have trailed off among dialectologists. Despite the gap in study of PG—or possibly because of it (see Gilbert 1971)—the Tenth Germanic Languages Symposium at the University of Texas at Austin dealt to a great extent with the status of long-term communities of German speakers in the United States. The years that followed saw a new resurgence in studies of the languages of the Pennsylvania Germans, with most of the researchers concentrated in the mid-Atlantic and Great Lakes regions of the United States, as well as Essen, Germany. The remainder of this paper will be organized somewhat like the section on studies conducted in the first half of the twentieth century—it will deal first with studies of PG itself, and then with studies of English as spoken by the Pennsylvania Germans.

4.1. Recent Studies of PG

As the twentieth century has continued, linguistic and cultural pressure on the remaining PG speakers has increased (see, among others, Hostetler 1993; Kraybill 1994). Reflecting this, most recent studies of PG have tended to deal with issues of language death, language maintenance, and linguistic

pressure from non-PG populations. Although it is difficult to draw lines between these sorts of studies, the following sections will deal with studies of communities in which PG is dropping out of use separately from the other studies.

4.1.1. Recent Studies of PG Death

The most rigorous studies of communities in which PG is falling out of use have been conducted by Huffines (1989a,1989b), who looked at the differences between PG as spoken by conservative Anabaptists and other Pennsylvania Germans in Pennsylvania, and Van Ness (1990,1992), who looked at PG in West Virginia (among other places). Van Ness, in documenting the various changes occurring in the PG of West Virginia, concluded that one of the principle factors causing the move away from PG to English was simply isolation from the larger PG community. Similarly, Huffines documented the loss of PG among a group of people in Pennsylvania, and she found that the deciding factor in whether a speaker would maintain PG was whether s/he was a member of a conservative Anabaptist group or not—conservative Anabaptists are maintaining PG, while all others are not. In light of this finding, it is worth noting that all of the speakers in Van Ness's study were non-Anabaptists.

Also worth mentioning in conjunction with these studies is the note by Umble (1994) that a relaxation of OOA religious laws to allow the use of telephones tends to increase the proportion of English to PG spoken by individuals. Although this is based on anecdotal evidence rather than anything quantitative, it is an interesting bit of support for the idea that the more conservative the community, the more likely the members of that community are to have uses for PG rather than English.

4.1.2. Recent Studies of Linguistic Pressure on and Maintenance of PG

Several studies have looked at the pressure that PG is under from English in various places in which PG is still actively being used, and at the efforts of PG speakers to maintain the use of PG. Some of these—Clausing 1986, Dow 1988, Enninger 1988, Johnson-Weiner 1989, Huffines 1988, Van Ness 1993,1994, and Thompson 1994—are described fairly quickly in the following paragraphs.

4.1.2.1. Clausing (1986)

Clausing's (1986) study does not restrict itself to PG (and in fact does not cover PG among Anabaptist groups much at all), but covers both German and Icelandic in North America. It is however very useful for seeing what other closely related languages have done in reaction to pressure from English, as well as in some cases showing what other groups have done to cope with the loss or maintenance of their non-English language. Such cases are especially important in relation to PG-speaking communities that are losing their PG, as many of the formerly German- and Icelandic-speaking communities Clausing reports on went through very similar sorts of responses to linguistic pressure from English that such PG-speaking appear to be going through now.

4.1.2.2. Dow (1988)

Dow's (1988) study is a quantitative review of ways in which English has put new or renewed linguistic pressure on PG in the past few years. Dow presents various proposals for ways in which English is placing pressure on PG in school, social, business, and printing contexts, along with ideas for future studies of these contexts in PG-speaking communities. In the end, Dow is rather pessimistic regarding the future of PG as a viable language.

4.1.2.3. Enninger (1988)

Enninger (1988) concludes that the OOA are able to maintain PG in the face of pressure from English because each variety has specific roles in which it is used, and that these roles do not overlap.[7] It is worthwhile to compare this situation with the one described by Johnson-Weiner (1989) (described in 4.1.2.4), who studied an OOA community and found that the separation of roles for each language is breaking down and PG is not being completely maintained.

4.1.2.4. Johnson-Weiner (1989)

Johnson-Weiner (1989) studied two OOA communities in which the separation of linguistic roles noted by Enninger (1988) had broken down over time; perhaps as a result there is an inverse relationship between proficiency in PG and age. Responses to surveys taken in these communities also support the idea that if a speaker sees no reason to continue using all of the

[7] Basically, strict diglossia in the sense that Ferguson (1959) presented it.

languages in a language contact situation, s/he will tend to discard the language(s) seen as superfluous.

4.1.2.5. Huffines (1988)

Huffines (1988) studied conservative Anabaptist PG speakers and discovered that certain convergences to English were in progress, namely the loss of the dative case, use of the verb *duh* 'to do' as an auxiliary verb,[8] and the use of English word order. Huffines concluded was that these convergences were an attempt to maintain PG as a viable language and at the same time cope with the surrounding English-language environment. In this conclusion she stands against Dow (1988), who tended to view any accommodation to English as a sign of the impending death of PG.

4.1.2.6. Van Ness (1993,1994)

Van Ness's (1993,1994) studies of changes occurring in PG show changes occurring that might be interpreted as signs of incipient language death through pressure—changes in the lexicon and the pronominal system, apparently under the influence of English. Van Ness, however, points out—as does Huffines (1989) in a study of an area in which PG actually *is* being discarded—that these changes are *not* necessarily signs of language death, but are in fact the sorts of changes that go on in healthy languages all the time. Van Ness goes on to show that in the communities she studied PG is not in any imminent danger of being abandoned.[9]

4.1.2.7. Thompson (1994)

Thompson (1994) studied a community in which two dialects of PG have come together, and found that English is occasionally used between PG speakers in order to avoid misunderstandings as a result of dialect differences. This casts doubt on the conventional wisdom that states that all varieties of

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[8] One cannot consider the use of *duh* as an auxiliary in and of itself as an example of convergence to English, as various dialects of European German use *tun* 'to do' as an auxiliary verb, as well. The article, however, points out that the use of *duh* in PG is moving closer to English usage.

[9] Although going into much detail on the topic would be beyond the scope of this review, it should be noted that this relates directly to the existing literature on leveling. It would be most useful to look at the leveling (or, perhaps, apparent leveling) occurring in some PG-speaking communities in the light of studies done elsewhere.

PG are easily mutually intelligible.[10] Despite this use of English as a sort of lingua franca, Thompson found no reason to conclude that PG is falling into disuse in this community, although it bears continued watching.

4.2. Recent Studies on the English of the Pennsylvania Germans

The question has at various times arisen of whether PG speakers speak English with a PG-influenced accent, as Frey (1945) asserted, or whether they speak English indiscernibly from non-PG speakers, as Hostetler (1993) has maintained. Certain researchers have looked at this question, sometimes approaching it quantitatively; among the studies conducted are those of Raith (1981), Enninger *et al* (1984), Huffines (1986), and Huffines (1990). As has been done before in this paper, each of these studies will be presented here separately. Some of them will, however, be presented somewhat more comprehensively than the earlier ones.

4.2.1. Raith (1981)

Raith's (1981) study of phonological interference in the English of PG speakers is the one that all of the more recent quantitative studies of the phenomenon start from. The study involved having various PG speakers all read the same English text, noting ways in which the speakers' pronunciations differed from Standard American English pronunciation.[11] The results of this test gave an implicational scale of twelve phonological interferences, so that someone who had the first one would have all twelve, someone who had the fifth one would also have the sixth through twelfth but not the first four, etc. In order to give an idea of what interferences were found, the list is reproduced in (1).

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[10] I should probably note here that an Old Order Mennonite man (who wishes to remain nameless) with whom I spoke earlier this year about the status of PG also noted that there are significant differences not just between the PG spoken by Amish and Mennonite speakers, but also between communities within the same branch of Anabaptism—and that the differences are great enough to cause occasionally severe problems in communication. It would appear that even if Van Ness (1990) is correct and PG was at one time a homogenous or near-homogenous language, dialect differences and the mutual intelligibility of PG dialects are an important issue that should be looked at more closely in the future.

[11] No information was given on the way Standard American English pronunciation was defined.

(1)	Standard English		PG-influenced English
1	initial θ	→	s
2	final r	→	Ø
3	initial v	→	w
4	ɔʊ[12]	→	o:
5	z	→	s
6	initial w	→	v
7	final v	→	f
8	dʒ	→	tʃ
9	eɪ	→	e:
10	ʌ	→	ɒ/ɔ
11	pre-s/final r	→	Ø
12	final b,d,g	→	b̥,d̥,g̊

Overall, those PG speakers who were part of groups with the least contact with the mainstream English-speaking culture showed the least PG interference in their English, while those PG speakers who had a greater amount of contact with the surrounding world had more interference. This is an interesting result, because at first glance, this seems to be a counterintuitive finding—that those with less contact with English-speakers would speak English with less interference than those with more such contact.[13]

4.2.2. Enninger *et al* (1984)

This paper was a product of the Essen-Delaware Project Team, led by Werner Enninger. The study looked at phonological features of a group of OOA PG speakers in an attempt to verify Raith's (1981) findings; the study also looked somewhat at morpho-syntactical and lexical interference, but the results in those areas were quite preliminary and tentative.

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[12] ɔʊ is the symbol used in the original table; in more standard usage the symbol would be ow or ou. In any event, the change signified by this line is simply a monophthongization.

[13] Gillian Sankoff (personal communication, 1996), in looking at this finding with me, conjectured that it might be the result of the groups with less contact with non-PG-speakers keeping their PG and English more separate than those in other groups. Such a hypothesis would require a great deal of testing.

In order to test phonological interference, two tests were used. The first was a reading of a text (not the same one used by Raith in his 1981 study); the results of this were that there was very little PG interference in the speakers' English, and what interference there was occurred sporadically. In addition, although the interferences which occurred were mostly (though not entirely) the sorts that occurred at the higher end[14] of Raith's implicational hierarchy, the interferences that occurred did not fit the implicational system Raith laid out.

The second test of phonological interference used a variant of the matched guise test. A tape was made with 9 OOA and 9 non-OOA speakers arranged randomly on one side of the tape, and the same 9 OOA speakers arranged randomly again on the other side of the tape. Listeners (all monolingual English-speaking) were asked to judge whether each speaker was a member of the OOA (and therefore a speaker of PG) or not after having been told that the tape contained samples of both types of speakers. The conclusion drawn was that there was no consistency in rating whether a speaker's English was affected by OOA, but there are two major criticisms of this test and the presentation of the results that would have to be dealt with before this conclusion could be taken at face value.

The first is that all of the results from the second side of the tape (the one that contained all OOA speakers) are suspect; given that listeners were told that the tape contained both OOA and non-OOA speakers, they might have expected that to be true of each side of the tape rather than just the entire tape taken as a whole. The second criticism is that not all of the results were presented; that is, the percentage (total numbers were not given) of the time that all nine OOA speakers were identified as OOA speakers was given, but the percentage of the time that the non-OOA speakers were mistakenly identified as OOA speakers is given for only three of the nine. If all of the percentages were given, one could tell whether there really was a difference in identification—and if the number of listeners were given, it would be possible to tell whether the difference in identification was significant. As it is, such conclusions cannot be drawn from the data presented.

With these criticisms of the phonological portion of the study, and the fact that the other portions of the study were preliminary, not much in the way of hard information can be drawn from it. However, the article offers some useful ideas about ways to test for the existence of PG-influenced English.

[14] That is, the items marked with higher numbers in the table reproduced in (1).

4.2.3. Huffines (1986)

Huffines did not deal with segmental phenomena in her 1986 study of PG-influenced English; rather, she studied the intonation patterns of speakers of various levels of ability in PG (from fluent PG-speaking to monolingual English-speaking) from an area of Pennsylvania in which PG is passing out of use. She found is that speakers in that area use two different sets of question-intonation patterns, one the standard one for the north midland region and the other a nonstandard one involving such things as *falling* intonation at the end of a yes-no question, with the nonstandard pattern being used slightly more than half the time.

Upon further investigation, it was found that PG uses the intonation pattern that appears in this area as the nonstandard one; this points to the conclusion that the intonation pattern is a remnant of PG. Interestingly, though, even the monolingual English-speakers from the area use the nonstandard intonation pattern, so the phenomenon is not simply a phenomenon of PG interference.[15] Huffines (1986) concludes that the intonation pattern is a marker of ethnicity, and thus is able to survive.[16] It would be most useful to test people (both ethnic Pennsylvania Germans and others) from this area to determine whether this actually *is* an ethnic marker, or whether it is a local variant that is perhaps in some other way the result of the area's historical English-PG contact.

4.2.4. Huffines (1990)

This study differs from the others in that it does not look at English as spoken by Pennsylvania Germans, but rather it looks at the languages (mainly English, but also PG) spoken by the Pennsylvania Germans as they are viewed by others (and by the tourist industry). In this study, Huffines (1990) looked at several of the booklets sold in tourist shops in Pennsylvania German areas and points out that they promote long-standing linguistic

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[15] This brings up a theoretical question which is well beyond the scope of this paper—at what level does such interference occur? As presented here, the interference is assumed to be internal—a sort of *intra*individual interference. However, at some level there must be *inter*individual interference occurring as well. Where exactly the line lies is an important question for future research.

[16] Interestingly, Zsuzsanna Fagyal (p.c. 1997) has informed me of a study she conducted among the Donauschwaben (ethnic Germans) in Hungary, in which she found that Germanic intonation remains in use by even native Hungarian-speaking members of that group in certain situations. It would likely be useful to compare the two situations and see whether the assertion that intonation can appear as a linguistic vestige of ethnicity may, in fact, be correct.

misconceptions about the Pennsylvania Germans. These misconceptions take various forms, such as the idea that all speakers of PG (and PG-influenced English) are Amish, that PG-influenced English is the result of poor grammar (rather than simply being influenced by nonstandard rules), and that such unconfirmed-by-fieldwork constructions as the infamous "Throw the mama a kiss the train" are common among the Pennsylvania Germans. These and other bits of this supposed PG-influenced English, both performed and written, tend to portray the Pennsylvania Germans as naïve, humorous, and non-threatening.

The conclusion drawn is that this misinformation serves to "validate...the prevailing misguided view that English is superior to other languages, that anyone in the United States should and must speak (only?) English, and that minority languages cannot serve the communicative functions of any American community...and effectively eliminates vestiges of competitive diversity" (Huffines 1990:124). This may be overreaching a bit, but it is certainly the case that playing on outsiders' (often pre-existing) misconceptions about the Pennsylvania Germans must serve some sort of culturally significant function. Whether it serves the function of the sort of cultural warfare Huffines describes merits a closer study than the cursory overview she gives it.

5. Conclusions

This paper has attempted to give an overview of the work that has been done in studying PG and the other languages of the Pennsylvania Germans over the past 125 years. In looking at what has been done, two things become apparent—more work on the English of the Pennsylvania Germans is needed, and more quantitative work is needed. In addition, it would be interesting to compare linguistic studies of PG communities with anthropological studies of those communities, because it is apparent (see, for example, sections 4.1.2.3-4.1.2.5) that cultural attitudes have a significant bearing on the use of PG in PG-speaking communities. Also, regrettably, no studies have been done (or at least the results of none have been published) which look at socialization patterns between PG speakers and non-PG speakers (as well as between conservative Anabaptists and others) in relation to retention of PG and PG influence on English.[17] Future research taking these things into

[17] Teenagers, it would seem, would be particularly good to study, particularly within conservative Anabaptist groups, as at that age they are allowed (some would say encouraged) to experiment a bit in the ways of the world at large, which would allow—if not require—a good deal of contact with non-PG speakers (or at least with those whose PG would likely be somewhat different).

account will not only help fill gaps in our knowledge of PG-related issues, but will also help resolve issues relating to language contact situations in general and the way that socialization patterns across language lines affect the languages involved in such cases.

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Tigrinya Root Consonants and the OCP

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The Obligatory Contour Principle (OCP), which expresses a prohibition on adjacent identical elements, has played an important role in the development of phonological theory. Originally proposed in the domain of tone, it has received some of its most striking support from the nature of consonantal roots in Semitic languages. For example, in Classical Arabic there are no roots which consist of identical adjacent consonants (**qql*), a fact which is attributed to the OCP. In its standard formal conception, the OCP is an absolute principle: it judges between identity or lack of identity, permitting only the latter cases. In fact, however, the Semitic data support a more gradient interpretation: while identical adjacent consonants are prohibited, nonadjacent identical consonants are disfavored but attested; so are adjacent nonidentical (but homorganic) consonants.

In this paper I survey evidence from the Ethio-Semitic language Tigrinya which supports these conclusions. I begin in §1 by describing the root-and-pattern morphology of Semitic languages, together with the consonantal roots which constitute a central element of the system. In §2 I survey traditional observations regarding restrictions on the cooccurrence of similar consonants within a root, and how the OCP has been applied to explain them. In §3 I describe the corpus used in the study, outline the methodology, and discuss the major results. In §4 I show how Pierrehumbert's (1993) similarity model accounts for the observed patterns. In §5 I consider an additional hypothesis regarding the role of root length in cooccurrences. A brief conclusion is given in §6.*

1. Roots and Templates

§§1–2 are a review of Semitic templatic morphology and the role of the OCP in phonological theory, respectively, which also makes my assumptions fully

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explicit. Readers who are already familiar with these topics can skip ahead to §3 where the core of the Tigrinya pattern is presented.

A fundamental characteristic of Semitic morphology is the use of consonantal roots and syllabic patterns, or **templates**, in various combinations. I use data from Tigrinya to illustrate, but the phenomena are typical for the family as a whole. For example, the following words illustrate the realization of the root /sbr/ 'break (tr.)' in a range of templates (Leslau 1941, Berhane 1991); in many cases there are also affixes.

(1)	a.	sʌbʌr-ku	'I broke (it)'
	b.	yɨ-ssʌbʌr	'may it be broken'
	c.	tɨ-sʌbbɨr	'she breaks (it)'
	d.	nɨ-sʌbr-o	'we break it'
	e.	sɨbʌr	'break (it)! (m.sg.)'
	f.	yɨ-sbʌr	'may he break (it)'

The data in (1) reflect various inflectional categories for a single verb, whose exponence is not only in prefixes and suffixes but also in the shape of the **stem**: that is, the combination of the consonantal root with the template, which in Tigrinya includes information about the distribution of vowels, consonants, and consonant gemination. Thus the template for the perfect in (1a) can be represented abstractly as *CʌCʌC*. This template happens to occur with an obligatory set of suffixes which indicate the person, number, and gender of the subject, as in (2).

(2)

		singular	*plural*
1st person		sʌbʌr-ku	sʌbʌr-na
2nd person	*masc.*	sʌbʌr-ka	sʌbʌr-kum
	fem.	sʌbʌr-ki	sʌbʌr-kɨn
3rd person	*masc.*	sʌbʌr-ʌ	sʌbʌr-u
	fem.	sʌbʌr-ʌt	sʌbʌr-a

Similarly, each of the other templates in (1) occurs with a particular set of affixes. My interest in this paper, however, is on the form of the stem, independent of the affixes. I will therefore generally omit affixes in illustrating stems, indicating the incomplete status of a stem by a hyphen.

In addition to the inflectional templates in (1), templates are also used for derivational purposes. For example, a root which can be used in verb patterns can often also be used as a noun in a different templatic pattern.

The pairs below, from Bassano (1918), illustrate the roots /dnk̓/, /drʔ/, and /ʔgs/.

(3)	a.	dʌnnʌk̓-	'be astonished'
	b.	dɨnk̓i	'wonder, surprise'
(4)	a.	dʌrrʌʔ-	'patch up, reinforce with patches'
	b.	dɨrʔ-ɨto	'patchwork quilt'
(5)	a.	ʔɨggus	'patient'
	b.	tɨ-ʔgɨs-ti	'patience'

In such cases, the consistent correlation between consonants and semantics motivates the positing of the consonantal root as an independent morpheme. It is the nature of this consonantal root which is the focus of this paper.

1.1. One-to-One Correspondences

All examples given so far involve roots with three consonants, or **triliterals**; this is by far the most common root type throughout Semitic, including Tigrinya. Additional examples are given below, in the perfect stem. In (6) are Type A verbs, the default class, while in (7) are verbs from Type C, a small class characterized by conjugations with the vowel [a] between the first two consonants (Leslau 1941: 95, Berhane 1991: 168ff).

(6)	a.	gʌrʌf-	'whip'
	b.	wʌlʌd-	'give birth'
	c.	lʌwʌs-	'mix'
	d.	bʌlʔ-	'eat'
(7)	a.	barʌk-	'bless'
	b.	laśʌy-	'shave'
	c.	safʌg-	'hesitate'

While this root type is the most common, both shorter and longer roots also exist. Following are the perfect stems of some **quadriliteral** roots, containing four consonants.

(8) a. mʌskʌr- 'witness'
b. gʌlbʌt- 'turn'
c. šʌmgʌl- 'mediate'

True **quinquiliterals**, i.e. roots with five underlying consonants, are exceedingly rare; Bassano (1918) gives only one root which is treated here as quinquiliteral. See the next section for discussion.

1.2. One-to-Many Correspondences

For the basic perfect stems examined so far, the number of root consonants is the same as the number of consonant slots in the template. For example, the common Type A verb exemplified by *sʌbʌr-* 'break' has a triliteral root with a three-consonant template. Similarly, the verbs in (8) have quadriliteral roots and four-consonant templates. But in many cases the number of root consonants is smaller than the number of consonant slots which they need to fill. For example, the common Type B verb is characterized by a triliteral root and a four-consonant template. To fill the extra consonant slot, this verb type has gemination of the medial consonant.

(9) a. bʌddʌl- 'hurt'
b. rʌssiʔ- 'forget'
c. wʌddʌs- 'praise'

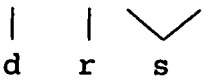
Less common, but reflecting the same combination of a triliteral and four slots, are verbs with spreading of the final consonant to fill the remaining slot.

(10) a. dʌrsʌs- 'heal'
b. saħbʌb- 'become exhausted'
c. lʌmtʌt- 'beat soundly'

The contrast between the verbs in (9) and (10) is illustrated below, using the templatic formalism introduced by McCarthy (1981).

(11) a.
```
C ʌ C C ʌ C     =     bʌddʌl
|   \/    |
b    d    l
```

b. C ʌ C C ʌ C = dʌrsʌs



There are various theories about how to derive the difference between the two verb types and the way they are realized in the template (see Buckley 1990 for Tigrinya); the important point here is that both verbs have three root consonants. That is, at the consonant level of representation, they are of exactly the same triliteral type, and are equivalent for the purposes of this investigation.

Except for three irregular verbs—*hab-* 'give', *ħaz-* 'hold', *bʌl-* 'say' —there are no templates with just two slots for consonants.[1] This means that when a **biliteral** root, with just two consonants, is associated to a template, at least one of the consonants has to serve double duty, as in (11). A very common pattern in Semitic is the repetition of the second consonant. This can occur with a three-slot template, as in (12).

(12) a. sʌdʌd- 'send'
b. kʌbʌb- 'surround'
c. mʌzʌz- 'draw sword'
d. nazʌz- 'forgive'

Similar (though less common) repetition can occur when a biliteral root is combined with a four-slot template, where the three final slots all instantiate one consonant.

(13) a. ƙʌnnʌn- 'pour off liquid'
b. gʌddʌd- 'be important to (someone)'
c. sʌbbʌb- 'become moldy (of bread)'
d. mʌssʌs- 'try, begin'

These are generally considered a subclass of Type B, since the medial consonant is geminated (Leslau 1941: 109). More typical when a biliteral associates to four slots is that the set of two consonants is reduplicated, creating what is often treated as a subclass of quadriliterals (Leslau 1941: 96).

[1] Even the irregular verbs can be shown to derive from the triliteral roots /whb/, /thz/, and /bhl/ (Leslau 1941: 122f). Other apparent two-consonant stems such as *kʌd-* 'go' and *mot-* 'die' involve deletion or coalescence of a glide (the roots are /kyd/, /mwt/).

(14) a. mʌrmʌr- 'examine'
b. lʌflʌf- 'chatter uselessly'
c. lʌmlʌm- 'be soft'

What all the roots from (12) to (14) have in common is that they consist underlyingly of just two consonants. As a result, they are, like the roots in (11), equivalent to each other for the purposes of the root-consonant cooccurrences investigated below.

Finally, there are certain verbs which involve a triliteral root linked to a template with five consonant slots. These entail reduplication of the final two consonants, similar to (14). Every five-slot template in Tigrinya includes a prefix such as causative *ʔa-* or passive-reflexive *tʌ-*.

(15) a. ʔa-ʔrʌmrʌm- 'resent'
b. ʔa-htʌftʌf- 'talk in sleep, delirium'
c. ʔa-zfʌrfʌr- 'hang heavy (with fruit)'
d. tʌ-k̓bʌzbʌz- 'look around curiously'

Abstracting away from the reduplicated part of the stem, these verbs are derived from triliterals such as /ʔrm/, and are assimilable to the large class of triliteral roots more typically realized as in (6). Only one root, identified by Bassano as belonging to the Hamasen dialect, is treated in this analysis as a true quinquiliteral (cf. also (37) below). It is also unique among five-slot templates in that it takes no prefix.

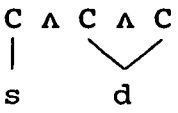
(16) gʌrʌngʌr- 'start to form pod (of legume)'

While this root might need to be treated synchronically as /grngr/, it is presumably the result of an irregular reduplication of /grn/. Due to its multiply exceptional nature, it is not included in the statistical analysis here.

2. The Obligatory Contour Principle

2.1. Identical Consonants

In (12) above we saw that when a biliteral root such as /sd/ associates with a three-slot template, it is the second consonant which occupies two slots (17a), rather than the first (17b). That is, while stems of the type *sʌdʌd-* are common, those of the form **sʌsʌd-* are absent.

(17) a. 

= sʌdʌd

b. 

= *sʌsʌd

This pattern is well known for Semitic and to some degree Afro-Asiatic (Greenberg 1950, Bender 1978), and requires a general solution. The standard explanation in modern phonological theory (McCarthy 1986) has two parts. First, as assumed tacitly in the discussion up to this point, roots cannot have two identical consonants in a row. That is, both */sdd/ and */ssd/ are prohibited as underlying roots. This effect is attributed to a general phonological notion motivated by tone and many other areas (Leben 1973, Goldsmith 1976, McCarthy 1986).

(18) *Obligatory Contour Principle (OCP)*

Adjacent identical elements are prohibited.

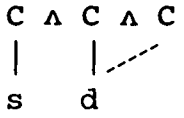
The OCP requires that a stem like *sʌdʌd-* be derived from the root /sd/, since */sdd/ is a violation of the principle, just as */ssd/ is a violation.

The responsibility for ensuring that it is the **second** consonant that spreads to two consonant slots then falls to the association algorithm, i.e. the rules that link up the root consonants to the template. The essential element of the explanation is that the consonants link up to the template slots one at a time, from left to right.

(19) *Left-to-right association*

The second step is spreading of the rightmost consonant to the remaining slot, yielding the correct output *sʌdʌd-*.

(20) *Rightward spreading*



If association is always left to right, the unattested form **sʌsʌd-* will not be derived, and the asymmetric pattern is correctly captured.[2]

2.2. Identical Place Features

In the preceding section we saw how the OCP operates at the segmental level (root tier) to prohibit adjacent identical consonants. This can be termed the 'total OCP' (Pierrehumbert 1993), since it refers to adjacent consonants that are identical in all their features. But the OCP is also important in explaining another widespread generalization regarding Semitic roots. As observed by Greenberg (1950) and others, not only are adjacent identical consonants prohibited within a root, but even nonidentical consonants of the same place of articulation, and even those which are nonadjacent, are strongly disfavored within a root. In other words, a 'place OCP' appears also to operate on individual place features to prohibit same-place consonants anywhere in the same root.

First it is necessary to clarify the category 'place of articulation'. For the purposes of this generalization, the following classes of consonants are relevant; the consonants which make up each class are given for Tigrinya, but the same basic classes hold across the languages.

(21)		
	gutturals	h ʔ ħ ʕ
	velars	k g k̓ kʷ gʷ k'ʷ
	coronal obstruents	s z ṡ t d t̓
	coronal sonorants	r n l
	labials	f p b p̓ m

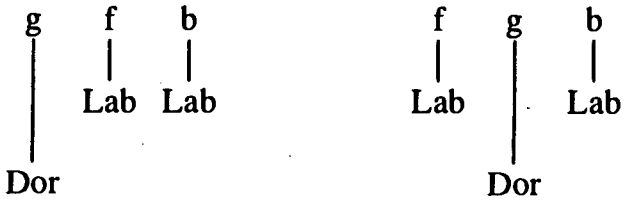
Thus while a root like */kbb/ is prohibited by the total OCP, there is also a strong 'place OCP' effect which disfavors roots such as /kbm/—adjacent and homorganic but nonidentical—and /bkb/—identical but nonadjecent. There

[2] See McCarthy (1981), Yip (1988), and Buckley (1990) for various analyses of other stem types such as *bʌddʌl-*.

is, further, a weaker effect disfavoring nonidentical, nonadjacent consonants, e.g. /bkm/. (Note: throughout this paper, "nonidentical" is used to refer to consonants which are homorganic but not identical in all other features.)

Since homorganicity is crucially involved in these generalizations, a proposed explanation of the cause is that, as suggested, the OCP operates not only on the consonant as a whole, but also on individual place features. The analysis is couched in a feature geometry framework which has privative articulator nodes which occur on different tiers of the representation (Sagey 1986, Mester 1986, McCarthy 1988, Yip 1989). The four articulator nodes Pharyngeal, Dorsal, Coronal, and Labial encode the four basic place classes in (21). Adjacency on an articulator tier is unimpeded by intervention of a different-place consonant, permitting consonants which are not strictly adjacent to interact in a local fashion at the level of articulator. In (22), notice that the consonants /f/ and /b/ both bear a Labial node, and that these nodes are adjacent to each other on their tier regardless of whether a consonant such as /g/ intervenes, since /g/ has no Labial node.

(22)



This approach has the weakness that it is categorical: it predicts that /gfb/ and /fgb/ should be equally disfavored, since the Labial nodes that constitute the OCP violation are equally adjacent in each case. However, as Pierrehumbert (1993) shows for Arabic, the degree to which coocurrence of homorganic consonants is disfavored correlates with their proximity in the root: /gfb/ is worse than /fgb/. Further, the degree of disfavoring is proportional to the relative identity of the homorganic consonants in features beyond those of place of articulation. For example, as we shall see, /gtd/ is worse than /gtz/, since the coronal obstruents in the first root share the feature [–continuant], while those in the second root do not.

In the next section I replicate Pierrehumbert's Arabic results using data from Tigrinya, following her fundamental approach and assumptions. Differences of approach will be pointed out as they arise.

3. Tigrinya Root-Consonant Cooccurrences

3.1. The Corpus

The data in this section are drawn from a corpus of all the verb roots found in Bassano (1918), the most complete dictionary of Tigrinya available at present. The consonantal roots were entered into a computer database for ease of seaching and analysis. For the purposes of this investigation, the template to which a root associates has been ignored (cf. §1.2). For example, while the following verbs have various templates, as well as different ways of associating to the template (spreading vs. reduplication), they are all treated here as underlyingly biliteral /zl/ or /mz/.

(23)	a.	zʌlʌl-	'jump (over an obstacle)'
	b.	ʔa-zlʌl-	'wear no pants, just a robe' *(caus.)*
	c.	zʌllʌl-	'dilute with too much water'
	d.	zʌlzʌl-	'cut meat in strips for drying'
(24)	a.	mʌzʌz-	'draw sword'
	b.	mʌzzʌz-	'belong, be fitting'
	c.	mʌzmʌz-	'be very long (of incisors); burn'

Similarly, the following verbs are treated as triliteral /sbl/ and /ħnk̓/ despite the templatic differences.

(25)	a.	sʌbbʌl-	'sprout'
	b.	sʌblʌl-	'load onto pack animal'
(26)	a.	ħanʌk̓-	'strangle'
	b.	ħank̓ʌk̓-	'be spoiled, finicky (of child)'

It may be that the template to which a root associates also affects cooccurrence patterns—for example, Lightner (1973: 58f) suggests that the presence of a vowel between two consonants helps explain certain cooccurrence facts—but I have not pursued this question here.

Bearing these definitions in mind, we can now examine the sorts of roots which occur in Tigrinya. The corpus used here consists of a total of 2744 roots from Bassano (1918), with the following root-template correspondences.

(27)	*n*	*root type*	*templatic realizations*
	477	Biliterals	three-slot $C_1C_2C_2$ four-slot $C_1C_2C_2C_2$ or $C_1C_2C_1C_2$
	1804	Triliterals	three-slot $C_1C_2C_3$ four-slot $C_1C_2C_2C_3$ or $C_1C_2C_3C_3$ five-slot $C_1C_2C_3C_2C_3$
	463	Quadriliterals	four-slot $C_1C_2C_3C_4$ five-slot $C_1C_2C_3C_4C_4$

The one true quinquiliteral in the dictionary (with neither spreading nor regular reduplication) has been omitted from the study; see (16).

Further notes on the data are in order. Recall the generalization that identical consonants occur only at the right edge of a stem: that is, we find *sʌdʌd-* but not **sʌsʌd-*. There are 52 roots in the corpus which are superficial exceptions to this generalization, e.g. *lʌlʌy-* 'separate'. Buckley (1990) argues that these verbs necessarily involve reduplication of a shorter root plus deletion of a consonant after association to the template, e.g. *lʌylʌy* → *lʌlʌy*. These roots are treated according to this analysis, i.e. not as /lly/ but as /ly/. See also Berhane (1991: 166f) for a list of these verbs, and Greenberg (1950: 167) for a wider context.

Due to the presence of similar verbs such as *zʌlʌl-* and *zʌllʌl-* in (23), the same string of consonants may appear as a root more than once in the corpus. The duplicates have not been removed because it is considered significant that such roots occur more than once. For example, the fact that several verbs have the root /zl/ is an indication that these two consonants combine freely, whereas a single root with this combination could more easily be seen as an anomaly. Similarly, Bassano sometimes gives separate entries for a passive or causative form of a verb that may also appear as a simple entry with similar semantics.

(28)	a.	ʔa-rʌddʌʔ-	'persuade' *(causative in form)*
	b.	rʌdʔ-	'help'
(29)	a.	ʔam-maśʔ-	'arrange marriage' *(caus-recip.)*
	b.	mʌśʔ-	'come'

(30) a. tʌ-kʌllʌl- 'have cataracts' *(passive in form)*
b. kʌllʌl- 'protect; be (partially) blinded'

Rather than second-guess his motivations, I have followed Bassano and treated these verbs as separate entries in the corpus. In other words, I have treated them in the same fashion as verbs which exist only in the causative or passive form, such as those below.

(31) ʔa-sgʌl- 'be engrossed in work' *(caus.)*
*sʌgʌl-

(32) ʔal-lagʌṡ- 'ridicule' *(causative-reciprocal)*
*lʌgʌṡ-

(33) tʌ-lʌḥam- 'spread gradually' *(passive in form)*
*lʌḥam-

Whether or not the semantic idiosyncrasies of the derived verb forms motivate this double inclusion of the roots raises issues of homonymy and polysemy well beyond the scope of this paper. At any rate it is unlikely that these roots exist in numbers significant enough to skew the results, and certainly they do not introduce spurious cooccurrences.

There are certain consonants occurring in the corpus which are excluded from the analysis. These are of two types. First, the rare segments /p, ṗ/ are found in only one verb each.

(34) a. rʌppʌs- 'iron (clothes)'
French *repasser*
b. ṗʌṗṗʌs- 'consecrate as bishop' [root /ṗs/]
Greek *pappas* 'father (bishop's title)'

Due to their extreme rarity, the cooccurrences of these stops are simply ignored; the cooccurrence of /r/ and /s/ in /rps/, however, is included in the calculations. Second, the palatal consonants /š, j, ċ/, which as a group are uncommon in the language, particularly in verbs, have not been included in any of the statistical analysis. For example, I have not investigated whether they pattern with the coronal obstruents.

In addition, there is an assimilatory process whereby the sequence /nb/ becomes [mb]. In a typical quadriliteral verb, where the syllable pattern

is *CvCCvC*, the second and third consonants occur adjacent to each other; thus when those two consonants are [mb] on the surface it is not obvious whether the nasal is underlyingly labial. There are 23 verbs of this type. Of course, if the nasal is underlyingly /m/, we have a number of new examples of the disfavored sequence of consonants from the same class. I therefore suspect that most or all of these nasals are actually /n/. There is, fortunately, a way of testing this claim: certain inflections include an /a/ between C_2 and C_3, and in the one relevant verb for which I have the necessary data, we see that the nasal is labial only when it is adjacent to the /b/.

(35) a. śʌmbʌr- 'mix one thing with another'
b. tʌ-śʌnabʌr- 'be mixed together'

Although I do not have the data required to prove it for every root, this pattern is likely to hold for the remaining 22 verbs, and I have taken the liberty of coding these nasals as /n/. Interestingly, none of these roots begins with a coronal sonorant, so that assuming /n/ as the second consonant never introduces a disfavored sequence of consonants from the same class. The third consonant, of course, is /b/; four of the roots have /l/ or /r/ as the final consonant, which as shown in (52) frequently combine with /n/. At any rate, given the small number of verbs, this assumption can have no important effect.

A similar situation holds for several roots which take a derivational prefix. These verbs can be analyzed as five-slot templates where the nasal is part of the root, or as four-slot templates with an independently attested /n/ prefix which assimilates to the root-initial /b/.

(36) a. tʌ-m-bʌrkʌk- 'kneel'
b. tʌ-m-bʌrt̓ʌt̓- 'be proud, strut haughtily'
c. ʔa-m-bahk̓ʌw- 'yawn'
d. ʔa-m-bʌdbʌd- 'fan (fire)'

I choose the latter solution, and simply omit the nasal from the root. For (36a) in particular, the word *birki* 'knee' supports treating the root for 'kneel' as /brk/ rather than /nbrk/. Leslau (1941: 108) explicitly gives this analysis for (36a,b).

Leslau (1941: 106ff) identifies three consonants which serve to extend the prefixes *tʌ-* (passive) and *ʔa-* (causative): not only /n/ as illustrated in assimilated form in (36), but also /s/ and /š/. Due to templatic

differences, it is easy to distinguish *prefix* + /n, s, š/ + *three-slot template* on the one hand, from *prefix* + *four-slot template* (where the first root consonant happens to be /n, s, š/) on the other. However, when the choice is between *prefix* + /n, s, š/ + *four-slot template* and *prefix* + *five-slot template* (with first root consonant /n, s, š/) there is no distinction in the overall shape of the stem (cf. Berhane 1991: 359). Along the same lines as in (36), I have uniformly treated the /n, s, š/ in such ambiguous cases as a prefixal element, and not as part of the root.

(37)	a.	tʌ-n-kʌtkʌt-	*root* = /kt/	'shiver'
	b.	ʔa-s-dʌmmʌm-	*root* = /dm/	'admire'
	c.	ʔa-š-kʌrkʌr-	*root* = /kr/	'make turn; laugh'

This conservative decision results in fewer overall consonant cooccurrences, including those within the same class, e.g. the coronal obstruents /s, d/ in (37b), as well as those from different classes, e.g. /n, k/ in (37a). The number of verbs of this type is small: 44 with /n/, 13 with /s/, and just one with /š/.

3.2. Method

The basic approach taken here, as in Pierrehumbert (1993), is to compare the expected cooccurrences of each pair of consonants with the occurrences which are actually attested. The method here differs since three types of roots are included, rather than just triliterals.

The first step in this investigation was to determine the cooccurrence facts as observed in the corpus. Specifically, for each pair of consonants **a** and **b**, the cooccurrences were tallied independently for each type of root (bi-, tri-, and quadriliteral). That is, the positions in which **a** and **b** occur (call them **x** and **y**) are defined with respect to the total number of consonants in the root, as well as position within the root (I, II, III, IV). There are 10 possible pairings of root-dependent positions in a corpus that contains roots of 2, 3, and 4 consonants.

(38)

biliteral		*quadriliteral*	
I-II	ab	I-II	ab··
		II-III	·ab·
triliteral		III-IV	··ab
I-II	ab·	I-III	a·b·
II-III	·ab	II-IV	·a·b
I-III	a·b	I-IV	a··b

The cooccurrences in various roots have been kept distinct; see §5 for discussion of whether the relative frequency of consonants varies according to the different root types.

After the number of observed cooccurrences (O) for a given pair of consonants in each possible combination of positions was calculated, values were added to derive larger values for more general categories: adjacent consonants and those separated by one or two other consonants.

(39) *adjacent consonants:*

biliteral	I-II
triliteral	I-II, II-III
quadriliteral	I-II, II-III, III-IV

separated by one other consonant:

triliteral	I-III
quadriliteral	I-III, II-IV

separated by two other consonants:

quadriliteral	I-IV

In addition, values for all cooccurrences, regardless of adjacency relations (i.e. all 10 pairings), were totaled to get an overall picture.

It should be noted that this method looks only at relative position; it treats cooccurrence of **a** and **b** in /ab·/ as equivalent to cooccurrence in /·ab/. This assumption is not obviously true—initial or final position could, for example, have some special status—and the role of absolute position deserves further investigation.

The second step was to calculate the expected values for each consonant cooccurrence. First, some definitions.

(40) A = attested occurrences of consonant **a** in position **x**
B = attested occurrences of consonant **b** in position **y**
N = total number of roots instantiating these two positions

For each combination of two positions within a root, the expected number of pairings of **a** and **b** was calculated as follows.

(41) A/N = maximum likelihood estimate of the probability that **a** will occur in position **x**
B/N = maximum likelihood estimate of the probability that **b** will occur in position **y**
$(A/N) \cdot (B/N)$
= probability that **a** will occur in position **x** and **b** will occur in position **y**
$E = (A/N) \cdot (B/N) \cdot N = (A \cdot B)/N$
= expected number of roots with **a** in **x** and **b** in **y** from a corpus of N roots

These expected values, like the observed values discussed above, were determined independently for each type of root.

The calculation of E in (41) assumes independence of A and B, which is the null hypothesis under investigation. To the extent that the predicted value differs significantly from the observed cooccurrences, we have reason to believe that some outside factor—such as the OCP—is intervening and must be accounted for. The third step, then, was to compare the observed and expected values. For each pairing of consonants, and within each category of adjacency, the observed number of cooccurrences (O) was divided by the expected number of cooccurrences (E). A value of 1, of course, indicates that there is no factor inhibiting the cooccurrence of the consonants, i.e. that the OCP has no effect. A value of 0 arises when O=0, i.e. when the OCP effect is absolute. Values between 0 and 1 indicate varying degrees of strength of the effect. It is this varying degree—correlated with degree of similarity and degree of adjacency—which interests us here.

3.3. Results

In conformity with claims for Semitic in general, the corpus does not contain any roots with adjacent identical consonants. However, there are some roots

with nonadjacent identical consonants, as well as numerous adjacent nonidentical consonants from the same place of articulation, and many nonadjacent nonidentical consonants. Statistical analysis confirms Pierrehumbert's results for Arabic regarding the role of identity and proximity: the closer and more similar the consonants, the less likely they will be found to cooccur in a root. In this section I pool data for the bi-, tri-, and quadriliterals, distinguishing the present study from Pierrehumbert's (1993), which includes only triliterals. Possible differences among these three root types are considered in §5.

3.3.1. Adjacency

As mentioned above, and observed by Greenberg (1950), same-place consonants occur with significantly less than expected frequency, but they are not absent, as identical adjacent consonants are. Some examples are given in (42) as pure roots, rather than as stems.

(42) *Some roots with adjacent homorganic consonants*

sd	'send'
zt̓	'lean'
lbm	'be rational, shrewd'
lkʷk	'seal with a cover'
gsṡ	'reproach, warn, correct'
wsd	'take (along)'
bt̓s	'break rope, wire'
szy	'not come true'
sṡy	'waste away from disease'
ħrnk	'snore'
mnt̓s	'tear out by roots'

The table in (43) shows the observed occurrences of such adjacent homorganic consonants in the corpus (O); the expected occurrences based on the frequency of relevant consonants in the necessary positions (E); and the degree to which cooccurrence is actually permitted (O/E).[3]

[3] In the tables here, figures for E have been rounded to whole numbers, but the exact values were used in calculating O/E.

(43) *Cooccurrences of adjacent homorganic consonants*

	O	*E*	*O/E*
guttural	0	78	0.00
velar	1	125	0.01
coronal obstruent	65	242	0.27
coronal sonorant	27	261	0.10
labial	2	132	0.02

Thus only one root contains two velars in adjacent positions—specifically, /lk^{w}k/ in (42)—but the overall frequency of velar consonants would lead us to expect 125 such roots. It can be observed that the effect is weaker for coronals than for the other classes; see also below.

Homorganic consonants are more common when nonadjacent than when adjacent, which the standard approach in (22) fails to capture in a principled way. Roots of this type are given in (44), and the numerical summary in (45). By definition, no biliterals appear in this group.

(44) *Some roots with nonadjacent homorganic consonants*

ṫmt	'stare at'
fsm	'become pale or discolored'
drt	'delimit a field'
bg^{w}m	'be sly, taciturn'
ħsʔ	'be dry (esp. of hair)'
zmd	'become related by marriage'
ṫys	'repopulate a region with former residents'
mlbs	'be weak and incapable of work'
wslt	'lie, cheat; miss a target'

The term 'nonadjacent' here includes only consonants separated by exactly one consonant. Chi-square tests show excellent significance for the adjacent and separated-by-one cases ($p \leq 0.001$), but no significance for the separated-by-two cases ($p \leq 0.250$): the number of tokens for the last category is too small. Data from this much smaller group of pairings separated by two consonants (i.e. I-IV in quadriliterals) are excluded in (45) to (49), but are consistent with these results.

(45) *Cooccurrences of nonadjacent homorganic consonants (separated by one consonant)*

	O	*E*	*O/E*
guttural	6	49	0.12
velar	10	73	0.14
coronal obstruent	112	162	0.69
coronal sonorant	106	140	0.76
labial	18	68	0.26

Since identical consonants are also homorganic, they are included in (45). The table in (46) compares more directly the strength of the OCP effect for these two classes of cases, divided by place of articulation. The lower the value of O/E, the stronger the inhibiting effect.

(46) *O/E values for homorganic consonants by adjacency*

	adjacent	*nonadjacent*
guttural	0.00	0.12
velar	0.01	0.14
coronal obstruent	0.27	0.69
coronal sonorant	0.10	0.76
labial	0.02	0.26

For each place of articulation, the effect is weaker when nonadjacent; that is, the value O/E is higher for the nonadjacent pairings. It is also the case that the OCP effect is weaker for coronals in both situations. It should be noted in addition that since biliterals are inherently excluded from the nonadjacent class, there is a possible confounding of the effect of adjacency with some difference between biliterals and other roots. However, the data in §5 indicate that biliterals and triliterals pattern in the same way.

3.3.2. Identity

Adjacent identical consonants are absolutely prohibited (so this again excludes biliterals), but the following roots illustrate the fact that identical consonants do occur in nonadjacent positions.[4]

[4] Some of these roots have known historical origins in roots without identical

(47) *Some roots with nonadjacent identical consonants*

sls	'plow a field the third time'
lʔl	'raise, lift off the ground'
trt	'tell stories, old traditions'
dndw	'threaten to hit'
mslm	'convert to Islam'

Only 12 such roots exist in the corpus, but just 125 are expected in the first place, since the requirement of full identity is quite stringent.

(48) *Nonadjacent cooccurrences of identical consonants (separated by one consonant)*

	O	*E*	*O/E*
guttural	0	16	0.00
velar	1	14	0.07
coronal obstruent	7	30	0.23
coronal sonorant	2	43	0.05
labial	2	22	0.09

The table in (48) excludes six roots with identical labiovelars in the pattern $C_iC_jC_iC_k$, which appear to be modified reduplications; see below for discussion.[5] Within the nonadjacent set, **nonidentical** consonants of the same articulatory class are far more common than those which are identical (Pierrehumbert 1993).[6] This is not predicted at all by the place OCP.

consonants. For example, /sls/ is the root for 'three'; earlier this was /śls/ (as in Ge'ez: Leslau 1987), but in Tigrinya the two fricatives merged. (However, other branches of Semitic also have identical obstruents, e.g. Arabic /θlθ/, Hebrew and Akkadian /šlš/.) Similarly, the root /mslm/ is from the Arabic noun *muslim*, where the /m/ belongs to a prefix and the original root is /slm/, with just one labial.

[4] Without this omission, the figures in (48) for velars are O=7, E=14, and quite aberrant O/E=0.51.

[6] The 'nonadjacent homorganic' figures in (45) are the sum of 'nonadjacent identical' in (48) and 'nonadjacent nonidentical' (but, of course, homorganic) in (49).

(49) *Nonadjacent cooccurrences of nonidentical consonants (separated by one consonant)*

	O	*E*	*O/E*
guttural	6	33	0.18
velar	3	59	0.05
coronal obstruent	105	132	0.80
coronal sonorant	104	97	1.07
labial	16	46	0.35

As usual, among the coronals the prohibition is weaker. In fact, no prohibitory effect is found for nonadjacent coronal sonorants, where O/E>1.

Important subregularities exist within the major articulatory classes (for Arabic, cf. Yip 1989, Padgett 1992, Pierrehumbert 1993, McCarthy 1994). The guttural class, for example, consists of the laryngeals /h, ʔ/ and the pharyngeals /ħ, ʕ/. While a laryngeal occasionally combines with a pharyngeal, there are no cooccurrences at all within either of these subclasses. This gap is particularly striking in the case of the pharyngeals, which are rather common in the corpus.

(50) *Cooccurrences of gutturals (regardless of adjacency)*

	O	*E*	*O/E*
laryngeal + pharyngeal	6	49	0.14
two laryngeals	0	8	0.00
two pharyngeals	0	78	0.00

This greater inhibition is due to relative similarity: the more similar the consonants are, the less they cooccur. So while /h, ʔ, ħ, ʕ/ share the property of being gutturals and their cooccurrence is consequently disfavored, the subset /ħ, ʕ/ shares the further property of being pharyngeals, and the prohibition on cooccurrence is absolute in this corpus.

Among coronals, the very fact that the sonorants and obstruents are placed in separate classes is due to the same notion of similarity. Perhaps due to the large size of the coronal class and the many distinctions that exist among its members, the central [±sonorant] dichotomy is strong enough to eliminate any OCP effect (cf. Greenberg 1950: 162f, Padgett 1992). The following table illustrates the lack of an effect across the two classes in Tigrinya.

(51) *Cooccurrences of a coronal sonorant and obstruent*

	O	*E*	*O/E*
adjacent	744	625	1.10
nonadjacent	339	290	1.17

Compare these large values for O/E to the lower values in (46). Within each of these coronal classes, we find further effects of relative identity. Among the coronal sonorants, /n/ combines rather freely with /l, r/, but the liquids never cooccur with each other (cf. Greenberg 1950: 172f, Pierrehumbert 1993).

(52) *Cooccurrences of coronal sonorants (regardless of adjacency)*

	O	*E*	*O/E*
one each of /n, l/	46	81	0.57
one each of /n, r/	85	99	0.86
one each of /r, l/	0	91	0.00

This result suggests that the most salient feature among the sonorants is [±nasal], splitting the members into the two classes /n/ and /l, r/. Within either class the cooccurrence restriction is absolute in effect,[7] but across the classes the effect is weak.

Among the coronal obstruents, the important dichotomy is defined by [±continuant]. The fricatives /s, z, ś/ combine rather freely with the stops /t, d, ť/, but within these classes cooccurrence is much less frequent (cf. Padgett 1992, Pierrehumbert 1993).

[7] Strictly speaking, the effect is not absolute within the /n/ class, because there are two quadriliterals which contain two instances of /n/: *tʌ-mʌnk'ʌn-* 'be cunning' and *tʌ-kʌnawʌn-* 'succeed'. These positions, II and IV, are the typical locations of those identical consonants that do occur in quadriliterals, and seem to involve a kind of semi-reduplication. There are also two roots with identical liquids: the common root /lˤ/ 'on, above' (originally from the preposition *la-* plus the root /ˤly/ 'up, high': Leslau 1987: 304) and the unusual quinquiliteral *gʌrʌngʌr-* (16).

(53) *Cooccurrences of coronal obstruents (regardless of adjacency)*

	O	*E*	*O/E*
fricative and stop	178	216	0.82
two fricatives	9	103	0.09
two stops	9	112	0.08

See (61) below for further data on coronal cooccurrence effects.

Finally, within the velar group, there is a striking difference between the plain velars /k, g, ḳ/ and the labiovelars /kʷ, gʷ, ḳʷ/. Cooccurrences among the labiovelars are far more common than among the plain velars.

(54) *Some roots with multiple velars*

lkʷk	'seal with a cover'
gʷnkʷ	'transport (grain) to threshing floor'
gʷɦnḳʷ	'have chin joined to chest'
ḳʷyḳʷ	'quarrel'

The only root which contains two plain velars is /grngr/ in (16), which is excluded from the analysis. Even if this root were added to the calculation for the table in (55), it would not change the stark difference between the relatively frequent cooccurrences of labiovelars (O/E=0.48), as opposed to cases where at least one plain velar is involved (less than 0.02).

(55) *Cooccurrences of velars (regardless of adjacency)*

	O	*E*	*O/E*
plain velar + labiovelar	2	88	0.02
two plain velars	0	96	0.00
two labiovelars	10	21	0.48

While a rather large number of labiovelar pairs exist, they are all in nonadjacent positions, where there seems to be no OCP effect at all.

(56) *Cooccurrences of labiovelars*

	O	*E*	*O/E*
adjacent	0	11	0.00
nonadjacent	10	10	1.05

Excluded from (48) above, but included here in (56), are six suspicious cases of cooccurring labiovelars. They all involve positions I and III in quadriliterals, suggesting a type of semi-reduplication. Five of them have /r/ in position II: /kʷrkʷm, kʷrkʷħ, kʷrkʷʔ, gʷrgʷħ, gʷrgʷċ/, while the sixth has /r/ in position IV: /ƙʷnƙʷr/. It is likely that most or all of these derive historically from reduplicated biliterals by substitution of /r/ (or /n/) in position II, or from a triliteral with infixation of the first consonant between the last two. Both possible origins are attested for Arabic, e.g. *qafqaf/qarqaf*, *ṭarib/ṭarṭab* (Fleisch 1968: 128f). Another scenario can be suggested for /gʷrgʷħ/ 'empty a container', which resembles /drgʷħ/ 'pour liquid from a vessel': here the initial /d/ has apparently been replaced to create a semi-reduplication. A plausible connection also exists between /ƙʷnƙʷr/ 'have sunken eyes' and /nƙʷr/ 'be blinded'. Whatever the exact origin of each root, the original forms were probably consistent with the OCP.

If these six roots are omitted from (56), overall O/E for labiovelars is reduced to 4/21 = 0.19, mitigating their difference from plain velars, but certainly not eliminating it. The remaining asymmetry—as well as the existence of the six aberrant roots—is perhaps due to the fact that the labiovelars are not inherited from Proto-Semitic, and seem attributable from the Cushitic substrate in Ethiopia (cf. Dillman and Bezold 1907: 50f). If the source language(s) for borrowed words did not enforce a place OCP on roots, then the resulting roots will bring with them violations of the native Semitic pattern. As we have seen, this prohibition is not absolute, and a certain number of such violations can be tolerated.

An additional point of interest regarding the labiovelars is their status relative to the labials. In Arabic, it is well known that consonants with secondary pharyngealization do not resist combination with the pharyngeal class (Greenberg 1950, McCarthy 1994, Pierrehumbert 1993). A similar nonequivalence of secondary and primary articulations exists for labiality in Tigrinya, since labiovelars occur quite often with labials.

(57) *Cooccurrences of a labial and labiovelar*

	O	*E*	*O/E*
adjacent	71	85	0.84
nonadjacent	98	60	1.64

There is apparently a weak effect in adjacent position, but certainly no effect for nonadjacent tokens. It is not clear whether this difference is related to the considerable adjacency asymmetry for labiovelars as a class, seen in (56). Further research on the history of labiovelars in Tigrinya may elucidate these patterns.

4. The Similarity Model

As Pierrehumbert (1993) notes, the standard approach to Semitic consonant cooccurrence restrictions requires two constraints: the total OCP, acting on adjacent segments, is absolute, while the place OCP, acting on potentially nonadjacent articulator nodes, is not absolute. The account is therefore not unified. In addition, the gradient effect of the place OCP, based on relative adjacency and relative similarity, is unexplained. Pierrehumbert's data for Arabic, as well as the data for Tigrinya presented in §3, show that the extent to which the cooccurrence of two consonants is disfavored depends on how close they are (degree of adjacency) and how many features they share (degree of identity); see also Greenberg (1950). It appears, then, that the OCP is not an iron-clad principle, but is instead a matter of degree.[8]

Pierrehumbert (1993) proposes that there is only a place OCP which targets (tier-adjacent) identical articulator nodes, but whose strength of effect is proportional to the similarity of the consonants which have those identical nodes. Similarity increases with proximity and featural identity, and these effects are cumulative. The case of maximal similarity—where the consonants are both adjacent and fully identical in their features—is prohibited absolutely. The extreme case of enforcement derives the effect of the total OCP, but is treated formally as a subcase of the place OCP. Thus by incorporating gradience into the analysis, the disunity of the standard approach (both place and total OCP) can be eliminated.

[8] See Berkley (1994a,b) for similar arguments based on English consonant cooccurrences.

This formulation relates to a more general notion of perceptual similarity, which is independently known to depend on the presence of intervening material (cf. Zechmeister and Nyberg 1982) and to be analyzable in terms of feature sets (cf. Tversky 1977). Analogies for Semitic root consonant strings are given in (58), using diagrams broadly inspired by those given by Tversky.

(58) a. *Adjacent, identical* (prohibited by OCP); cf. bbk

b. *Adjacent, nonidentical* (disfavored); cf. bfk

c. *Nonadjacent, identical* (disfavored); cf. bkb

d. *Nonadjacent, nonidentical* (mildly disfavored); cf. bkf

The smiling face in (58a) is more easily recognized as similar to an identical face when that second face is adjacent to it, in essence facilitating comparison. In the same way, a /b/ is easily recognized as identical to another /b/ when it is adjacent to it—and so this root type is ruled out. When similarity is actually lessened by a change in features—whether a change in expression for the face in (58b), or a change in continuancy and voicing for /f/—the two objects are less offensive to any principle against adjacent identical items. But a reduction in **perceived** similarity is achieved by moving the objects further apart, with an intervening object, whether another kind of "face" (58c) or another consonant. The two effects combine in a case like (58d), where nonidentical, nonadjacent objects are the least likely to be perceived as similar.

Pierrehumbert (1993) proposes a simple mathematical formula for calculating the degree of Similarity according to featural identity.[9] It

[9] For a revised approach, not pursued here, see Frisch, Broe, and Pierrehumbert (1995). See also Pierrehumbert (1994) for more general discussion.

depends on the distinctive features that are assumed for the consonants in question—more specifically, on how many of these features of the consonants are the same, and how many are different.

(59) a. Same = number of shared features
b. Different = number of features which differ
c. Similarity (S) = Same/(Same + Different)

The advantage of this formulation is that it produces a result that ranges from 0, if no features are the same: $0/(0+n)$; to 1, if no features are different: $n/(n+0)$. I propose an additional metric of Distinctness, which is simply the difference between Similarity and 1.

(60) Distinctness (D) = 1 – S

Ideally, this figure will stand in rough correspondence to O/E. That is, as Similarity increases, Distinctness (D) decreases, and the greater strength of the OCP effect should also lead to a lowering of the value for O/E.

This approach provides a means of testing proposals for feature specifications (cf. Pierrehumbert 1993). Here I pursue an interesting confirmation of recent arguments that laryngeal features are privative. Consider the following fricative-stop pairings according to laryngeal articulation.

(61) *Cooccurrences of coronal obstruents (regardless of adjacency)*

	O	*E*	*O/E*
voiceless /s, t/	39	70	0.56
voiced /z, d/	8	43	0.19
ejective /s̀, t̀/	4	33	0.12

The voiceless consonants cooccur much more freely than either the voiced or ejective pairs. Yet at first glance it seems that each of these pairs is comparable, differing only in [continuant]. To capture the special status of the voiceless pair, /s, t/ must count as less similar than either /z, d/ or /s̀, t̀/.

There is considerable evidence from a wide range of languages and phonological phenomena that the features which define these pairs, i.e. [voiced] and [constricted glottis], are privative (Mester and Itô 1989,

Lombardi 1991, 1995); that is, they exist only in their positive values, and there is no formal object corresponding to [–voiced] or [–constricted glottis]. A plain voiceless obstruent, then, bears no laryngeal features at all.

(62)

	s	z	ṡ	t	d	ṫ
[Coronal]	+	+	+	+	+	+
[continuant]	+	+	+	–	–	–
[voiced]	0	+	0	0	+	0
[constricted glottis]	0	0	+	0	0	+

In order to capture this difference in feature marking, the determination of similarity must ignore the joint lack of a feature (cf. Yip 1989).

(63)

Same	[+ +], [– –]
Different	[+ –], [+ 0], [– 0]
Neither	[0 0]

Under these assumptions, pairs of consonants in which both possess the same privative feature ([voiced], [constricted glottis]) receive a greater relative value for Same and therefore greater S. Where both members of a pair lack a feature, that shared property is not counted and a smaller value for S results.

(64)

	Same	*Different*
voiceless /s, t/	[Cor]	[cont]
voiced /z, d/	[Cor]	[cont, voiced]
ejective /ṡ, ṫ/	[Cor]	[cont, cg]

Using the formulas given in (59) and (60), we arrive at the following values for Similarity and Distinctness. The values for O/E in (61) are repeated below as well.

(65)

	S	*D*	*O/E*
voiceless /s, t/	0.50	0.50	0.56
voiced /z, d/	0.67	0.33	0.19
ejective /ṡ, ṫ/	0.67	0.33	0.12

While the correspondence of D and O/E is far from exact, the overall pattern is the same: the voiceless pair is higher than the other two, which are (roughly) the same as each other. The important point is that the

achievement of this asymmetry depends on accepting the privative status of laryngeal features, and provides support for that conclusion from an unexpected source.

Although they cannot be pursued here, interesting questions arise from the nature of the calculations required to correctly predict the strength of the OCP effect based on the featural representations (see Frisch, Broe, and Pierrehumbert 1995). In particular, certain features seem to carry more weight than others. For example, the table in (52) suggests that a difference in [nasal] entails greater distinctness than a difference in [lateral], thereby permitting freer cooccurrence of /n/ with /l/ or /r/ than of the two liquids together (cf. Pierrehumbert 1993). The special status of [lateral] in the system, as a feature which serves to distinguish only this pair of sounds, may be the ultimate explanation; or it might be captured in approaches to the representation of sonorants, such as the Spontaneous Voice node of Rice and Avery (1991). I leave resolution of such questions for future research.

5. The Role of Root Length

In this section I consider an additional hypothesis which is testable due to the inclusion of more than just triliterals in the corpus. Specifically, is there evidence that perceived similarity of adjacent consonants decreases as the total number of consonants in the root increases? We might call this the 'distraction' factor: just as an intervening item reduces perceived similarity, perhaps the presence of flanking items serves a similar function.[10]

This hypothesis can be meaningfully tested in Tigrinya only for the coronals, because the other classes cooccur too infrequently in all root types: see (43) and (45). Among the coronal sonorants, there is a significant difference between tri- and quadriliterals, but not between bi- and triliterals. Since biliterals are included in the comparison, only adjacent pairs are considered for the longer roots.

[10] Root length is clearly relevant to significance. Given 27 consonants, there are $27^2 = 729$ possible biliterals, $27^3 = 19{,}683$ possible triliterals, and 27^4 = over 14 million possible quadriliterals. Thus the absence of a particular cooccurrence among the biliterals is far more significant than the absence of a cooccurrence among the triliterals.

(66) *Cooccurrences of adjacent coronal sonorants*

	O	E	O/E
biliteral	0	15	0.00
e.g. *nr* (absent)			
triliteral	8	178	0.04
e.g. *knr, nrk* (very rare)			
quadriliteral	19	67	0.28
e.g. *bknr, bnrk, nrbk* (uncommon)			

Notice that both bi- and triliterals show a strong OCP effect, while quadriliterals show a much weaker effect. A possible explanation is that the presence of the other consonants creates a distraction effect which reduces perceived similarity, and thus reduces the strength of the OCP. However, it is surprising that the same effect does not distinguish the bi- and triliterals.

Among the coronal obstruents, consideration of the full data does not yield the same pattern. Rather, we find very similar O/E values for each root type.

(67) *Cooccurrences of adjacent coronal obstruents*
('quadriliteral' = all pairings: I-II, II-III, III-IV)

	O	E	O/E
biliteral	9	30	0.30
triliteral	44	168	0.26
quadriliteral	12	43	0.28

These data suggest that there is no distraction effect. However, the pattern for the obstruents closely parallels that for the sonorants if we omit the pairing of the last two consonants (III-IV) in the quadriliterals. This pairing is strikingly aberrant, as demonstrated by its divergent O/E value.

(68) *Cooccurrences of adjacent coronal obstruents in quadriliterals*

	O	E	O/E
pairing I-II	4	8	0.50
pairing II-III	4	8	0.49
pairing III-IV	4	27	0.15

In other words, the pattern *bkts* is proportionally far rarer than *tsbk* or *btsk*. The explanation for this asymmetry is unknown, but possibly diachronic. It is interesting to note that the absolute numbers of observed cooccurrences are the same; but in III-IV the expected numbers are much greater, because for quadriliterals in general, position IV contains a large number of coronal obstruents. This in turn is perhaps because some coronal-obstruent suffix has been incorporated into many historically triliteral roots, but subject to the OCP, so that its current distribution is skewed in favor of roots which do not contain another coronal obstruent, at least in adjacent position. At any rate, if we exclude the pairing III-IV from the quadriliteral data, we arrive at a pattern more similar to that for the sonorants in (66).

(69) *Cooccurrences of adjacent coronal obstruents*
('quadriliteral' = pairings I-II, II-III, but not III-IV)

	O	*E*	*O/E*
biliteral	9	30	0.30
triliteral	44	168	0.26
quadriliteral (nonfinal)	8	16	0.49

As with the sonorants, the bi- and triliterals are roughly the same, while the quadriliterals show much greater freedom of cooccurrence.

While the modification of the data in (69) produces a similar pattern to that in (66), which together might be taken to suggest a distraction effect in the quadriliterals, the fact remains that there is no such difference between the bi- and triliterals. Since the quadriliterals introduce considerable complications—they are in some cases reanalyses of a triliteral plus an affix, or involve semi-reduplications—there are many other potential explanations for their differences from the shorter roots. Based on the more straightforward bi- and triliteral data, there does not in fact appear to be any distraction effect.

5. Conclusion

I have shown that the patterning of root consonants in Tigrinya obeys the same restrictions on homorganic cooccurrences found in Arabic and other Semitic languages. In particular, the data support the conclusion of Pierrehumbert (1993) that the OCP which holds of place features relies on a gradient notion of similarity. The case of maximal similarity (adjacent and

identical) is ruled out; identical consonants obscured by nonadjacency are permitted in small numbers; nonidentical (homorganic) consonants are permitted with some freedom if adjacent, and with considerable freedom if separated by one or more consonants. Comparison of bi- and triliteral roots also suggests that the number of consonants in a root has no bearing on the nature of consonant cooccurrences found in the root.

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Duration of Onset Consonants in Gay Male Stereotyped Speech

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Gaudio (1994) found that listeners are largely accurate in identifying the sexual orientation of male speakers from recordings of a read passage not marked for gay content. In search of the phonetic cues which listeners use in this identification, Gaudio studied F0 differences between gay and straight male speakers. Gaudio subjected the recorded speech to multiple kinds of F0 analysis (mean F0, median F0, etc., as well as several different measures of pitch dynamism), and concluded that range and variability of F0 do not appear to correlate with sexual orientation, at least by any of the measures used.

If listeners can identify the sexual orientation of speakers with reasonable reliability, then what are the salient phonetic cues, if not range and variability of F0? One possibility is that F0 plays an important role in sexual orientation identification, but does so in a way which has not yet been identified. Another possibility is that some or all of the salient cues are unrelated to F0. Without ruling out the former possibility, the present study[1] takes a preliminary look at some variables not related to F0. I will argue that the performance of a gay male stereotyped voice involves the systematic lengthening of certain consonants.

My general methodology differs from Gaudio's in one major regard. Gaudio recorded gay and straight men speaking in their ordinary voices, and then compared the two groups. By contrast, the speakers in the present study (who included both gay and straight men) were asked to read the same passage twice, once in an "ordinary" voice, and again in a "queeny" voice.

One must be extremely cautious in making inferences about natural speech on the basis of a consciously performed stereotype: there is no guarantee that the cues used by listeners to identify gay male speakers are the same cues which speakers employ to deliberately produce an exaggerated gay male stereotype. In spite of this shortcoming, there were two reasons for my choosing this methodology over one involving the comparison of the ordinary read speech of gay and straight male speakers. First, the question of how speakers perform a gay male stereotype is an interesting one in its own right; and when our knowledge reaches a state where it is possible to do so, it will be of interest to compare the cues used in stereotype production against

[1]This paper has benefited from comments from a long list of individuals. Special note should be given to Gene Buckley, Rolf Noyer, Mark Liberman, William Labov, and two anonymous reviewers. Any errors in this work are of course my own.

the actual cues used in sexual orientation identification of males. Second, and more importantly, we presently simply do not know what variables are involved in either of these two tasks (stereotype production vs. identification of sexual orientation on the basis of natural speech). It is a reasonable guess that the variables involved in stereotyped speech are likely to undergo a more extreme exaggeration than those in the former, thus lending themselves to easier identification by the linguist. Once some of the variables involved are identified, it becomes a much easier task to determine whether a more subtle variation along the same dimensions helps listeners to distinguish gay men from straight men in non-stereotyped speech. The present study is thus an instance of searching where the light is best, which is not an unreasonable place to look when next to nothing is known.

Since there are many factors which can affect segment duration, this study restricts its scope to the onsets of word-initial syllables bearing primary stress, thus controlling for syllable position and stress. The possibility that duration of consonants in other environments plays a role in the performance of a gay male stereotype is not ruled out and is left for future study.

The present study involves two separate experiments.

1. First Experiment

The subjects of the first experiment were three white males who were native speakers of American English. One self-identified as gay and two self-identified as straight; all had at least a bachelor's degree[2]. Both of the straight speakers had some graduate-level training as linguists, but the gay speaker had none.

The task given to the subjects was to read a short printed story, first in "your ordinary voice", and then in "the queeniest, most flaming gay stereotype you can do." The story was written to exclude any gay-specific content, and was intended to resemble extemporaneous speech, while

[2]Actually, a total of seven subjects were recorded for the first experiment. Three of the subjects were more or less arbitrarily excluded from analysis because of the time required to segment the passages (approximately three hours per recording, for a total of around six hours per speaker). The speech of four subjects was segmented, but the data of one speaker were excluded from the analysis since they were wildly unlike those of the other speakers in nearly every regard, even for variables where the other speakers were consistent both across speakers and across stereotyped and non-stereotyped speech. The recordings of this subject were played for a group of a half dozen linguists, who agreed with my subjective assessment that the speaker had some mild sort of speech disorder.

including as many tokens of the types under study as reasonably possible[3].

Subjects were digitally recorded at a sampling rate of 8000 Hz on a Sun Workstation. Measurements in milliseconds of certain segments were later made from spectrograms of the recordings using the xwaves software package. The following segments were measured when they occurred in the onsets of stressed word-initial syllables:

- Closure and aspiration time for /p/, /t/, /k/ in the environment #_V (= 6 token types)
- Frication time for /s/ in the environments #_V and #_mV (= 2 token types)
- Frication, closure, and voice onset time for /sp/, /st/, /sk/ in the environments #_V and #_rV, as well as frication, closure, and voice onset time for /sp/ in the environment #_lV (= 21 token types)
- Frication time for /f/ in the environments #_V, #_lV, #_rV (= 3 token types)
- Duration of /h/ and /l/ in the environment #_V (= 2 token types)

The rationale for this choice of token types was as follows. In preliminary recordings, there seemed to be differences in the duration /l/ (the effect was particularly pronounced in the word 'believe', but this word was later excluded from measurement when the experiment was restricted to word-initial onsets). Further, an similar effect was informally noticed for word-initial /s/ as it occurs in complex clusters. There is a common stereotype

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[3] The text of the story used in the first experiment was as follows: "You wouldn't believe what just happened! I was just sitting here studying, and it was getting pretty late, and I was going to go to bed here pretty soon. But then I started hearing these people screaming out in the street. So I got up, and I was going to yell out the window, 'Will you please hold it down out there!' But as soon as I poked my head out, I smelled smoke, and you know that ski store down at the corner? It was all full of flames. There were all these people in the apartments upstairs screaming out of the windows; they must have been trapped. I was scared that the fire might spread down the street to my place too. Then I heard sirens screaming, and all these cop cars and fire trucks pulled up. The firemen went up on ladders and helped all the people get out. One girl looked like she had bad burns on her skin, and this other guy fell, and the ambulance guys had to put a splint on his leg. I could see the guys down on the ground; they were having some kind of problem with the fire hydrant, but they finally got the hoses hooked up to the spouts, and then they went up and poked a hole in the roof with a big metal kind of stick, and they sprayed tons and tons of water in. It took them better than two hours to get the fire out. You know that Spanish student down the hall from me? Later, he told me he heard the owner set the fire himself. The whole thing was a big scam to get the insurance money. Unbelievable!"

that gay male speech is 'breathy' or 'lisping', which could conceivably be realized in the durations of aspiration and of /s/, respectively (i.e., instead of or in addition to actual laryngeal breathiness on vowels or particular spectral qualities of /s/); a group of onsets was chosen to study the duration of aspiration and of /s/ in detail. Another fricative, /f/, was chosen to determine whether any effects discovered with /s/ were obviously true of other fricatives as well. Naturally, this selection omits a large group of possible English onsets. The overall intent was to cast as wide a net as possible within the bounds of a single, manageable study.

Excluded from measurement were tokens occurring in an environment with a phonetically confounding factor which made measurement impossible or of questionable salience. For example, /s/-frication time was not measured in the case where the word-initial /s/ is preceded by a word-final /s/, as in "...upstairs screaming", since there is of course no basis for dividing the duration of the single observed region of frication between the two /s/ segments (the story script was written with the general avoidance of such cases in mind, but there remained some problematic cases which were explicitly excluded from measurement).

Altogether, a total of 41 token types were measured[4]. The script contains 176 tokens for which values were sought. Instances where measurements could not be obtained (because of speaker misreadings of the script, unresolvable ambiguity in the spectrogram, etc.) were not coded and were excluded from analysis.

1.1. Analysis of the First Experiment

Boxplots were produced for each of the 37 duration token types using DataDesk, a Macintosh statistical package. The stereotyped vs. non-stereotyped recordings for each speaker were compared; and these three pairs of boxplots were in turn compared, giving a total of six boxplots per variable. The boxplots were examined in search of cases where the gay

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[4] Additionally, the four following token types were coded with binary values for application or non-application of the relevant rule:

- •Flapping: t, d → □ / ʌ□_ʌ
- •gonna-contraction (going to → gonna)
- •Final t deletion in the word "just"
- •Use of /-in/ rather than /-□ŋ/ for the -ing suffix

However, it became immediately apparent that there were too few of these token types to make any kind of analysis possible; a substantially larger corpus would be needed for the investigation of these variables.

stereotyped measurements varied from the non-stereotyped measurements in a consistent way across speakers.

For the great majority of variables, no regularity of this sort was observed, although it should be noted that some patterns may have been obscured by the relatively small number of tokens in each category. However, there were a few important exceptions where such an apparent pattern was to be seen, i.e. variables which might serve as cues for the sexual orientation of the speaker.

First, duration of /l/ in the environment #_V was consistently longer across speakers in stereotyped than in non-stereotyped speech.

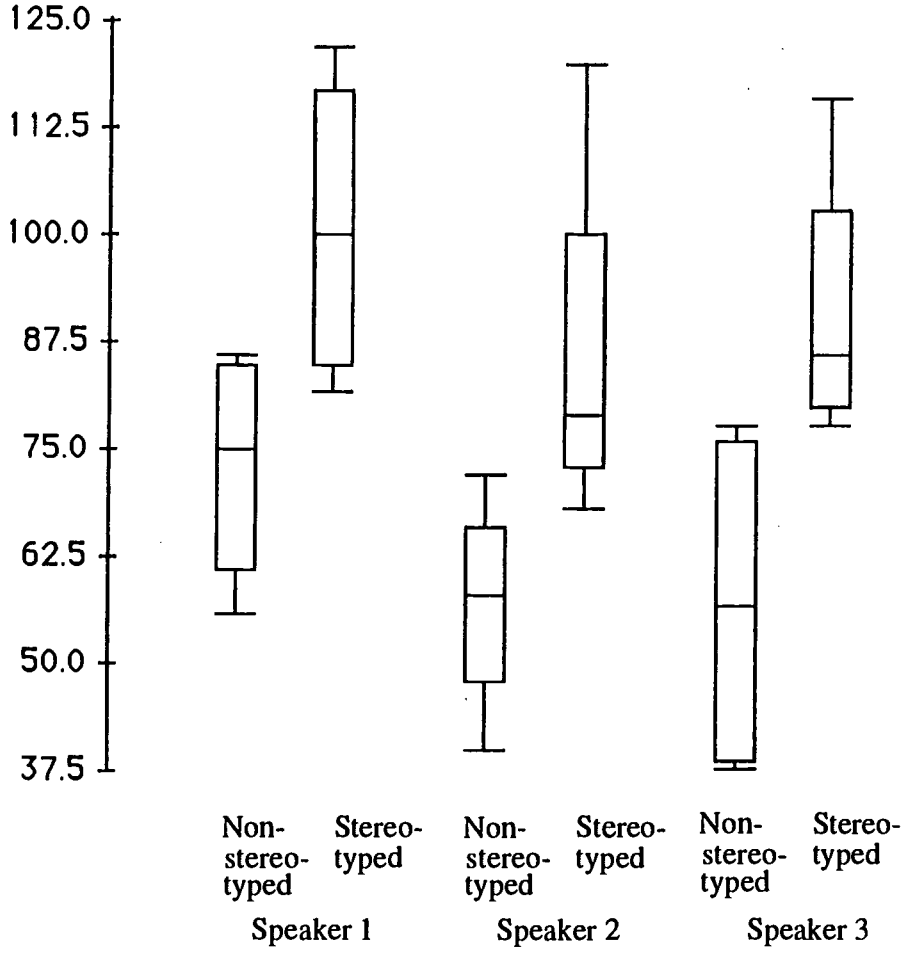


Figure 1: Duration of /#l/ (n=5 per boxplot)

Using the DataDesk statistical analysis package for the Macintosh, pooled t-tests were performed for each speaker comparing $\mu 1$-$\mu 2$, with a Ha of $\mu 1 \neq \mu 2$, for the stereotyped and non-stereotyped /l/ durations. For none of the individual speakers was the result significant at p=.05 (p=.0579, .0949,

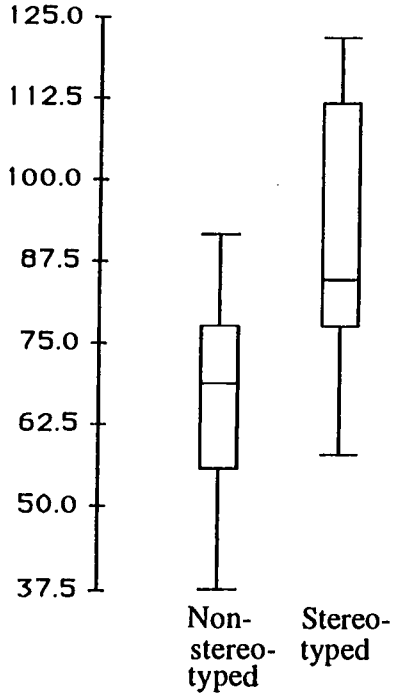
.0949, for the three speakers respectively), which is not surprising given the relatively small number of tokens. However, when the non-stereotyped tokens for the three speakers are pooled (giving a total of 15 tokens in each of the two categories) the difference is significant (p=.0015)[5].

Second, frication of /s/ in #skV clusters was consistently longer in

[5] Since the means for stereotyped and non-stereotyped /l/ duration differ across speakers, it could be argued that some kind of normalization should be applied before lumping speakers together in this way. As an aside, it is not obvious what kind of normalization should be used in the case where each speaker has *two* means, which must somehow be considered in tandem. In any case, I think the fact that the lumped data differ significantly (in spite of not being normalized) actually argues that the difference is a robust one.

Suppose that speakers do in fact systematically lengthen /l/ when producing a gay male stereotype, but that speakers differ with what durations they count as a "long" or "short" /l/ (such a difference between speakers could be as simple as a function of overall speaking rate). If this is the case, then we should expect that a failure to normalize the data would tend to *obscure* this pattern when speakers are lumped, rather than create a false pattern where none actually exists. If the pattern remains in spite of failure to normalize, it would seem to mean that the pattern is robust.

When the raw data for /l/ are lumped, the resulting boxplot is as follows:



Durations of /#lV/for all three speakers (p=.0015)

stereotyped than in non-stereotyped speech.

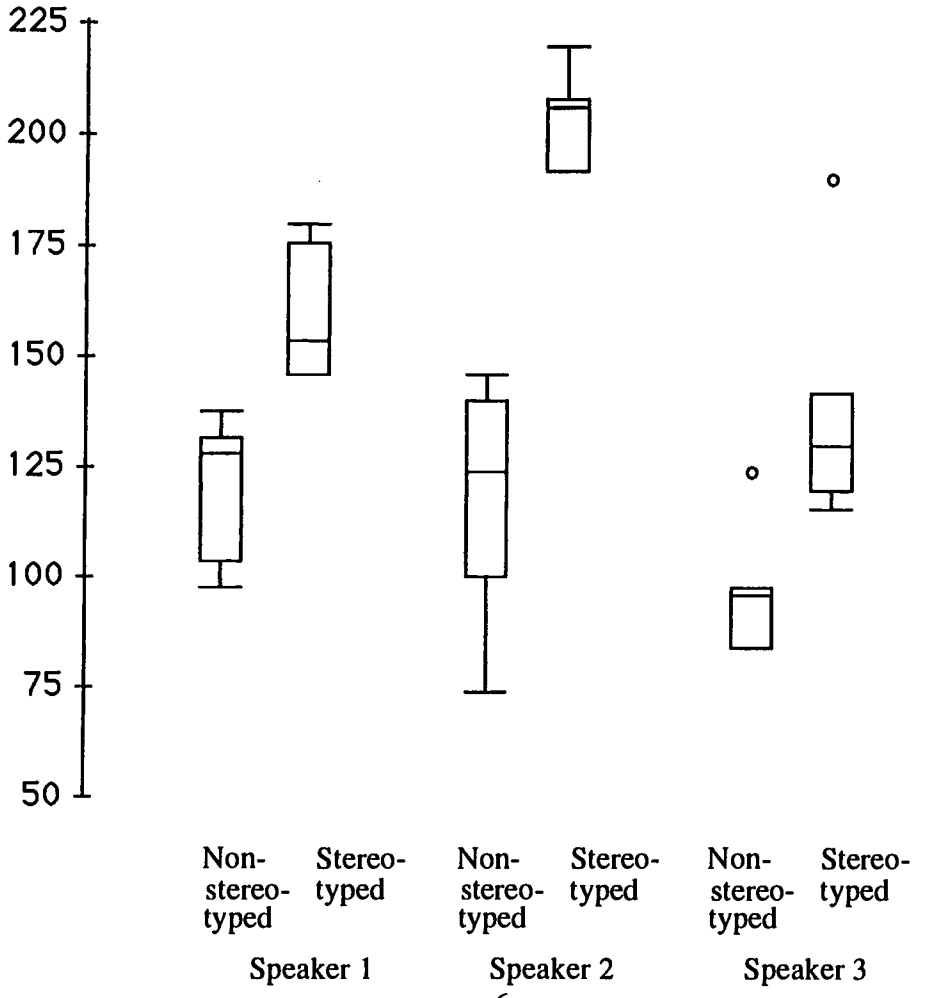


Figure 2: Duration of /#sk/ frication[6]. (n=5 per boxplot)

Again, t-tests were performed comparing each speaker's stereotyped and non-stereotyped speech. For each individual, the difference was significant (p=.0058, .0003, .0239, respectively).

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[6]The DataDesk software package uses the ° symbol in boxplots to mean "an extreme data point," i.e. one which falls outside the whiskers. The upper whisker extends to the highest data point not outside:

high hinge + 1.5 (high hinge - low hinge)

The lower whisker extends to the lowest data point not outside

low hinge - 1.5 (high hinge - low hinge)

The * symbol found in later boxplots represents "a very extreme data point"; the formulae are the same as those for "extreme data points", except that the coefficients are 3.0 rather than 1.5 (William Labov, personal communication).

The pattern found for #skV frication time might also hold true for #spV frication time; however, since there are only two tokens of #spV in the script, nothing conclusive can be said about this variable at present. The lumped #spV tokens for the three speakers produce a pattern at least consistent with that of #skV:

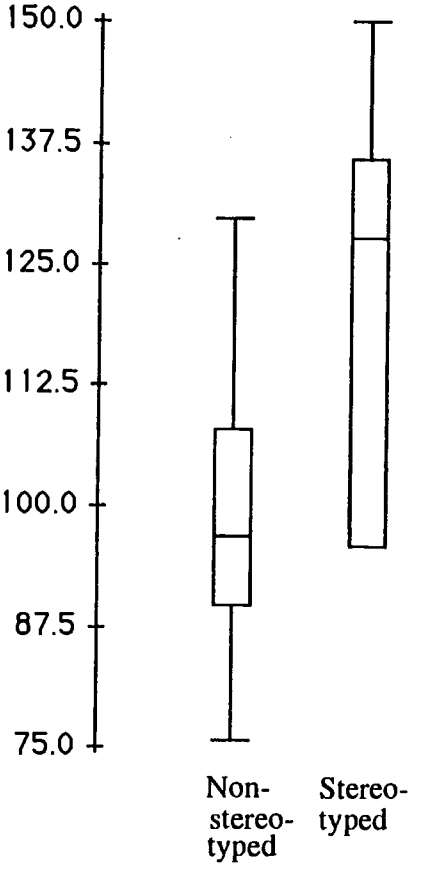

Figure 3: Lumped durations for /#sp/ frication

A t-test over these two groups is suggestive (p=.0803). This variable is studied in greater detail in the second experiment.

By contrast, frication time for #stV appears not to participate in the pattern of #skV (and possibly #spV):

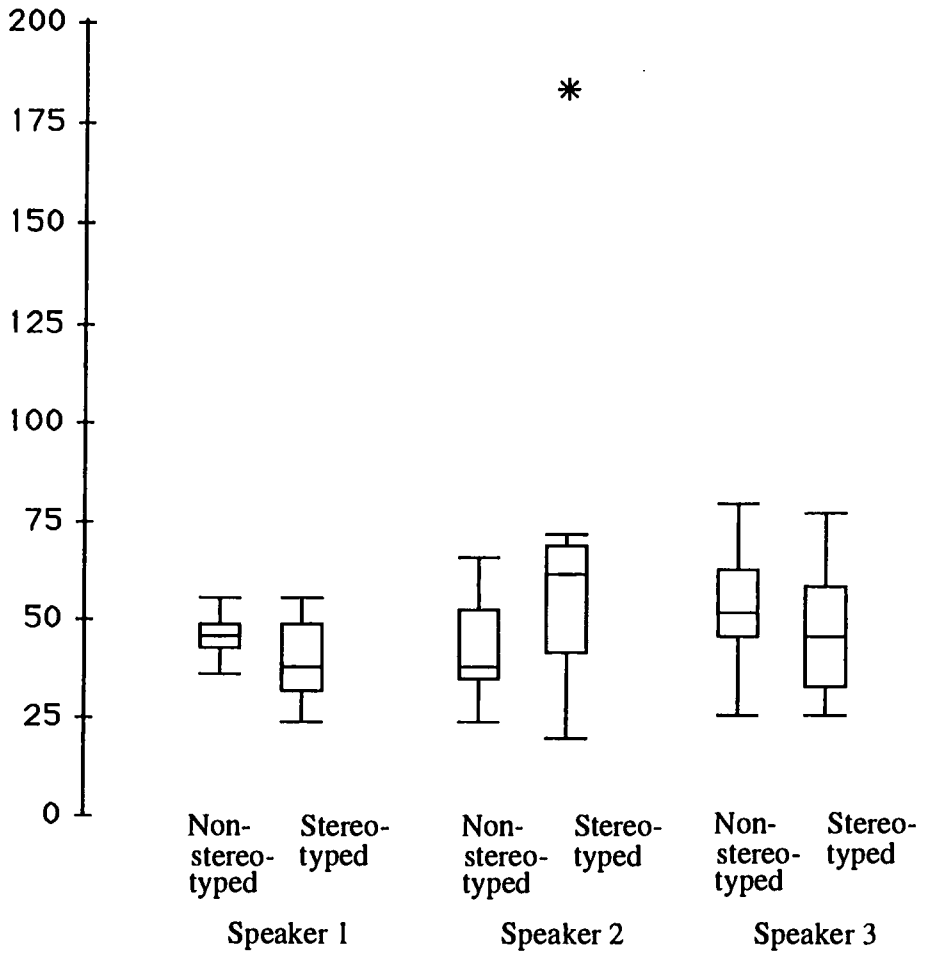

Figure 4: Duration of /#st/ frication.

2. Second Experiment

Once an apparent pattern with /l/, /sp/, and /sk/ (but not /st/) had been identified, a second experiment was constructed to obtain more tokens of these types to overcome the paucity of tokens in the first experiment. A new script was written[7] including 15 tokens of /l/, 6 of /sp/, 8 of /st/, and 4 of

[7] The text of the story used in the second experiment was as follows: "You wouldn't believe what just happened! I was just here studying, and I heard this big loud noise outside. So I was going to go yell out the window, 'Listen, will you please hold it down out there!' But then I looked out, and you know that ski store downstairs next door to me? Oh, my God, it was on fire! I guess the stairs were blocked, because the tenants upstairs looked like they were stuck up there. They were screaming out of the windows in Spanish, but I don't speak Spanish, so I

/sk/, all in the appropriate environment.

The subjects for the second experiment were three gay males. One was an undergraduate majoring in a field unrelated to linguistics (Speaker 4); a second was a professor in a field unrelated to linguistics, who was in his mid-thirties (Speaker 5); and the third was an elementary school counselor in his fifties (Speaker 6). All were Caucasian and were native speakers of American English. None had participated in the first experiment.

The methodology for the second experiment was identical to that of the first, with the exception that two of the speakers were recorded at a sampling rate of 16,000 Hz rather than 8000 Hz, in anticipation of a future study of the spectra of /s/.

2.1. Analysis of the Second Experiment

During segmentation, it was noticed that the durations of /l/ in the second script's three instances of *looks... like* were consistently very short. These tokens were separated out and analyzed separately. The data for /l/ are as follows shown in figure 5.

The data for Speakers 4 and 5 in figure 5 are consistent with those found in the first experiment, and the differences are significant for both speakers without any lumping of speakers. The p-value for Speaker 6 is unexpected, however; as will be seen below, this speaker is inconsistent with the other speakers for other variables.

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didn't know what they were saying. And then I saw this one guy leap out of the window, and it looked to me like he really hurt his leg bad. It was really awful! And you know, there's not really a lot of space between that building and mine, so I was getting scared for myself, too. Anyway, then I saw a lot of red lights flashing, and finally the firemen got there from the station. They went up on ladders and got the people out, and also, they used that round thing that looks like a trampoline with a big red spot in the middle. And they had problems; I think the hoses were tangled up on those big spools they have on the trucks. But finally they got the hoses hooked up to the spouts on the fire hydrants. Then they went up and poked a hole in the roof with a big metal kind of stick, and it made the sparks fly all over the place. You know that Spanish student down the hall from me? Later, he told me he heard the owner of the ski store set the fire himself! The whole thing was a big scam to get the insurance money. Unbelievable!"

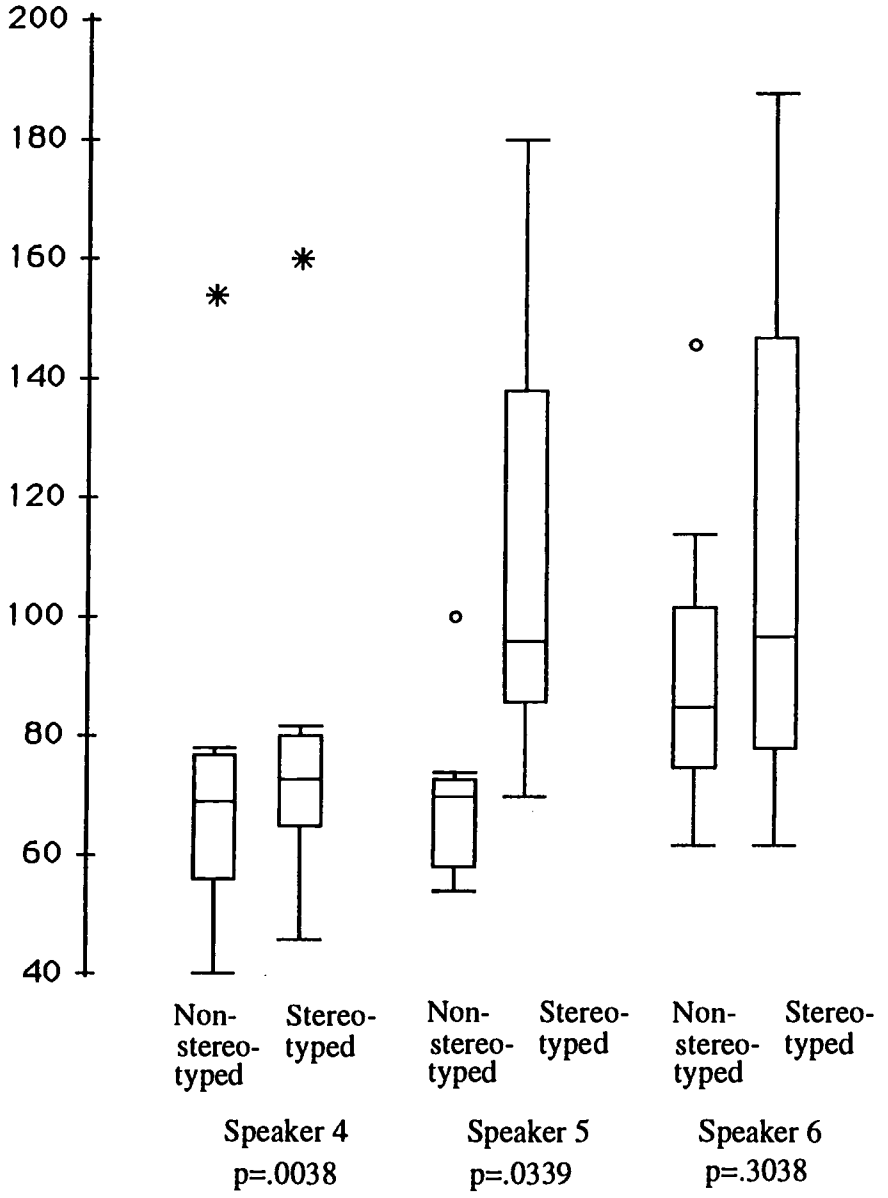

Figure 5: Duration of /#l/, excluding tokens in *looks... like.*

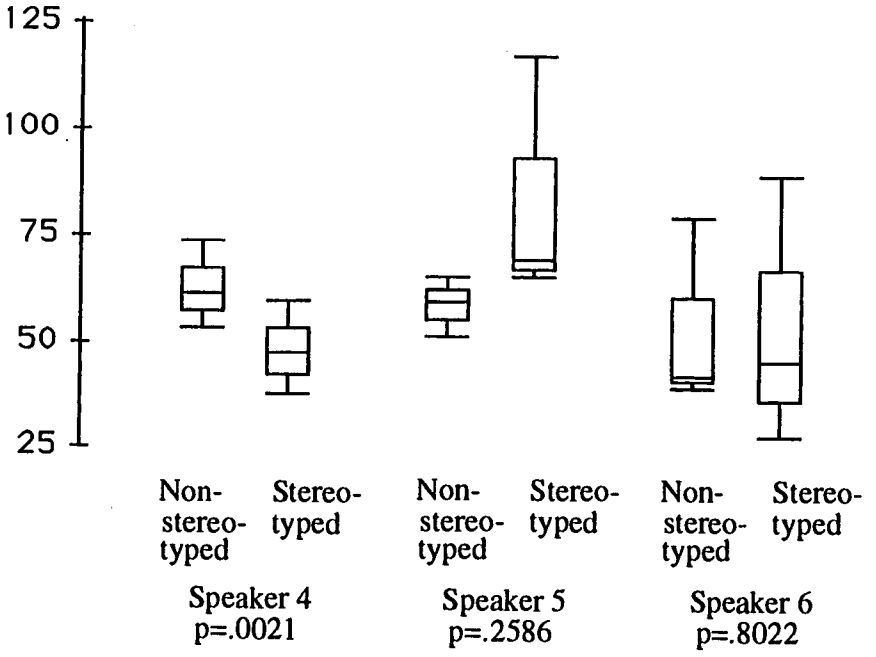

Figure 6: Duration of /#l/ in *looks... like.*

Figure 6 contains the durations for /l/ in *looks...like.* The pattern in Figures 1 and 5 does not seem to be not present here; the p-values are insignificant, except for Speaker 4, for whom the data are significant in the wrong direction. It appears that *look... like* does not participate in the gay-stereotyped lengthening of /l/, but what specific property of these words is responsible for this difference is not known. Perhaps these words are exempt from l-lengthening because of their prosodic status, or their status as quasi-function words, or perhaps there is something about the particular phonetic environment of /l/ in these words. The data at hand do not allow us to distinguish these hypotheses.

The data for /#sp/ are as follows:

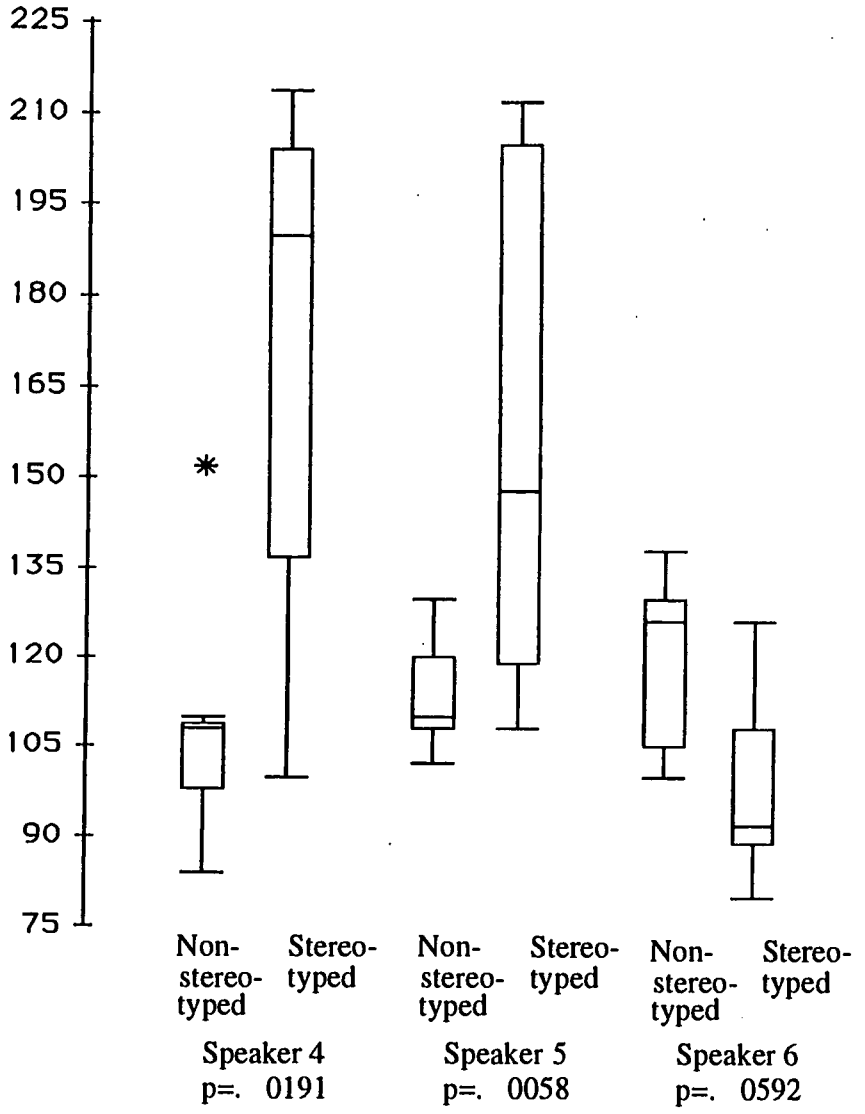

Figure 7: Durations for /#sp/

The data for Speakers 4 and 5 are consistent with the hypothesis that the gay male stereotype involves lengthening of /s/ in /#sp/, and are strongly significant without any lumping of speakers. The data for Speaker 6, however, runs counter to the hypothesis—nearly significantly so (the possibility that this anomaly was the result of a simple incorrect formatting of data was carefully disconfirmed).

The speakers' patterns for /#sp/ appear to hold true for /#sk/ as well:

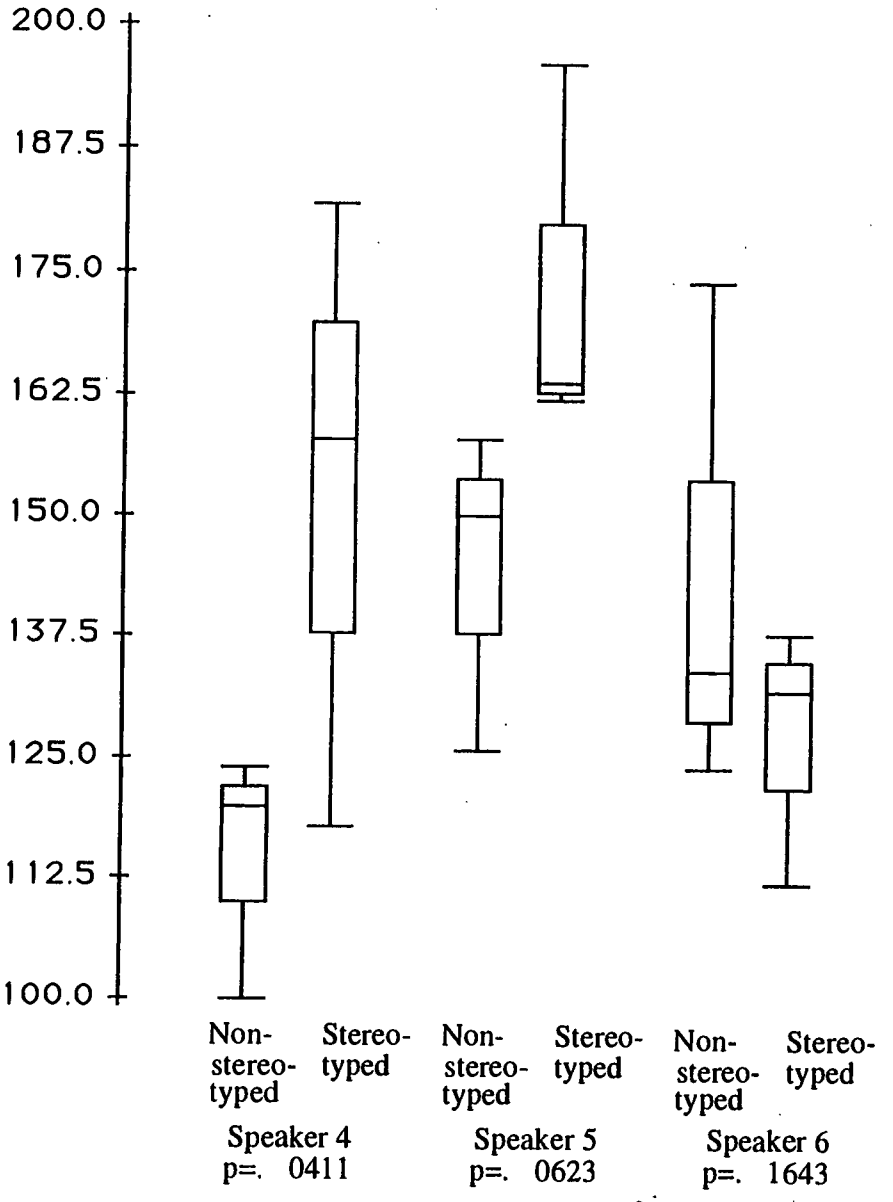

Figure 8: Durations for /#sk/

The data for Speakers 4 and 5 are consistent with those for Speakers 1, 2, and 3, as well as with those for /#sp/. The t-test for Speaker 5 revealed that his difference between stereotyped and non-stereotyped speech was not quite significant for this variable; this is not particularly distressing, however, since only 4 tokens of /#sk/ were elicited in the second experiment. The first experiment had found a strong enough pattern for /#sk/ that the second script was directed more at obtaining more tokens of /l/ and of /sp/.

As with /#sp/, the data for Speaker 6 are nearly the reverse of what would be expected.

The data for /#st/ are as follows:

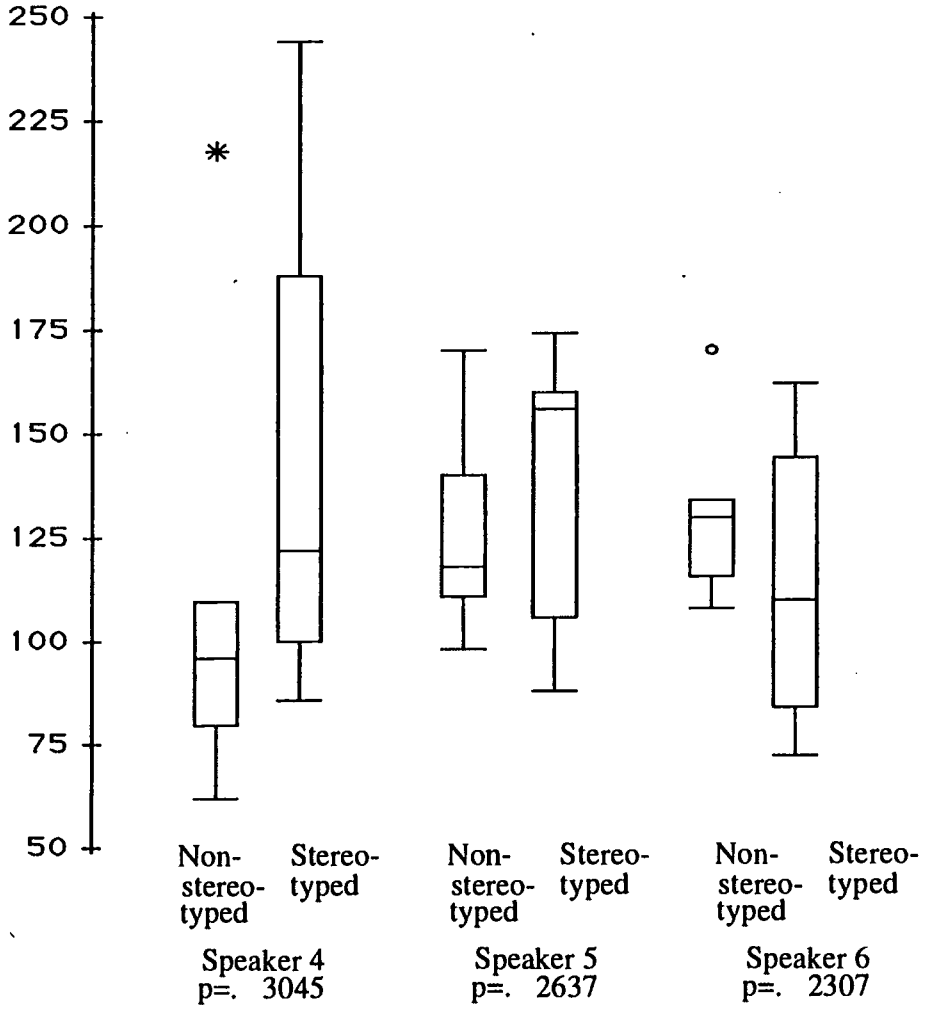

Figure 9: Durations for /#st/

For Speakers 4 and 5, the mean duration of /s/ in /#st/ is longer in stereotyped than in non-stereotyped speech, but this effect is massively insignificant. This finding is consistent with that of the first experiment; /#st/ seems not to participate in the lengthening found in /#sp/ and /#sk/. Speaker 4 appears to have very long /s/ durations in /#st/ overall, but these durations do not differ significantly between stereotyped and non-stereotyped speech.

3. Discussion

By finding quantitative support for the long-standing intuition that listeners can identify the sexual orientation of speakers strictly on the basis of

phonetic cues, Gaudio set a research agenda for discovering what those cues may be. Since there are a great many dimensions along which speech can vary, this question is too large for any single study to answer. Both Gaudio and the present study have surveyed patches of the broad phonetic landscape.

At present, the tentative findings are as follows. The /s/-frication of /sp/ and /sk/ (at least as the onset of a word-initial stressed syllable) is lengthened in gay male stereotyped speech. /st/ appears not to be subject to this lengthening. Why /st/ should fail to participate in this pattern is not clear. Many possible explanations have been suggested by others after earlier presentation of the present work (e.g. perhaps the answer has to do with the fact that /s/ and /t/ have the same place of articulation, or that /t/ is coronal, etc.), but I presently have no basis for choosing among these possibilities.

Word-initial /l/ shows the same sort of systematic lengthening in stereotyped speech as is found for /sp/ and /sk/, but there are specific words for which this lengthening of /l/ is not found.

All of these findings are true for five out of the six subjects. Speaker 6, for whom none of these generalizations hold, is in his mid-fifties and is at least ten years older than the next youngest speaker. Subjectively, my impression is that Speaker 6 is "queenier" in his personality than any of the other speakers. Perhaps these observations might help toward an eventual explanation of Speaker 6's anomalous data, but it is not presently known what independent variable might predict a Speaker 6-type pattern.

Given the data currently available, the correct generalization would seem to be that a speaker may either employ or not employ /s/-lengthening in the production of a gay male stereotype; however, lengthening in /sp/ and /sk/ appear in tandem. Based on the limited number of speakers examined so far, it does not seem that a speaker can employ lengthening for /#sp/ but not /#sk/, nor /#sk/ but not /#sp/.

As is usually the case, a single answer raises a great many more questions. Is the artificial (electronic) manipulation of duration of /s/ and /l/ in the appropriate environments sufficient to induce a different listener judgment about the sexual orientation of the recorded speaker? What other segments seem to vary in this manner, and in what environments? Are other segments (e.g. syllable nuclei) compensatorily shortened in syllables where /l/ and /s/ are lengthened as described? What demographic variables correlate with a speaker's use or non-use of the described lengthening in the production of stereotyped speech?

Zwicky (in press) notes that it may be very difficult to determine the phonetic cues salient for sexual orientation identification of male speakers, since it is not necessarily the case that all speakers employ the same cues. By way of analogy, Zwicky cites the phonetic strategies used to disambiguate structures of the form *big cats and dogs,* where each speaker *emits* only one

out of a set of several available cues to the intended parsing (e.g. pausing), but where all speakers *recognize* all of these strategies, even those which they do not personally employ. It could likewise be the case that the cues for sexual orientation identification are drawn by each speaker from such a set which all listeners recognize; in this case, it could prove very difficult to identify the set of salient cues. In the natural sciences, one should assume simplicity until the facts force complexity. However, the present findings seem to be consistent with the hypothesis that not all speakers employ the same cues in producing a gay male stereotype.

In future research, it would be of interest to investigate whether the lengthening of certain onsets is compensated by a shortening of other segments. For example, it could conceivably be the case that vowel nuclei are compensatorily shortened. This is an important question, because if compensatory shortening occurs, then an additional possible explanation for the informally observed "swoopiness" of gay men's F0 might be available. In particular, it is established that a difference in F0 contour (flat vs. rise-fall) can induce a difference in the perception of vowel length (van Dommelen, 1993)[8]. If it turns out that the converse is true (which would not be especially surprising), then one could reasonably expect that a compensatory shortening of a vowel would result in a *perceived* change in the F0 contour (a perceived higher peak when the peak is not in fact measured to be higher). This situation would be not be expected to be detectable by the analyses used in Gaudio's study.

Further, it has long been known that there are differences between adult males and females with regard to spectra of /s/; indeed, listeners are able to identify the sex of speakers from unvoiced fricatives played in isolation (Ingemann, 1968; Schwartz, 1968). While segmenting speech for the present study, I informally and subjectively observed that at least one of the subjects was pronouncing the /s/ segments in his stereotyped speech with a markedly exaggerated lisp. This observation is consistent with the widely made but (to my knowledge) quantitatively unverified claim that lisping is a cue which allows gay men to be identified. Empirical work will be needed to confirm

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[8] The relationship here is actually rather complicated. It has been known for a long time that in the case of *isolated* vowels, an up-down F0 contour results in the vowel being perceived as longer than an isochronous vowel with a flat F0 contour. Van Dommelen (1993), however, found that this relation is exactly reversed when the vowel occurs within the context of a whole syllable. If the converse of this relationship turns out to be true, then the prediction would seem to be as follows: if vowels within syllables are shortened without a change in the initial, peak, and final values of F0, then the F0 contour of the shortened vowel will be perceived to be exaggerated.

or disconfirm this stereotype.

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PRO, the EPP and Nominative Case: Evidence from Irish Infinitivals

Heidi Harley and Andrew Carnie

1. Introduction

Recent work in the Minimalist Program has made use of the Extended Projection Principle as a licensing feature for subject nominals, a feature which is explicitly separate from abstract nominative Case (Chomsky 1995). Both features are checked in Chomsky's system by the Tense head. Chomsky adopts the case system for licensing PRO proposed in Chomsky and Lasnik (1993), whereby PRO receives null case from an appropriate infinitival Tense head. This approach essentially maintains the intuition of the EST that the appearance of PRO is the result of a fact about the Case system.

In this brief paper, we argue against this approach, adopting instead the ideas of McCloskey (1996), who claims that the EPP and nominative Case are features checked by two distinct heads T and Agr respectively, which crucially can be separately active or inactive. Similar claims are found in Carnie (1995) and Harley (1995).

In this paper we demonstrate that if the clausal architecture argued for by McCloskey is correct, we are forced to rework the standard account of the distribution of PRO. In particular, we draw the following three conclusions, in I:

I Conclusions:

i) Case assignment may not be dependent upon or linked to Tense.

ii) Since the distribution of PRO in languages like English *is* linked to tense, the conditioning factor governing its distribution can not be Case.

iii) The conditioning factor governing the distribution of PRO in infinitivals is the EPP.

If the above conclusions are correct, we make two strong predictions, listed in II:

II Predictions:

i) Languages demonstrating no EPP effects will permit overt nominals in the subject position in infinitivals.

ii) PRO is case marked in the same manner as any overt NP.

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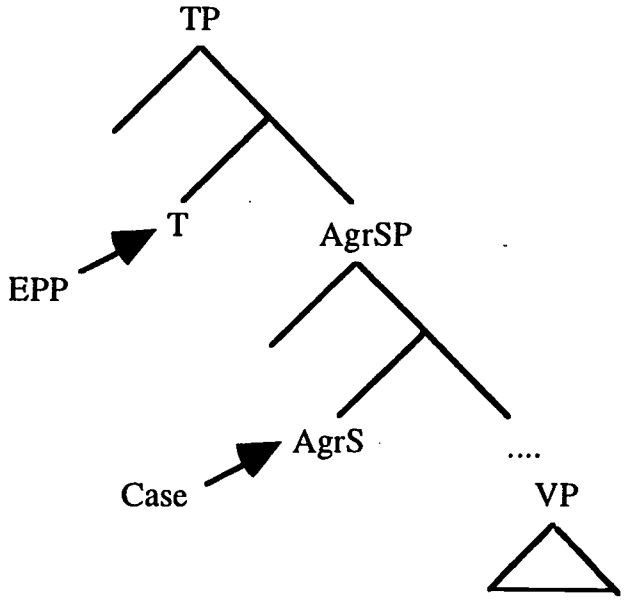
We show that the first prediction is true of Irish, where overt nominals are always possible in the subject position of infinitivals. The second conclusion is borne out by evidence from case agreement facts in Icelandic (Sigguröson 1991).

2. Case and the Extended Projection Principle in Irish

First let us quickly review the analysis of McCloskey (1996) which provides the initial basis for separating the locus of subject case-checking and satisfaction of the EPP. The clausal architecture he proposes can be seen in (1) below, where the functional head which checks the EPP dominates that which checks nominative Case and subject phi-features.

(1)

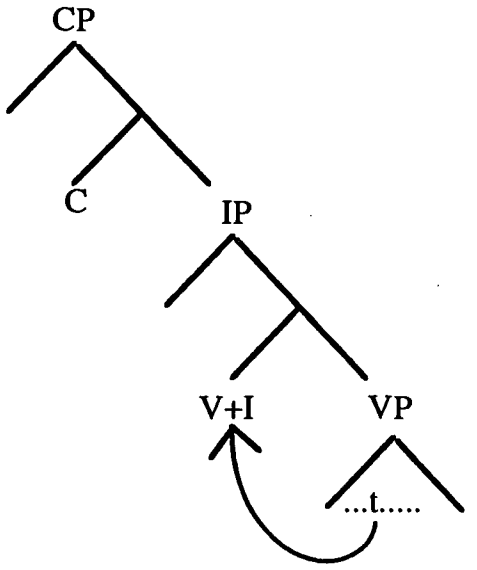


Recall that the basic word order of Irish is verb, subject, object, as you can see in the example in (2).

(2) Leanann an t-ainmní an briathar in Gaeilge
follow.PRES the subject the verb in Irish
'The subject follows the verb in Irish'

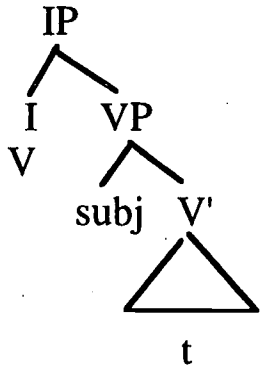
The derivation of the position of the verb is shown by McCloskey (1992) to result from moving the verb leftward out of VP through any intervening inflectional heads to the leftmost head in IP, illustrated in (3):

(3)

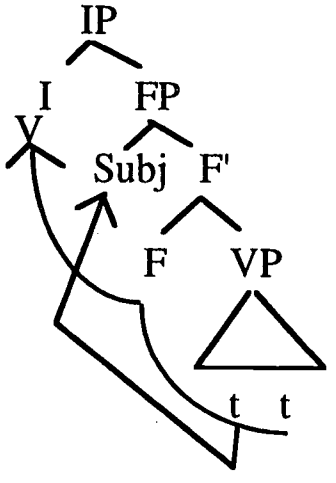


McCloskey (1996) argues against the widely accepted view that subjects in VSO languages are VP internal at spellout. McCloskey and Chung (1987), Duffield (1991,1995), Chomsky (1993) assume that only the verb moves out of VP, and the subject and object remain in situ inside VP (4) A contrasting line of analysis, suggested in Bobaljik and Carnie (1992) and Carnie (1995) among others, holds that in addition to the verb's movement to the head of a high functional projection, the subject and object move to the specifiers of lower functional projections outside of VP(5):

(4)



(5)



On the basis of Irish unaccusative clauses, McCloskey argues for the second line of analysis. In Irish there are two large classes of semantically

unaccusative verbs. The first class, what McCloskey dubs the "salient" unaccusatives, are those whose single internal argument appears in a prepositional phrase. The second class is termed the "putative unaccusatives", whose internal argument, like that of unaccusatives in more familiar languages, is a simple NP (DP). Some verbs can belong to either class, taking their single argument in a PP or as a simple DP, like the one in our example (6). An example of a "salient" unaccusative construction can be seen in (6a); a "putative" unaccusative in (6b).

(6) *Salient unaccusative*

a.	Neartaigh	ar	a	ghlór
	strengthened	on	his	voice
	"His voice strengthened"			

Putative unaccusative

b.	Neartaigh	a	ghlór
	strengthened	his	voice
	"His voice strengthened"		

In these examples, the VS word order does not indicate any obvious structural difference (other than the presence of the preposition) between these two sentences. There are several tests, however, indicating that the argument in the salient unaccusative cases is VP-internal, while the argument in the putative unaccusative cases has undergone movement outside the VP to the position in which canonical Irish subjects appear. The cluster of properties which distinguishes the position of the single argument in constructions of the salient type from constructions of the putative type can be seen in the table below in (7), corresponding to examples in (8a-d). In every case, the single argument in putative unaccusatives behaves exactly like a canonical subject in an Irish transitive clause (indicated by the shading of that column), while the argument in the salient unaccusative behaves like a canonical VP-internal PP.

In this short paper we will not recapitulate all these arguments, but will discuss one. Please refer to McCloskey's work for the other arguments. In Irish, as noted above, umarked finite clause order is VS. By contrast, in non-finite clauses and small clauses, the order is SV. This is generally assumed to be because the verb does not move to the left edge of IP in non-finite clauses, either remaining in VP or only moving partially. In (8a) one can see that the PP of a salient unaccusative appears to be in the VP, as it follows the verb even in a non-finite clause, like objects and PPs in transitive non-finite clauses. It thus appears to be VP-internal. In putative unaccusative non-finite clauses, however, the single argument precedes the verb, like a canonical subject (8b).

(7)

	Salient Unaccusative	Putative Unaccusative
Prepositionally case-marked	Yes	No
Postverbal argument in non-finite and small clauses (6a)	Yes	No
Argument can be clefted with the verb (6b)	Yes	No
Highest Subject Restriction applies (6c)	No	Yes
Argument appears to the left of VP adverb (6d)	No	Yes

(8) *Non-finite clauses*

a) Salient unaccusatives
I ndiaidh fealladh air fiche uair
after fail [-finite] on-him twenty time
"After he had failed twenty times"

b) Putative unaccusatives
I ndiaidh a shaibhreas méadú
after his weath increase [-finite]
"After his wealth had increased"

Similar evidence from, clefting, restrictions on subject resumptive pronouns, and adverbial placement are shown in (9a-f). We refer you to McCloskey for more details.

(9) *Clefting with the verb*

a) Salient unaccusatives
[Ag éirí ar an leanbh] a bhí *t*
[rise [PROG] on the child] COMP was *t*
"It was becoming more agitated that the child was"

b) Putative unaccusatives
*[Is mo shaibhreas ag méadú] a tá *t*
[Cop my wealth increase[PROG]] COMP is *t*
"*It's increasing that my wealth is"

Highest Subject Restriction

c) Salient unaccusatives
an cnapán ar laghdaigh air
the lump COMP lessened on-it
"The lump that shrank"

d) Putative unaccusatives
*an cnapán ar laghdaigh sé
the lump COMP lessened it
"The lump that shrank"

VP-adjoined adverbs.

e) Salient unaccusatives
Mhéadaigh i gcónaí ar mo shaibhreas
increased always on my wealth
"My wealth always increased"

f) Putative unaccusatives
Mhéadaigh mo shaibhreas i gcónaí (tréis mo ghuí-se)
increased my wealth always (after my prayer)
"My wealth always increased (after my prayer)"

McCloskey's argument is straightforward. The single argument of an unaccusative verb moves out of the VP only when it cannot receive Case from a preposition. This movement for Case-checking is clearly still lower than the highest inflectional head in expanded Infl, as the verb still appears to the left of the subject in finite clauses. If, on the other hand, the single argument receives Case from a preposition, as in the case of the salient unaccusatives, the whole prepositional phrase remains within the VP in its base-generated position.

Notice that in the Salient Unaccusative case, we have sentences without any subject NP, as the PP is a complement. This means that it is not essential that an argument appear in "subject" position in Irish. This entails that either the feature associated with this position is optional, or that the position itself is only projected optionally, the sort of behavior which in a Minimalist system is associated with AgrPs. We will assume then, with McCloskey, that movement of Irish subjects out of the VP is motivated for Case reasons, and that such movement is to the specifier of an AgrSP projected within expanded Infl. This corresponds to the fact that Irish has movement of NPs for case reasons in passives, as you can see in the example in (10):

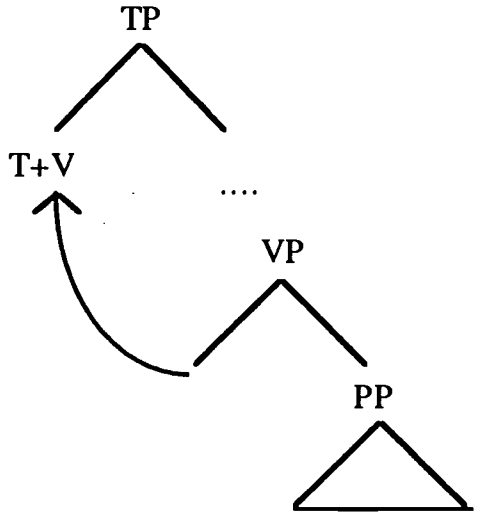
(10) Bhí an obair criochnú
was the work done
"The work has been done/The work was done"

Let us now consider the identity of the highest functional projection which is overtly occupied by the finite verb in Irish. The obvious candidate is T, since the verb moves to this position in finite clauses but doesn't in non-

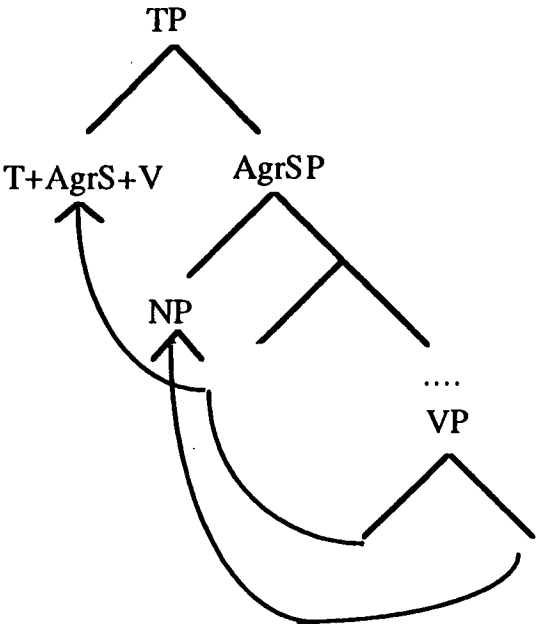
finite clauses. This entails that the strength of the V-feature of T correlates with finiteness. This gives us the clause structure in (1) for Irish, and the structures in (11) for the salient and putative unaccusatives.

(11)

a) Salient unaccusative



b) Putative unaccusative



The explanation for the lack of movement to the specifier of TP in Irish is evident: the EPP feature of T is weak in Irish, and movement to this position before Spell-out is hence ungrammatical. Further, if insertion of expletives, as commonly assumed, is to satisfy the EPP, McCloskey's claim that Irish entirely lacks expletives anywhere (as in (12)) is explained.

(12) *Mhéadaigh sé i gcónaí ar mo shaibhreas
increased it always on my wealth
"it increased always, my wealth"
(cf. Fr. *Il est arrivée trois hommes*).

For these reasons, we assume with McCloskey that Irish does not obey the EPP.

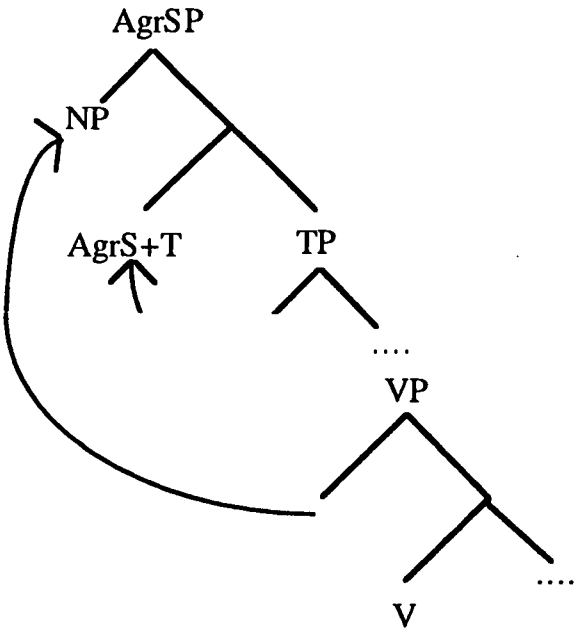
3. TP Above AgrSP, Case and the EPP

Let us consider, then, the effect that McCloskey's reversed clausal architecture has on the system of feature values developed in the Minimalist Program of

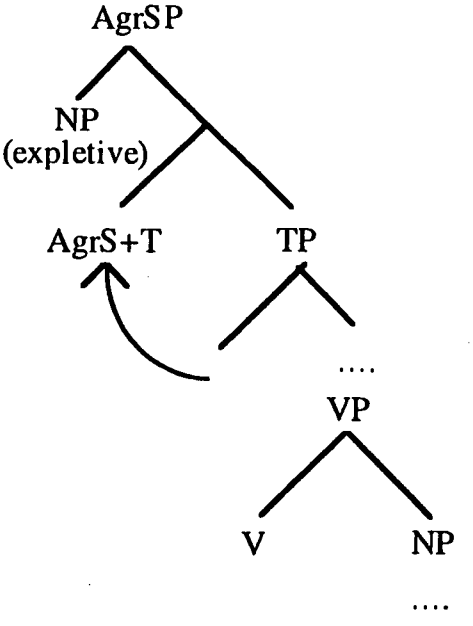
Chomsky (1995). The standard assumption about the order of the functional projections in the Minimalist Program is in fact the reverse of what is motivated by McCloskey's facts: AgrSP dominates TP (see also Ouhalla (1993)). The derivation of an English finite clause under Minimalist Program assumptions is illustrated in (13). The EPP feature of T on this system can be checked in one of two ways: either by an NP occuping the specifier of AgrSP to whose head T has adjoined (13a), or by an expletive chain formation with covert movement of the NP at LF (13b).

(13)

a) John walked



b) There was a chair (in the room)

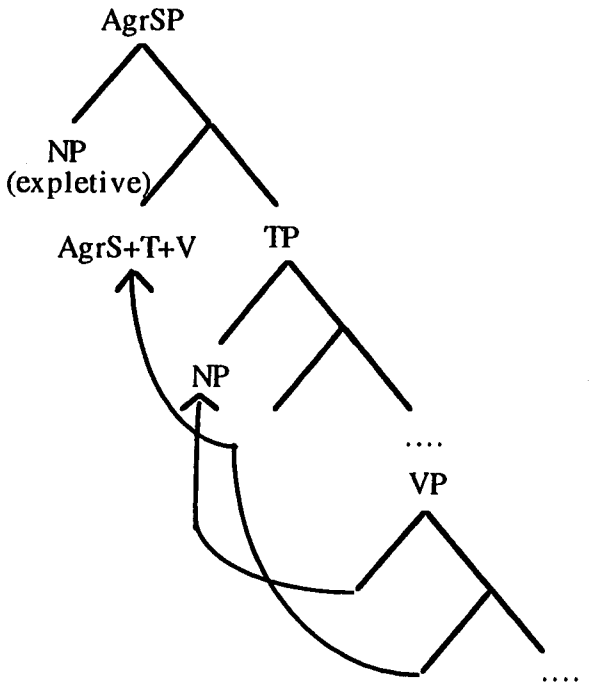


Another way of checking the EPP feature is available in the Minimalist Program in a language like Icelandic, as seen in the transitive expletive construction in (14) below. Unlike English, in Icelandic, subjects can appear overtly in Spec-TP, checking its EPP feature, as long as an expletive is inserted in initial position in Spec-AgrSP. This clausal analysis is proposed in Bobaljik and Jonas (1996).

(14) Icelandic Transitive Expletive Construction

a)	það	lauk	einhver	verkefninu
	there	finished	someone	the.assignment

b) Bobaljik and Jonas (1995)

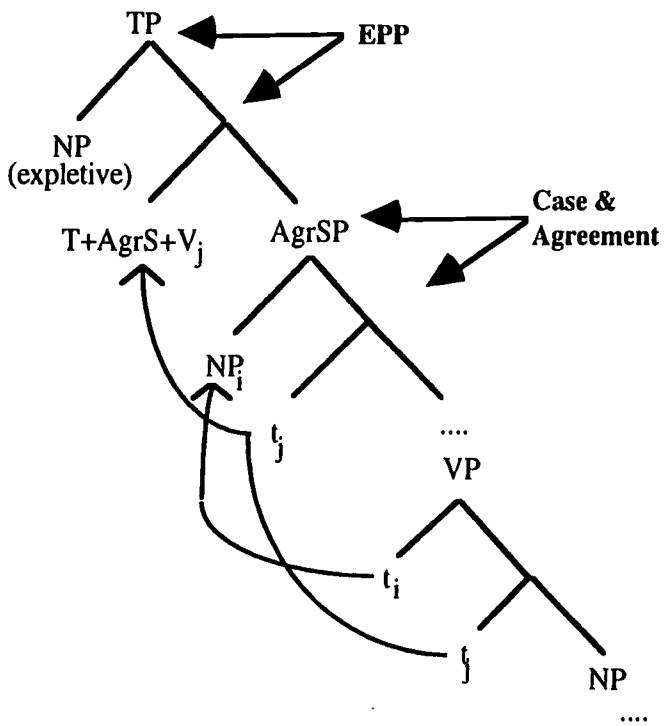


However, this analysis, while obtaining the correct word order facts, has an undesirable consequence: the expletive *það* is inserted in Spec-AgrS to check strong phi-features, not to satisfy the EPP, which is checked in Spec-TP by the indefinite subject. Note that this entails that the properties of the Icelandic expletive are strongly different from that of the English expletive *there,* which is inserted to satisfy the EPP. Given the the similar nature of their discourse functions and the expletive-argument chains which they form, this difference between the two expletives seems unmotivated. Further, despite the fact that its phi-features are checked by an expletive, the finite verb in Icelandic TECs agrees with the indefinite subject in Spec-TP, just as the case with constructions using the English expletive *there.* For these reasons, we assume that the clausal architecture proposed by Bobaljik and Jonas is less than optimal.

The clausal architechture established for Irish by McCloskey, on the other hand, permits an elegant account of the aggreement and expletive positioning in Icelandic TECs. The current analysis appears illustrated in the tree in (15). The subject appears in Spec-AgrS at Spell-Out rather than Spec-TP, and the expletive is inserted in Spec-TP to satisfy T's strong EPP feature (exactly as is assumed by Chomsky for English expletive *there*)[1].

[1]As pointed out to us by John O'Neill, on this account there is no non-arbitrary

(15)



það	lauk	einhver	verkefninu...	
there	finished	someone	the.assignment	...

4. Tense Cannot Affect Case

There is one serious consequence of such a move for Chomsky's case-assignment system. Under the clausal architecture proposed here no dependence between the T head and the case-assigning Agr head can exist.

On the MP proposal, the nominative case feature is a property of the lexical T head. The AgrP which dominates TP serves merely as a facilitator, providing a locus for the establishment of the necessary spec-head relationship between the NP and the T head which is checking its nominative case.

Consider the present proposal, with the architecture in (16).

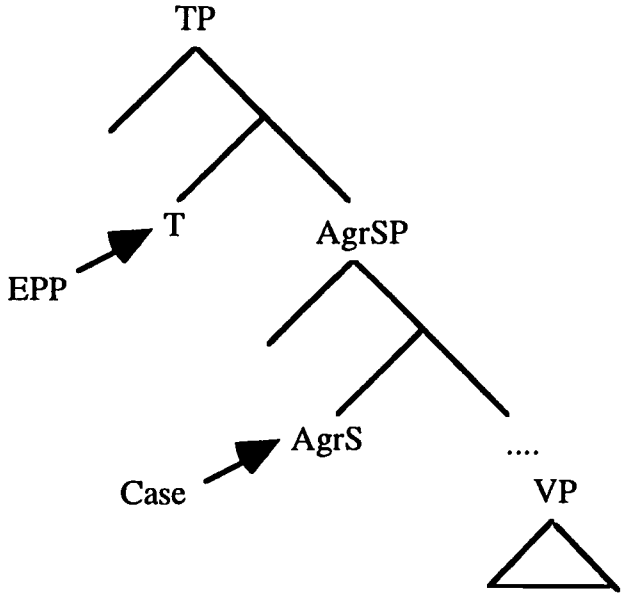
---

way to rule out the equivalent of a Transitive Expletive construction in English, when an auxiliary is present:

i) *There had a doctor examined Billy.

At the moment, we leave an account of the existential/locative restriction on English expletive *there* for later explorations of the consequences of this structure.

(16)



T here dominates Agr. If it were necessary for the Agr head to combine with T to permit T to assign case, McCloskey's account of Irish would be impossible. Thus on this system, nominative Case is crucially not a feature of T. Rather, the Case feature of an NP must be satisfied purely by the content of the Agr head alone, without support from T one way or the other. T's only feature, then, is the EPP feature. The feature specifications for English and Irish in the current system are listed in (17).

(17)

	English	Irish
D-feature of T	Strong	Weak
D-feature of Agr	Weak	Strong

5. The Distribution of PRO: the EPP and Irish Infinitivals

So far we have reached the conclusion that T is not a case-assigner. Not only that, T cannot affect the case-assignment possibilities of the Agr head it dominates. Hence, we cannot assume that finiteness will affect case-assignment possibilities at all. In this system, then, in infinitival clauses the Agr head will be able to assign case exactly as usual.

What this means is that no account of the distribution of subjects in infinitival clauses can depend on Case. For instance, we cannot accept the Minimalist Program's assertion that the appearance of PRO is conditioned by

the assignment of a special non-finite "null" case. Nor is any other Case-based account of the distribution of PRO tenable if the clausal architecture we argue for here is correct. How, then, can we account for the appearance of PRO in non-finite clauses?

The feature which could presumably be affected by the finiteness of T is precisely the EPP feature, since it's the only D-feature T has. We will claim that there are two possible variants of the strong EPP feature, which we will call for the moment [+phonological] (in finite clauses) and [-phonological] (in non-finite clauses).[2] These variants can be seen in (18):

(18)

	Variants of the strong EPP feature
Finite clauses	[+Phon]
Non-Finite clauses	[-Phon]

[+] and [-] phon are intended to indicate a restriction on whether or not the EPP-satisfying NP can be phonologically spelled out. In finite clauses, the EPP-satisfying NP can be spelled out, while in non-finite clauses, it cannot, forcing the appearance of PRO. Note that this variation can only affect a *strong* EPP feature, as only NPs satisfying the EPP before Spell-Out will be phonologically realized in that position.

This set of assumptions makes an interesting prediction about Irish non-finite clauses. If, as we have argued, the EPP is weak in Irish, the [+/-phonological] variation cannot be relevant in that language. In Irish, then, there is nothing to force the appearance of the phonologically null PRO in non-finite clauses. Further, as outlined above, nothing prevents the Agr head from checking the case feature of a subject NP in a non-finite clause.

Thus, in Irish, overt subjects should be possible even in non-ECM infinitivals. This prediction is borne out. In (19a) we see a non-ECM verb taking an overt subject in its complement. Example (19b) shows a root

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[2]This feature is similar to a requirement proposed for elements appearing in functional projections in Mohawk by Baker (1996); these elements are restricted to *pro*, wh-traces or parasitic gaps; that is, essentially those which are not overtly realized. Evidence that this is perhaps relevant for the English case comes from the paradigm of *wager*-class verbs which take an infinitival complement. Such verbs accept a *wh*-trace in the subject position of their complement, where an overt subject is unacceptable:

i) *John wagered the grey horse to win
ii) Which horse did John wager to win?

Thanks to Norvin Richards for pointing these cases out to us.

infinitival with an overt subject (Guilfoyle 1993). This is true of any embedded or root infinitival in the language.

(19) a) Ní thaithneann liom [mé an abairt aL scríobh]
Neg please with.2 me the sentence tran write
"you are not pleased (for) me to write the sentence"

b) Tú a bheith 'do luí...
you prt be.inf in.2 lying
"You to be lying there..."

To repeat, on this system, a language without EPP effects is predicted to permit overt subjects in non-finite clauses, since the [+/- phonological] feature is irrelevant when the EPP is weak. The possibility of overt subjects in infinitival clauses in Irish thus follows from the fact that Irish lacks the EPP.

6. PRO with Case: Icelandic (Sigurðson 1991)

Independent evidence for the assertion of our analysis that case is available in infinitivals comes from Icelandic (a strong EPP-feature language, as shown above) where it is clear that PRO receives morphological case (Sigurðsson 1991). Recall that Icelandic nominals may bear inherent, or "quirky" case assigned to them by a particular verb. Floated quantifiers and verbal participles always show case agreement with the NP with which they are affiliated.

Now, consider the examples in (20). Case agreement with floated quantifiers or participles in an infinitive clause is always with the PRO subject. In both (20a and b), you will see that the quantifier bears the quirky case that the subject argument would bear if it were overt, rather than, for instance, the case of PRO's controller.

(20) a) Strákarnir vonast til [að **PRO** leiðast ekki **öllum** í skóla]
the boys-N hope for [to **PRO**-D bore not **all**-Dplm in school]
"All the boys hope to not be bored in school."

b) Strákanum leiddist [að **PRO** verða **kosnir** í stjórnina]
The boys-D bored-dflt [to **PRO**-N be **elected**-Nplm to the board].
"The boys were annoyed at being elected to the board."
(Siggurðson 1991)

This clearly suggests that PRO bears morphological case, and mitigates again against a case-based treatment of the distribution of PRO[3].

7. PRO in Finite Clauses (Stenson 1989)

The system so far outlined here, as the reader may have noticed, offers no way to rule out *finite* clauses in Irish containing a PRO subject. That is, if case is available in finite clauses, which it clearly is, and Irish lacks the [±phon] feature, then PRO should appear freely in finite clauses in Irish. In fact, there is a plausible candidate construction which seems to meet just these requirements: that of the "impersonal passive", extensively discussed in Stenson (1989). In this construction, illustrated in (21), no overt subject appears, and the interpretation of the null subject is roughly that of arbitrary "they."

(21) a. Buaileadh PRO Ciarraí sa gcluife deireanach
beat.Pst.Imp PRO Kerry in the game last
"*They* beat Kerry in the last game."/ "Kerry was beaten..."

b. Siúilfear PRO abhaile
walk.Fut.Imp PRO homeward
"One will walk home."

c. Deirtear PRO go bhfuil droch-aimsir in Éirinn.
say.Prs.Imp PRO that be.Prs bad weather in Ireland.
"They say that Ireland has bad weather."

[3]Note that throughout we have not discussed the structure of the functional complex which we assume exists between the VP and the AgrSP. In Carnie (1995) and Harley (1995) a Chomsky (1995)-style split-VP is adopted, which we continue to assume although we have not indicated its presence here as it is not relevant to the discussion of the topmost two functional projections in Infl. However, it must be noted that in ECM and Raising infinitival complements in strong-EPP languages like English and Icelandic, the upper TP head must not be present or else we will force the appearance of PRO in the infinitival, incorrectly. Hence we assume an impoverished complement clause is selected for by ECM and raising verbs, containing no CP nor TP, nor AgrSP. Raising and ECM verbs take a vP infinitival complement. This assumption is borne out by facts from Icelandic which demonstrate that verb-raising of infinitivals takes place in control clauses but not in ECM or raising clauses; if it is a strong V-feature on T which forces the raising of an Icelandic verb, the absence of T will account for the lack of raising in Raising and ECM infinitival complements. For discussion see Harley (1995).

Stenson argues that the only reasonable phonologically null candidate for the subject of these constructions is in fact PRO. Further investigation of this construction is necessary before a firm conclusion is drawn; however, the preliminary result is promising for the proposed line of research.

8. Summary and Conclusion

We have sketched a clausal architecture which follows directly from the conclusions reached in McCloskey (1996), and demonstrated that it has a number of desirable consequences. First, it unifies the treatment of expletives across English and Icelandic, and explains the observed lack of expletives in Irish. Secondly, it argues in favor of an EPP-based approach to the distribution of PRO, and makes the correct prediction that overt subjects can always licensed in infinitivals in Irish. Thirdly, it provides a straightforward account of the case agreement with PRO in control clauses in Icelandic.

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Palatalization and Umlaut in Korean

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It has been reported in the literature on Korean phonology (Ahn 1986, Iverson 1993 and Iverson & Wheeler 1988) that coronal consonants (/s/, /n/ and /l/) excluding /t/ and palatal /c/, undergo (allophonic) secondary palatalization before a high front vocoid. On the other hand, it has also been reported that /t/ undergoes (phonemic) primary palatalization to [c] at a suffixal or clitic boundary without undergoing secondary palatalization. It was observed by Ahn, Iverson and others that /t/ before tautomorphemic /i/ undergoes neither primary nor secondary palatalization. Contrary to this observation, Kiparsky 1993 reports for Korean that underlying /c/ and /t/ undergo secondary palatalization and the /c/ which is derived from /t/ at a suffixal and clitic boundary also undergoes secondary palatalization. Based on this newer observation, we provide analyses of primary and secondary palatalization in Native Korean in the framework of OT. We will further show that Umlaut, which has been analyzed in Hume 1990, is identified as secondary palatalization.

1. Native Korean Palatalization and Kiparsky 1993

In the literature on Korean phonology (Ahn 1986, Iverson 1993 and Iverson & Wheeler 1988), it is reported that /t, t^h/ undergo (neutralizing) primary palatalization to [c, c^h], respectively, before a high front vocoid-initial suffix or clitic environment. Note in the data below that the derived /c/ and /c^h/ also undergo secondary palatalization:

(1) /t/-palatalization

a.	/mat-i/	mac^j-i	'the oldest son' ('oldest' 'NOML')
b.	/kut-i/	kuc^j-i	'stubbornly' ('to be firm' 'ADVL')
cf.	/kut-ə/	kut-ə	'become hard-Cont' ('to be firm' 'Cont')
c.	/pat^h-i/	pac^{jh}-i	'field-Nom'
cf.	/pat^h-ɨl/	pat^h-ɨl	'field-Acc'
d.	/kat^h-i/	kac^{jh}-i	'together' ('to be same' 'ADVL')
cf.	/kat^h-a/	kat^h-a	'be same-Cont'

e. /put^{h}-i/ puc^{jh}-i 'to make something stick to'
('to stick to' 'Caus')
cf. /put^{h}-ə/ put^{h}-ə 'to be sticked-Cont'

Phonemic /t/-palatalization takes place only at a morpheme boundary where a suffix or a clitic is attached to a preceding Root (Ahn 1986, Iverson 1993, Cho & Sells 1991, H. S. Kim 1982, Y. S. Kang 1991 and S.-H. Han 1991). However, previous researchers ignored the fact that the phonemically palatalized [c] is realized as secondarily palatalized [c^{j}]: namely, /t/ becomes [c^{j}], undergoing phonemic primary palatalization and allophonic secondary palatalization (Kiparsky 1993 for Korean).

When we consider the data below, we can observe that underlying /c, c^{h}/ also automatically undergo allophonic secondary palatalization before a high front vocoid, as shown in (2a):

(2) a. /kac^{h}i/ kac^{jh}i 'value'
/cəc-i/ cəc^{j}-i 'milk-Nom'
b. /ca/ ca 'ruler'
/cəc-il/ cəc-il 'milk-Acc'

The underapplication of primary /t/-palatalization, however, is observed morpheme-internally, as shown in (3), in which /t/ is realized as secondarily palatalized [t^{j}] before /i/ within a morpheme: no phonemic primary /t/-palatalization to [c] but only secondary allophonic palatalization is seen.

(3) Lack of phonemic primary /t/-palatalization in a non-derived environment

a. /mati/ mat^{j}i 'a knot'
b. /puti/ put^{j}i 'please'
c. /t^{h}i/ t^{jh}i 'a mote'
d. /pət^{h}i-/ pət^{jh}i- 'to withstand'
e. /panti/ pant^{j}i 'firefly'
f. /canti/ cant^{j}i 'lawn'

Korean has other types of palatalization in addition to phonemic primary /t/-palatalization and allophonic secondary /t/- and /c/-palatalization: allophonic secondary /s/-, /n/- and /l/-palatalization, which were analyzed as

postlexical phenomena in Lexical Phonology (Ahn 1985, Cho & Sells 1991, H. S. Kim 1982, Y. S. Kang 1991 and S.-H. Han 1991).

(4) Allophonic /s/-, /n/-, /l/-palatalization (S. Lee 1994: 73, S.-H. Han 1991: 66 and K.-M. Lee 1972)

a.	/os-i/	os^{j}-i	'clothes-Nom'
b.	/si/	s^{j}i	'poem'
c.	/si-kan/	s^{j}i-kan	'time'
d.	/po-si-əs-ta/	po-s^{j}y-ət-t'a	'see-Hon-Pst-Mood'
e.	/mun-i/	mun^{j}-i	'door-Nom'
f.	/k'ini/	k'in^{j}i	'meal'
g.	/an-nyəŋ/	an^{j}-n^{j}yəŋ	'hello'
h.	/col-li-/	col^{j}-l^{j}i	'to be sleepy-Cau'
i.	/p'al-li/	p'al^{j}-l^{j}i	'quickly'('be-fast' 'ADVL')
j.	/talli-/	tal^{j}l^{j}i	'to run'
k.	/holli-/	hol^{j}l^{j}i	'to seduce'
l.	/il-lyu/	il^{j}-l^{j}yu	'first class'

Hence, we can generalize that all coronal segments undergo secondary palatalization before a high front vocoid regardless of a morpheme boundary. On the other hand, we can also generalize that underlying /t/ before a high front vocoid undergoes phonemic primary palatalization to [c] only at a morpheme boundary.

Ahn 1985[1] argues in the framework of Lexical Phonology that secondary palatalization has postlexical characteristics (i.e., allophonic, across-the-board and exceptionless) whereas primary /t/-palatalization has lexical characteristics (structure-preserving and derived environment effect). He categorizes secondary palatalization as a postlexical phenomenon and primary palatalization as a lexical phenomenon. Since he misses the fact that /c/ and /t/ undergo secondary palatalization (also in Kim-Renaud 1974), he analyzes primary palatalization as one process but analyzes secondary palatalization as three separate processes, since only coronal /n, s, l/ excluding /t, c/ cannot form a natural class:

[1] Ahn misses the observation that /t/ and /c/ undergo secondary palatalization before a high front vocoid.

(5) Primary /t/-palatalization (a lexical rule)

t --> c / _____{i, y}

(6) Secondary Palatalization (postlexical rules)

/n/-palatalization

n --> n^j / _____{i, y}

/s/-palatalization

{s, s'} --> {s^j, $s^{j'}$} / _____{i, y}

/l/-palatalization

l --> l^j / _____{i, y}

However, the three rules of secondary palatalization will be unnecessary if /t, c/ also undergo secondary palatalization. Furthermore, the lexical and postlexical dichotomy in the analysis of Korean palatalization as in Ahn 1985 leads to a rule ordering paradox with Umlaut phenomenon in Korean, as pointed out in Iverson & Wheeler 1988 and Lee 1994. In the Kyungsang dialect, back vowels are optionally fronted before a high front vowel /i/ in the speech of older generations.

(7) (Lack of) application of Umlaut in specific morphological environments (data partly from Lee 1993: 275)

a. Umlaut occurs in a derived environment

i) Nominalizer /i/

/mək-i/	[məki], [meki]	'food' ('eat' 'NOML')
/son-cap-i/	[soncapi], [soncæpi]	'handle' ('hand' 'grip' 'NOML')

ii) Passive/Causative marker

/cap-hi/	[cap^{h}i], [cæp^{h}i]	'to be caught' ('catch' 'Caus')
/mək-hi/	[mək^{h}i], [mek^{h}i]	'to be eaten' ('eat' 'Caus')

iii) Nominative /i/ (cf. Y.-K. Han 1980, Y-C. Chung 1968, Y. Lee 1993)

/pəp-i/	[pəpi], [pepi]	'law-Nom'
/cam-i/	[cami], [cæmi]	'sleep=Nom'

iv) Copular /i/ (cf. Y.-K. Han 1980, Y-C. Chung 1968, Y. Lee 1993)

/pəp-i-/	[pəpi], [pepi]	'be a rule'
/səm-i-/	[səmi], [semi]	'be an island'

b. Umlaut occurs in a non-derived environment

/aki/	[aki], [æki]	'baby'
/nampi/	[nampi], [næmpi]	'kettle'
/əmi/	[əmi], [emi]	'mother'
/tali/	[tari], [tæri]	'to iron'

c. Exceptions in Umlaut across a morpheme boundary

i) Adverbial /i/

/kak'ap-i/	[kak'ai], *[kak'æi][2]	'near' ('be near' 'ADVL')

ii) Gerundive /ki/

/cap-ki/	[capk'i], *[cæpk'i]	'catching' ('catch' 'Ger')
/nəh-ki/	[nək^{h}i], *[nek^{h}i]	'putting in' ('put' 'Ger')

iii) Copula /i/

/kam-i/	[kami], *[kæmi]	'to be a parsimon'
/pal-i/	[pari], *[pæri]	'to be a foot'

d. Umlaut has lexical exceptions within a morpheme

/nəpi/	[nəpi], *[nepi]	'width'
/napi/	[napi], *[næpi]	'butterfly'
/cəki/	[cəki], *[ceki]	'there/that place'

Umlaut applies in both derived and non-derived environments as in (7a & b). Only the causative/passive marker and a nominalizer suffix trigger Umlaut whereas other suffixes or clitics don't.

However, we observe that secondary palatalization blocks Umlaut (for different views but with the same effect, Iverson & Wheeler 1988, Hume 1990, Y. -S. Kang 1991, Lee 1993[3]):

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[2] /p/ is deleted before a vowel.

[3] In Iverson & Wheeler 1988, Hume 1990, Y. S. Kang 1991 and Lee 1993, they miss the fact that [c], whether derived or nonderived, undergoes allophonic secondary palatalization. Hence, the argument for palatal blocking of Umlaut goes two ways: Secondary palatalization of /s/, /l/ and /n/ and primary /t/-palatalization block Umlaut. In this paper, however, we will show that allophonic secondary palatalization, which is assumed to be spreading of the V-pl/Cor from a following /i/, is blocking Umlaut, which is assumed to be spreading of the same feature from the same source vowel to another vowel.

(8) Umlaut blocked across a secondarily palatalized consonant[4]

a.	/mat-i/	mac^{j}-i, *mæc^{j}-i	'the eldest' ('first' 'NOML')
b.	/mul-pat-i/	mul-pac^{j}-i, *mul-pæc^{j}-i	'water holder' ('water' 'receive' 'NOML")
c.	/kət-hi-/	kəc^{jh}i, *kæc^{jh}i	'be removed' ('remove' 'Caus')
d.	/ənni/	ən^{j}n^{j}i, *en^{j}n^{j}i	'sister'
e.	/alli-/	al^{j}l^{j}i, *æl^{j}l^{j}i	'to inform'
f.	/kəci/	kəc^{j}i, *kec^{j}i	'beggar'
g.	/tac^{h}i-/	tac^{jh}i, *tæc^{jh}i	'get hurt'
h.	/əti/	ət^{j}i, *et^{j}i	'where'
i	/kasi/	kas^{j}i, *kæs^{j}i	'thorn'

The assumption that secondary palatalization is postlexical and Umlaut is lexical in the framework of LP leads to a rule ordering paradox:

(9) Two potential rule orderings

a. If Umlaut is ordered before Secondary Palatalization

UR	/kasi/
1. (lexical) Umlaut	kæsi
2. (postlexical) Secondary Palatalization	kæs^{j}i
Output	*[kæs^{j}i]

b. If Secondary Palatalization is ordered before Umlaut

UR	/kasi/
1. (lexical) Secondary Palatalization	kas^{j}i
2. (lexical) Umlaut	------
Output	[kas^{j}i]

[4]A reviewer points out the following counter-example in Standard Korean:

/cəc-hi-/ cəc^{jh}i, cec^{jh}i 'bend back' ('bend' 'Caus')

Umlaut in Standard Korean is a pending question for further study since it is rare and irregular. In the Kyungsang Dialect, however, [cec^{jh}i] is the only possible output and hence the input must be /cec-hi-/ since no alterantion is allowed. In other words, [e] is not the result of Umlaut in this case.

The demonstrated ordering paradox suggests that rule-based approaches with two levels in the framework of LP are problematic.

Kiparsky 1993 correctly observes that all (phonologically derived and non-derived) coronals undergo allophonic secondary palatalization. However, Kiparsky analyzes primary and secondary palatalization as a single process which can apply lexically and postlexically in the framework of Lexical Phonology. He tries to explain why primary /t/-palatalization takes place only in a derived environment by proposing that the Non-Derived Environment Blocking effect in some phonological processes is the result of structure-building rules which apply to an underspecified representation. According to Kiparsky, structure-building rules can apply to only underspecified representations. As a result, if a feature [F] is underlyingly prespecified, structure-building rules cannot override the prespecified [F]. Hence, NDEB effect is achieved.

Kiparsky's new approach to NDEB handles Korean palatalization as follows. As secondarily palatalized segments are not phonemic and arise only before a high front vocoid, secondary palatalization is automatic and obligatory. The following output sequences are not allowed on the surface:

(10) a. *[...s^{j}a...], *[...n^{j}u...], *[...t^{j}o...], *[...c^{j}a...] . . . etc.
b. *[...si...], *[...ni...], *[...ti...], *[...ci...]

Under the assumption that underlying /t, t^{h}/ are distinguished from /c, c^{h}/ by [±anterior], Kiparsky proposes that coronal segments are minimally specified as follows in terms of the feature [anterior].

(11)

	/t, t^{h}/	/c, c^{h}/	/s, n, l/
Before i	[+ant]	[0ant]	[0ant]
Elsewhere	[0ant]	[-ant]	[0ant]

According to Kiparsky, the underlying /t/ before a high front vocoid within the same morpheme is prespecified for [+anterior] but an underlying /c/ in the same position is underspecified for [-anterior], under the assumption that the following phonetic specifications of the (non-)palatalized coronals are used in Korean:

(12) from Kiparsky 1993

	t	t^j	c	c^j	s	s^j
High	-	+	-	+	-	+
Anterior	+	-	-	-	+	-
Delayed Release	-	-	+	+	-	-

Note that Kiparsky crucially assumes that palatal /c/ is an affricate. Kiparsky assumes that both primary and secondary palatalization are uniformly represented as the spread of [-anterior] and [+high] to coronal consonants from a following [+high] front vocoid, following the proposal of Clements 1989 and Lahiri and Evers 1989 that front vowels are represented with [+coronal]. Kiparsky actually assumes that palatalization is the spreading of the Place node with dependents [-anterior] and [+high], not the independent spreading of each feature [-anterior] or [+high]. The core of his proposal is as follows, though he did not spell out details:

(13) a. In the lexical component, palatalization applies to all coronals. Secondary Palatalization is also allowed to apply lexically in spite of lack of secondarily palatalized segments in the lexical inventory due to linking constraint (Hayes 1986, Itô 1986) under the assumption that multiply linked structures as a result of spreading are allowed in the lexical component.

b. In the postlexical component, palatalization applies in feature-changing fashion.

According to Kiparsky, the different realization of lexical and postlexical palatalization is due to a word-level rule at the end of the lexical component, which specifies [-anterior, +high] obstruent stops (i.e., secondarily palatalized [t^j] before a high front vocoid at a morpheme boundary in the lexical component) as [+delayed release] (refer to the difference between /mati/ and /mat-i/ below). According to Kiparsky, this word-level delayed released rule crucially enables /mat-i/ to be realized as [mac^{j}i] at the end of the lexical component. Kiparsky's analysis provides the following derivations for primary and secondary palatalization:

(14) Derivations according to Kiparsky 1993

Input	rules	/mati/ | [+ant]	/mat-i/ | [0ant]
Lexical Component	Pal.		t i [+hi] [-ant]
Word-level	[-ant, +high] --> [+delayed release]		mac^{j}i
Postlexical Component	Pal. (feature-changing)	t i [+ant] [+hi] [-ant]	
Output		[mat^{j}i]	[mac^{j}i]

Input	rules	/paci/ | [0ant]	/nac-i/ | [-ant]
Lexical Component	Pal.	c i [+hi] [-ant]	c i [+hi] [-ant]
Word-level	[-ant, +high] --> [+delayed release]	pac^{j}i	nac^{j}i
Postlexical Component	Pal. (feature-changing)		
Output		[pac^{j}i]	[nac^{j}i]

Kiparsky's analysis of Korean (primary and secondary) palatalization treats palatalization as a single process which spans both lexical and postlexical components. Furthermore, it crucially relies on underlying

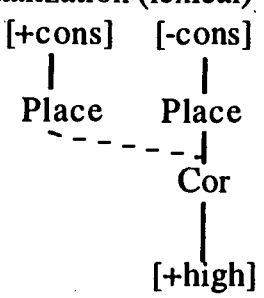
specification of [+ant] for /t, t^h/ before a tautomorphemic high front vocoid and underspecification of [-ant] for underlying /c, c^h/ before a tautomorphemic high front vocoid. Furthermore, Kiparsky crucially depends on the word-level delayed released rule which affects only the obstruent which inherits [-ant, +high] features via lexical palatalization. However, the problem of this approach is that it cannot explain why Umlaut is blocked in /mati/ [mat^{j}i]. We have shown that Umlaut must precede Palatalization. According to Kiparsky, postlexical application of Palatalization is assumed to derive [mat^{j}i] from /mati/. Then there is no way to explain why Umlaut is blocked, as in *[mæt^{j}i] in the Kyungsang Dialect, since palatalization must precede Umlaut.

2. Iverson 1993

On the other hand, Iverson 1993 tries to analyze the two types of palatalization as one uniform process within one level via appealing to Kiparsky's 1973 revised alternation condition, which restricts application of neutralization rules only to derived environments. As mentioned previously, Iverson misses the fact that not only /s/, /n/ and /l/ but also /t/ and /c/ undergo secondary palatalization. On the other hand, according to him, /t/ undergoes primary palatalization only in a derived environment but /t/ and /c/ are realized as [t] and [c] (i.e., no primary or secondary palatalization), respectively, before a tautomorphemic high front vowel (i.e., in a non-derived environment).

Iverson also proposes that primary and secondary palatalization are a uniform process. His rule of Palatalization is characterized as spreading of the tongue body features of a high front vocoid to a preceding underspecified consonant in the lexical component.

(15) Palatalization (lexical)



On the other hand, Iverson provides the following default configuration for those (coronal) consonants without inherent place of articulation:

(16) Default coronal consonants

Iverson proposes the following context-free underspecification for coronals:

(17) Context-free underspecification

/t, t^h, t'/	unspecified for [high]
/č, c^h, č'/	[+high]
/s, s'/	unspecified for [high]

Iverson suggests that if we adopt the reversed implication of revised alternation condition as a constraint, we can explain why phonemic primary palatalization is restricted to a derived environment whereas allophonic secondary palatalization is blind to a derived environment.

(18) a. If a rule is lexical (observes the derived environment constraint), then it is also structure-preserving (neutralizing). (Kiparsky's 1973 revised alternation condition in Iverson's interpretation)

b. If a rule application is neutralizing (structure-preserving), then it also observes the derived environment constraint. (Iverson's 1993 reversed implication of revised alternation condition)

Hence, Iverson assumes that the derived environment constraint restricts only structure-changing applications of a lexical rule. And he also assumes that Korean palatalization is a lexical rule, based on the aforementioned observation that Umlaut is blocked across a palatal or a palatalized coronal (Hume 1990, Iverson & Wheeler 1988) (see the data in (8), the rule ordering paradox in (9)). The phonological change from the underspecified /t, t^h, t'/ (= /T, T^h, T'/) to /č, $č^h$, č'/ is the result of neutralizing (structure-preserving)

application of the palatalization rule (15), and the neutralizing application of palatalization has to be confined to a derived representation according to the Derived Environment Constraint (18b). And the neutralizing application of palatalization in /mat-i/ to [maci] 'the first son' must involve a morpheme boundary (to avoid violation of the Derived Environment Constraint). Hence, the derived environment constraint in (18b) is respected in this case since a morpheme boundary is involved. On the other hand, the neutralizing application of palatalization in /mati/ -> *[maci] (the correct output is [mat^{j}i]) does not respect the Derived Environment Constraint since a morpheme boundary is not involved (violation of the Derived Environment Constraint). However, the structure-changing application of lexical palatalization need not involve a morpheme boundary since the structure-changing application of the lexical palatalization is not restricted to a derived environment. Hence, structure-changing application of the lexical palatalization can occur in /si/ -> [s^{j}i] 'poem' and /mas-i/ -> [mas^{j}i] 'taste-Nom' and it does not violate the Derived Environment Constraint, regardless of whether a derived environment is involved or not.

The problem in the analysis of Iverson 1993 is that he cannot explain why /t, t^{h}, t'/ undergo primary and secondary palatalization to [c^{j}, c^{hj}, c$^{j'}$] before a high front vocoid, as observed in this paper. This is because Iverson does not distinguish between primary /t/-palatalization and secondary /t/-palatalization. Furthermore, Iverson cannot explain why /t, t^{h}, t'/ undergo secondary palatalization to [t^{j}, t^{jh}, t$^{j'}$] before a tautomorphemic high front vocoid, as observed in this paper. Note that /mati/ is realized as [mat^{j}i] in which /t/ is secondarily palatalized but not primarily palatalized. According to Kiparsky's account, on the other hand, the /t/ before a tautomorphemic /i/ is prespecified for [+ant] and lexical application of palatalization is blocked due to the prespecified [+ant]. Only postlexical application of palatalization applies to change /t/ to [t^{j}] (refer to the similar derivation of /mati/ in (14). Hence, Kiparsky provides a correct prediction in this case.

We will show that primary and secondary palatalization are independent of each other and one level is enough to analyze primary and secondary palatalization. Furthermore, we will also argue that underlying specification of [+ant] for /t, t^{h}/ before a tautomorphemic high front vocoid alone is enough to analyze primary palatalization.

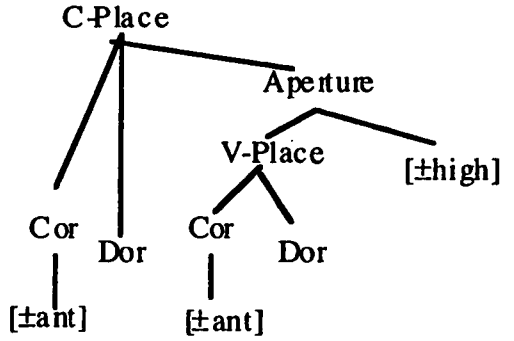
3. Assumed Hierarchical Feature Representations

First of all, we assume that palatal /c/ is represented as having a Coronal node with a [-anterior] dependent (Hume 1992, Clements 1991, Chomsky & Halle 1968). On the other hand, we assume that /t/ has only the Coronal node. Other coronal segments are minimally represented for place like /t/.

(19)

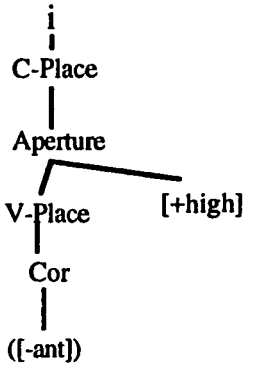
We assume the following feature geometry, adopted from Clements & Hume 1995 and Hume 1992:

(20) Feature Geometry



We further argue that a high front vocoid has the following hierarchical structure.

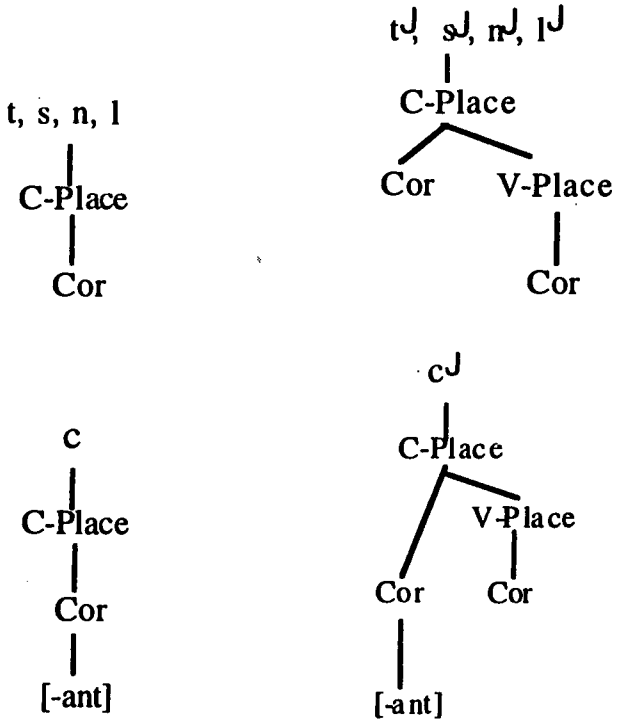
(21) Front high vocoid



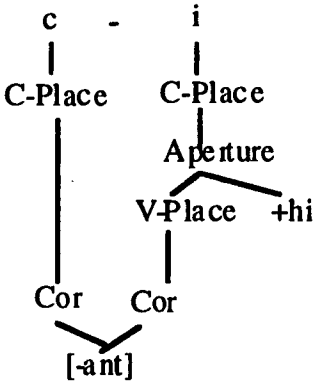
([-anterior] is a redundant feature which need not be underlyingly present, see discussion below).

Hence, unlike those specifications assumed for primary and secondary palatalization in Kiparsky 1993 (see (12)), we will have the following representations of the non-palatalized, primarily palatalized and secondarily palatalized coronals in Korean:

(22) Hierarchical feature specifications of coronal consonants

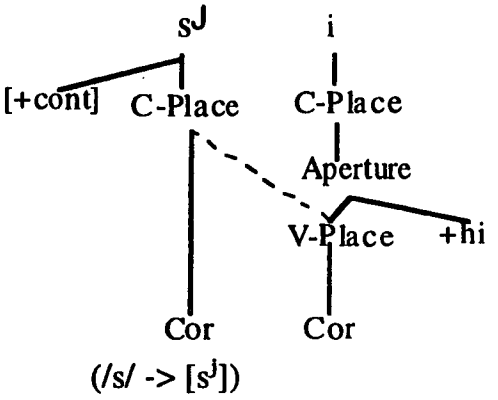


As for the redundant feature [-ant] in a high front vocoid, we propose that [-ant] is a redundant feature in a high front vowel which surfaces only when the high front vocoid is able to obtain [-ant] by sharing it with a consonantal neighbor. We will show in the next section that the behavior of [-ant] in Korean is similar to [voice] in a nasal consonant in Yamato Japanese in Itô, Mester & Padgett 1993b (hereafter IMP). We propose that [-ant] is shared by a coronal consonant and a following high front vocoid in primary palatalization, ignoring secondary palatalization for the moment:



For comparison, we will propose in section 5 that secondary palatalization is represented as sharing of a V-Place node of a high front vowel with a preceding coronal consonant (see discussion in section 5):

(24) Secondary Palatalization



Note that in secondary palatalization, the V-Place node of a high front vocoid is shared by the preceding coronal consonant. This is the topic which will be discussed in detail in section 5.

4. Analysis of Primary Palatalization

Itô, Mester & Padgett 1993b implement the two notions licensing and redundancy in OT to explain voicing assimilation in a sequence of a nasal C and a voiceless obstruent in Yamato Japanese:

(25) Observation: a nasal must share [voice] with a following consonant (IMP 1993b)

a.	/yom-te/	yon-de	'reading'
b.	/šin-te/	šin-de	'dying'
c.	tombo	'dragonfly'	*tompo
d.	šindo-i	'tired'	*šinto-i

From the observation that a nasal must share [voice] with a following consonant, IMP propose the following LICENSE[voice] and NasVoi constraints which appeal to the two notions licensing and redundancy, respectively:

(26) a. LICENSE[voice]: [voice] is licensed when linked to an obstruent

b. NasVoi: [nasal] ⊃ [voice]
[nasal] implies [voice] redundantly.

c. Constraint ranking: LICENSE[voice] >> NasVoi

d. Tableau

	LICENSE[voi]	NasVoi
☞ k a m i		*
k a m i | V	*!	
t o m p o		*!
t o m p o | V	*!	
☞ t o m b o \/ V		

In the first tableau above, the second candidate violates high ranked LICENSE[voi]. On the other hand, the first candidate violates low ranked NasVoi. As a result, the first candidate is optimal. In the second tableau, the last candidate does not violate any constraint and is optimal.

We are going to show that the redundant feature [-ant] of a high front vowel in Korean patterns exactly together with [voice] in Yamato Japanese in terms of feature licensing and redundancy[5]. We argue that [-ant] is a redundant feature of a high front vowel and we provide the following constraint:

(27) FRONT-HI[-ant]: [V-pl/Cor, +high] ⊃ [-ant]
A front high vowel implies [-ant] redundantly.

We further argue that the consonantal feature [-anterior] must be licensed by the feature [-son][6].

(28) LICENSE[-anterior]
[-anterior] is licensed by [-son].

(29) Constraint ranking
LICENSE[-anterior] >> FrontHi[-ant]

The licensing constraint LICENSE[-anterior] is probable since [-anterior] is a typical coronal consonantal place feature. Furthermore, only /t/ undergoes primary palatalization (i.e., sharing [-ant] by an obstruent coronal and a following high front vocoid) excluding sonorant coronal /l, n/. The reason why /s/ does not undergo primary palatalization will be spelled out later. As a result, any [-anterior] which is associated with a high front vocoid must be licensed by being additionally linked to an obstruent. On the other hand, [-anterior] is not allowed to appear under a high front vocoid which is preceded by a non-coronal consonant. This is because the feature [dor] or [lab] in a non-coronal consonant is not compatible with [-ant] (*[dor, -ant] or *[lab, -ant]). Hence, delinking of [dor] or [lab] from the non-coronal consonant is necessary if sharing of [-ant] between the non-coronal consonant and a following high front vocoid occurs. Then delinking of [dor] violates IDENT-IO[dor]. When we assume that IDENT-IO[dor] (and LICENSE[-ant]) is ranked above FRON-HI[-ant], we can explain why [-ant] cannot be shared by a dorsal consonant and a following high front vocoid: i.e. lack of primary palatalization in /ki/. The following is a tableau to illustrate this idea:

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[5]This observation is due to Rolf Noyer (p.c.).

[6]Recall that secondary palatalized [n^{j}] and [l^{j}] are represented with V-pl/Cor.

(30) /ki/ ki 'flag'

/ki/	IDENT-IO [dor]	LICENSE [-ant]	FRON-HI [-ant]
☞ k - i | | Dor V-Place | Cor			*
k - i | | Dor V-Place | Cor | [-ant]		*!	
c - i | | Cor V-Place | Cor | [-ant]	*!		

The tableau above shows that the optimal candidate (the first candidate) does not have [-ant] under the V-place of the high front vocoid. Other candidates violate either LICENSE[-ant] or FrontHi[-ant] and are eliminated.

When a high front vowel is preceded by a coronal nasal consonant, the optimal candidate shows that [-ant] does not appear on the surface at all:

(31) /kan-i/ kan^{j}-i 'saltiness-Nom'
(secondary palatalization is ignored.)

/kan-i/	LICENSE [-ant]	FRON-HI [-ant]
☞ k a n - i (V-pl; Cor Cor)		*
k a - - i (Cor; V-pl; Cor; [-ant])	*!	
k a n - i (Cor; V-pl; Cor; [-ant])	*!	

In the tableau above, the second and third candidates violate higher ranked LICENSE[-ant] since [-ant] is not licensed. On the other hand, the first candidate violates lower ranked FRONT-HI[-ant]. Hence, the first candidate is optimal.

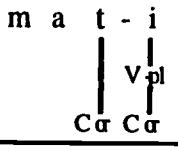
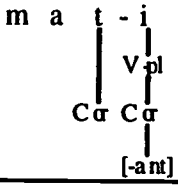
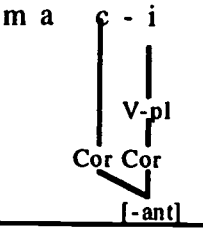
The redundant feature [-ant] will not appear under a high front vocoid which is preceded by a vowel, since it will not be licensed..

(32) /oi/ oi 'cucumber'

/oi/	LICENSE [-ant]	FRON-HI [-ant]
☞ o i (V-pl; Cor)		*
o i (V-pl; Cor; [-ant])	*!	

The following tableau illustrates how the two constraints interact with each other in primary palatalization (note that we assume tentatively that primary palatalization always involves a morpheme boundary and we ignore secondary palatalization in the following tableau):

(33) /mat-i/ mac^{j}-i 'first son'

/mat-i/	LICENSE [-ant]	FRON-HI [-ant]
a 		*!
b 	*!	
c ☞ 		

Candidate (a) violates FRON-HI[-ant] since [i] does not carry [-ant] under the V-pl node. Candidate (b) violates LICENSE[-ant] since [-ant] is not licensed. However, candidate (c) does not violate any constraint and is therefore optimal.

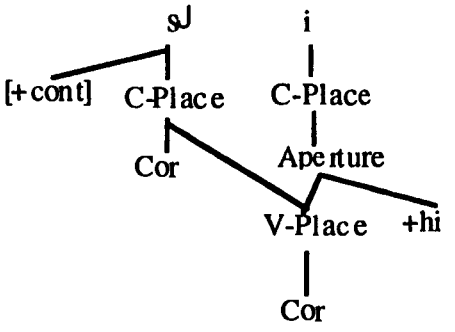
Based on the discussion so far, we propose the following constraint ranking:

(34) Constraint ranking for primary palatalization
LICENSE[-ant] >> FrontHi[-ant]

5. Analysis of Secondary Palatalization

As for secondary palatalization, in which a coronal consonant secondarily palatalizes before a high front vocoid, we propose the following representation in which the V-Place of a high front vowel is shared by a preceding coronal consonant:

(35) Feature sharing in secondary palatalization[7]



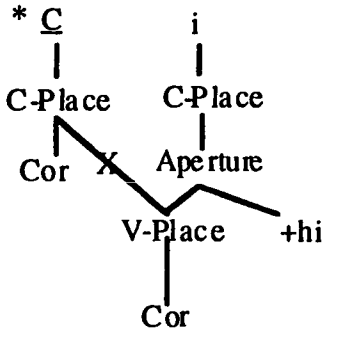
(t -> t^j, s -> s^j, c -> c^j, n -> n^j, l -> l^j)

The spreading of the V-Place of a high front vocoid to a neighboring consonant is limited to a coronal consonant due to its close relation with coronality (Zubritskaya 1995 for Russian, Selkirk 1991).

To explain the spreading of the V-Place of a high front vocoid to a preceding coronal consonant in secondary palatalization, we propose the following constraint for secondary palatalization of a coronal consonant before a high front vocoid (Rolf Noyer, personal communication):

[7]Primary palatalization is represented by sharing [-ant] by /t/ and a following front high vocoid whereas secondary palatalization, by sharing the V-pl/Cor by a coronal and a following front high vocoid. It may seem strange to see that sharing more structure entails a smaller change. Actually this problem stems from the feature hierarchy in Clements & Hume 1995, which is assumed in this paper. It is also possible to assume that [-back] replaces V-place/Cor in the feature hierarchy, since we will show that secondary palatalization and Umlaut involve spreading of V-place/Cor.

(36) PAL:



Ill-formed (*) unless a coronal consonant and a following high front vowel share a V-Place.

Since secondary palatalization is obligatory in Korean, PAL is ranked highly in the constraint ranking.

Korean has allophonic flapped coronal [r], which is not subject to secondary palatalization. Bhat 1974: 66 also reports that /r/ resists palatalization cross-linguistically. Mester & Itô 1989 and Zoll 1996 also note that /r/ resists palatalization in Japanese mimetics. As for non-existence of secondarily palatalized version of the flapped [r], it is probable from the articulatory point of view that flapped [r] preferentially resists palatalization[8], as noted by Kim-Renaud 1974/1991: 201-202:

> "It seems natural that the flap ɾ should escape palatalization, because the most agile front is employed in making the quick flipping contact and it would require more effort for the tongue tip to make the contact with the palatal region rather than with the alveo-dental region or for the blade of the tongue to make that flipping contact with the roof of the mouth."

Now we have to handle the idiosyncratic nature of /t/ before a tautomorphemic high front vowel which does not undergo primary palatalization. Recall that only /t/ before a high front vocoid across suffixal and clitic boundaries undergoes primary palatalization. We observe that the frequency of the /ti/ sequence within a morpheme is quite limited and morpheme-internal /ty/ does not exist at all.

---

[8] Rolf Noyer (personal communication) notes that Irish has secondarily palatalized [rʲ], though Irish [rʲ] is not realized as flapped but as slightly fricative.

We propose that morpheme-internal /t/ which appears before a high front vocoid is underlyingly specified for [+anterior], based on the observations that only underlying /t/ before a tautomorphemic font high vocoid does not undergo primary palatalization. The underlying specification of [+anterior] idea was first introduced in Kiparsky 1993 for Korean primary palatalization and secondary palatalization, though it was utilized in a different analysis of the same Korean primary palatalization (and also secondary palatalization). We propose an OT analysis with the spirit that prespecified [+ant] of /t/ before a tautomorphemic high front vocoid will block spreading of [-ant] from a following high front vocoid. There is a piece of diachronic evidence for the [+ant] prespecification in /t/ before a high front vocoid. Evidence comes from diachronic data of primary palatalization. According to K.-M. Lee 1961/1972 and Kim-Renaud 1974/1991, morpheme-internal /t/-palatalization took place around the late 17th and 18th centuries.

(37) Diachronic phonemic /t/-palatalization (Data from K.-M. Lee 1971 and K.-W. Nam 1992)
(allophonic secondary palatalization ignored)

a.	tikhi-ta	>	cikhi-ta	(> cik^{h}i-ta)	'to keep'
b.	ti-sik	>	ci-sik		'knowledge'
c.	kuti	>	kuci		'insistently'
d.	pat-ti	>	pat-ci		'to receive-Neg'
e.	tyuŋ-ha-ta	>	cuŋ-ha-ta		'to be important'
f.	taŋt^{h}i	>	taŋc^{h}i		'unreasonable'
g.	o-ti	>	o-ci		'to come-Neg'

The current regional variation of the result of diachronic primary palatalization is summarized as follows (K.-M. Lee 1972):

(38) a. In south-eastern Korean, /t, t^h, t'/ and /k, k^h, k'/ palatalize to phonemic [c, c^h, c'] before a high front vocoid and /y/ deletes.
b. In standard Korean, only /t, t^h, t'/ palatalize to phonemic [c, c^h, c'] before a high front vocoid and /y/ deletes.
c. In north-eastern Korean, palatalization does not take place at all and /ti/ sequence is still retained on the surface nowadays.

As the result of diachronic primary palatalization, morpheme-internal /ti/ and /ty/ sequence would not be expected to occur in Standard Korean. However,

as shown previously, some morpheme-internal /ti/ sequences survived the diachronic primary palatalization. According to the historical data, these morphemes had a back unrounded vowel between /t/ and /i/ before the 19th century. /ɨ/-deletion in that position took place around the 19th century: /ɨ/ was deleted before /y/ which in turn became /i/. This phonological change revived the appearance of /ti/ sequence within a morpheme by the time the phonological change of ti -> ci is restricted to the derived environment only.

(39) Diachronic /ɨ/-deletion around the 19th C (Data from K.-M. Lee 1972) (secondary palatalization is ignored)

a.	kyəntɨy-ta	> kyənti-ta		'to endure'
b.	mutɨy-ta	> muti-ta		'to be dull'
c.	stɨy	> sti	> t'i	'belt'

From the synchronic point of view, primary palatalization can be viewed as lexical diffusion. Kiparsky 1988, 1995 provides English ū-shortening as a typical case of lexical diffusion. English ū-shortening tends to extend its phonological context from the core environment (40a) to the peripheral environments (40b) and (40c) in an idiosyncratic manner by relaxing its context on the left and on the right (Dickerson 1975).

(40) From Kiparsky 1995: 643-644

a. [-anterior] ____ [-anterior, -coronal]
cook, hook, shook, rook, brook, crook, hookah (short)

b. ____ [-anterior, -coronal]
took, book, nook, look, forsook, Wookie (short)
snook, snooker, stook, boogie, Sook, gadzooks, spook (variable)
bazooka (long)

c. [-anterior] ____
good, could, should, hood "covering", hoodwink (short)
roof, rooster, hoodlum, hoof, room, Root, hoodlum, hood "ruffian", coop, proof (variable)
brood, shoot, hoot, behoove, scoop, coon, coot, roost, groove ... (long)

Kiparsky 1995 explains this case by appealing to underspecification. The core regularity can be explained by assuming a rule which assigns a single

mora to stressed /u/ between certain consonants and two moras elsewhere. The original rule which is assumed to apply in the context [-anterior] ____ [-anterior, -coronal] extends in the contexts in (40b) and (40c) by simplifying the rule's environment. The extended rule simply applies to the words which always have short [ŭ] in the context which is reanalyzed as unmarked. On the other hand, lack of application of the rule in (40b) and (40c) is explained by lexical prespecification of two moras in words with long [ū] in those contexts. The explanation for this lexical diffusion case is based on the observation that there is a systematic context (the core shortening environment) where length is systematically predictable.

Now, let us turn back to Korean primary palatalization. As was shown previously, primary palatalization takes place systematically before a high front vowel. By prespecifying [+anterior] for /t/ before a tautomorphemic high front vocoid, we will have the following [anterior] specification for /t/:

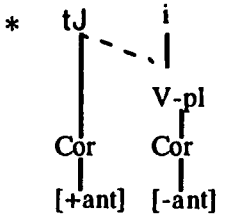
(41)		in morpheme-internal /ti/	elsewhere
	/t/	[+anterior]	Ø

Since /t/ which is prespecified for [+ant] is not allowed to additionally link to [-ant] without deleting the existing [+ant], if IDENT-IO[+ant] is highly ranked, we can explain why primary palatalization cannot take place in the prespecified /t/ for [+ant] before a tautomorphemic /i/.

Since [+ant] is not compatible with [-ant] within a segment, we propose the following phono-constraint (42) to block the case in (43):

(42) *[+ant, -ant]

(43)



In (43), /t/ is prespecified for [+ant] before tautomorphemic /i/ and the redundant [-ant] surfaces under the V-place shared by a coronal obstruent and a high front vocoid. We will assume that *[+ant, -ant] is a property of GEN rather than an actual (violable) constraint due to the inviolable nature of

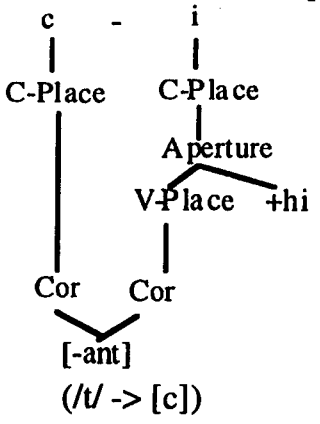
*[+ant, -ant]. No language has a segment which has both [+ant] and [-ant] at the same time.

Let us turn to the data in which primary or secondary palatalization occurs:

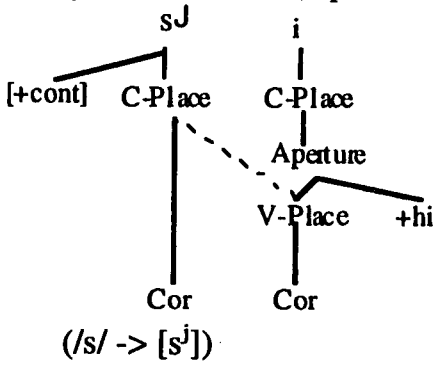
(44) a. /mati/ mat^{j}i 'knot' (Root)
b. /mat-i/ mac^{j}-i 'the first son' (Root-ADVL)

We proposed in section 3, 4 and 5 that primary palatalization and secondary palatalization are represented as follows:

(45) Primary Palatalization (repeated from (23) in section 3))



(46) Secondary Palatalization (repeated from (24) in section 3))



We further proposed that /t/ before a tautomorphemic high front vocoid is underlyingly specified for [+ant], as we treated the example in (44a) as a case of lexical diffusion. The following tableau illustrates why /t/ which is prespecified for [+ant] before a tautomorphemic /i/, does not undergo primary palatalization though it undergoes secondary palatalization:

(47) /mati/ mat^{j}i 'knot'

input	LICEN [-ant]	IDENT-IO [+ant]	PAL	FRON-HI [-ant]
ma t i, V-pl, Cor Cor, [+ant]				
ma t i, Cor V-pl, [+ant] Cor, [-ant]	*!		*	
ma t i, V-pl, Cor Cor, [+ant]			*!	*
ma c i, V-pl, Cor Cor, [-ant]		*!	*	
☞ ma tJ i, V-pl, Cor Cor, [+ant]				*
ma cJ i, V-pl, Cor Cor, [-ant]		*!		

The tableau above shows how the underlyingly specified [+ant] in /t/ blocks the double linking of [-ant] to the prespecified /t/ for [+ant] and a following /i/. Hence, the /t/ which is prespecified for [+ant] does not undergo primary palatalization.

Now we are going to show why /t/ undergoes primary and secondary palatalization to [cʲ] before a high front vocoid at suffixal and clitic morpheme boundaries. Recall that /t/ before a tautomorphemic high front vocoid is prespecified for [+ant] but /t/ elsewhere is unspecified for [+ant].

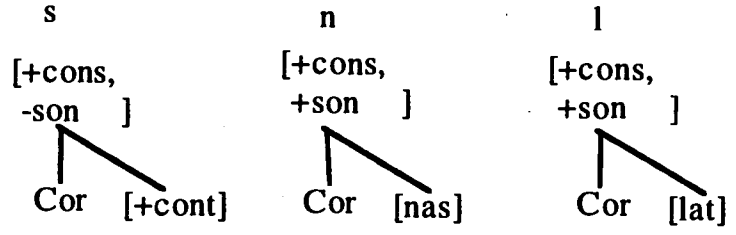
(48) /mat-i/ macʲ-i 'the oldest son' ('first' 'NOML')

input	LICEN [-ant]	PAL	FRON-HI [-ant]
	*!		
		*!	*
		*!	
	*!		
			*!
☞			

In the tableau above, only the last candidate, in which primary and secondary palatalization take place, does not violate any constraint and is therefore optimal.

/n/, /s/ and /l/ undergo only secondary palatalization. We assume the following hierarchical feature representations for coronal segments in Korean:

(49) Hierarchical feature representations for /n/, /s/ and /l/



We propose the following constraint which says that continuants /s, s'/ are not compatible with [-ant] given the assumed hierarchical feature specification in (22).

(50) *[+continuant, -anterior]

This phono-constraint, which is assumed to be highly ranked, can explain why /s/ does not undergo primary palatalization to [ʃ]. Recall that we already proposed that the reason why /n/ and /l/ do not undergo primary palatalization (i.e., sharing [-ant] by a coronal obstruent and a following high front vocoid) is that [+son] in /n/ and /l/ cannot license [-ant] in Korean. We proposed that [-ant] is licensed by [-son] (i.e., LICENSE[-ant]).

The following tableau illustrates how input /s/ before /i/ is realized as secondarily palatalized [sʲ]:

(51) /os-i/ os^{j}-i 'clothes-Nom'

input	LICEN [-ant]	*[+cont, -ant]	PAL	FRON-HI [-ant]
a	*!		*	
b			*!	*
c		*!		
d ☞				*
e		*!	*	

Candidate (d) violates only lower ranked FRONT-HI[-ant] since /i/ does not surface with [-ant]. Since other candidates violate at least one higher ranked constraint, candidate (d) is optimal.

The following tableau illustrates how the fake geminate /l/ is realized as a secondarily palatalized [l^{j}l^{j}]:

(52) /mal-li-/ mal^{j}-l^{j}i- 'stop-Caus'

input	LICENSE [-ant]	PAL	FRON-HI [-ant]
a	*!	*	
b		*!	*
c	*!	*	
d ☞			*
e	*!		

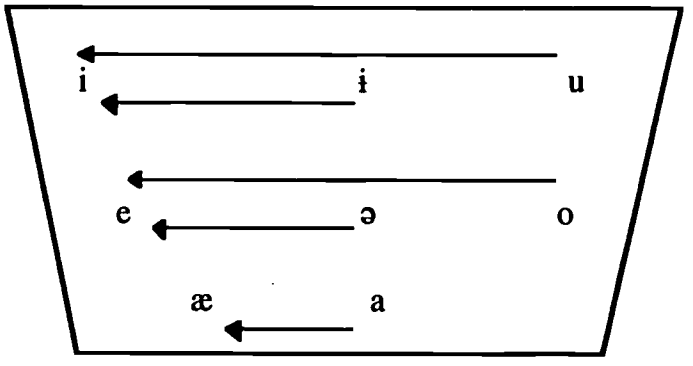
So far we have proposed the following constraint ranking for primary palatalization and secondary palatalization in Korean:

(53) Proposed constraint ranking
LICENSE[-ant], PAL, *[+cont, -ant] >> FRON-HI[-ant]

6. Umlaut in the Kyungsang Dialect

As shown previously in the data on Korean Umlaut in the Kyungsang dialect in section 1, Umlaut is a phonological phenomenon in which a back vowel optionally becomes a front vowel of the same height when followed by a high front vocoid. The following diagram shows the phonological changes of back vowels in Korean Umlaut:

(54) Vowel transitions in Korean Umlaut



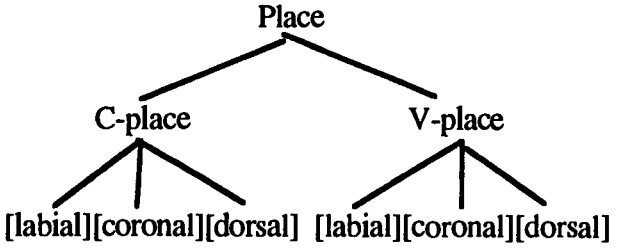
Hume 1990 observes that Umlaut does not take place across a palatal consonant /c/, including a derived palatal /c/, or across secondarily palatalized [n^j, s^j, l^j]. Other intervening consonants are argued to be transparent to Umlaut. Under the assumption that primary and secondary palatalization can be unified as a single process and can be uniformly represented by spreading of [+coronal] from a high front vocoid to a preceding coronal consonant, she provides the following generalization as to Umlaut blocking:

(55) Hume's generalization as to Umlaut blocking
Observation 1: Umlaut is blocked across derived or non-derived palatal consonant c.
Observation 2: Umlaut is blocked across secondarily palatalized [n^j, s^j, l^j].
Generalization: Umlaut is blocked across a palatal consonant.

Hume's generalization as to palatal blocking of Umlaut is based on two incorrect observations that the phonological change of /t/ to a palatal before /i/ at a suffixal or clitic boundary (i.e., primary palatalization) does not involve secondary palatalization, and that /t/ does not undergo secondary palatalization before a tautomorphemic high front vocoid (Kim-Renaud 1974, Iverson 1987, Iverson 1993 and references therein), unlike the observations provided in this paper (also in Kiparsky 1993 and K.-M. Lee 1972).

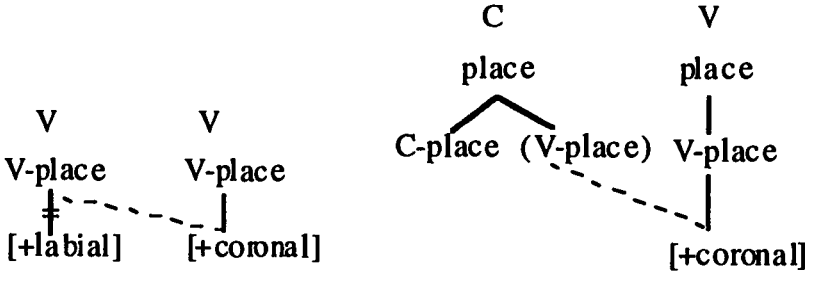
Before we consider the analysis of Umlaut in the framework of OT, we will summarize Hume's 1990 analysis of Umlaut and its palatal blocking. Hume assumes the following feature geometry, adopted from Clements 1989a:

(56) Feature Geometry (Clements 1989a)



Hume assumes without detailed discussion that primary and secondary palatalization need not be distinguished and can be unified as a single process: spreading of [+coronal] of a high front vocoid to the V-place node of a preceding consonant. She further argues that Umlaut is represented by spreading of [+coronal] of a high front vocoid to a preceding back vowel.

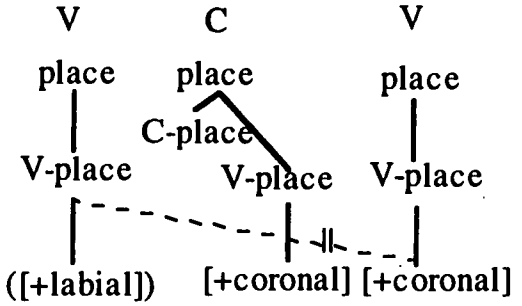
(57) a. Umlaut b. Palatalization



Structure preservation, which prevents cooccurrence of [+labial, +coronal], plays a crucial role in her analysis of Umlaut. In her feature geometry, palatal consonants and front vowels are specified for [+coronal] as a dependent

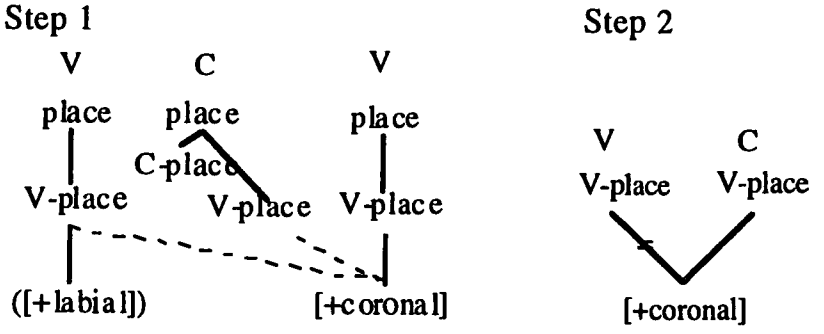
of V-place node. In this way, she derives the opacity of underived /c/ in Umlaut by appeal to the Line-Crossing prohibition:

(58) Blocking of Umlaut across an underived palatal /c/



The Umlaut blocking effect across intervening derived palatalized consonants is explained by two separate steps. Namely, [+coronal] spreads to a preceding vowel across a derived palatalized coronal consonant. But according to Hume, a later Dissimilation rule delinks [+coronal] from the V-place of a preceding vowel. This Dissimilation rule is purely ad hoc.

(59) Blocking of Umlaut across derived palatalized coronal consonants



Hume's analysis of Umlaut is crucially based on the assumption that primary and secondary palatalization can be unified as a single process and as a result, it does not distinguish between primary and secondary palatalization. This assumption results in a wrong generalization that any intervening palatal or palatalized consonant blocks Umlaut. However, we have already shown that Umlaut is blocked only by a secondarily palatalized consonant, and primary and secondary palatalization are independent from each other. In previous sections, we provided the following motivation to treat primary palatalization and secondary palatalization as separate phonological phenomena:

(60) Phonological differences between primary and secondary palatalization
   a. Only /t/ is subject to primary palatalization whereas all coronal consonants including /t/ are subject to secondary palatalization
   b. Primary palatalization has lexical idiosyncratic exceptions (a lexical diffusion case) whereas secondary palatalization does not.

Unlike Hume's generalization that Umlaut is blocked by a palatal consonant, we observe that Umlaut consistently does not take place across a coronal consonant which has undergone secondary palatalization.

(61) Umlaut blocked by secondary palatalization

a.	/mat-i/	mac^{j}-i, *mæc^{j}-i	'the eldest'
b.	/əti/	ət^{j}i, *et^{j}i	'where'
c.	/mati/	mat^{j}i, *mæt^{j}i[9]	'knot'
d.	/mal-li/	mal^{j}-l^{j}i, *mæl^{j}-l^{j}i	'to stop'
e.	/kasi/	kas^{j}i, *kæs^{j}i	'thorn'
f.	/ənni/	ən^{j}n^{j}i, *en^{j}n^{j}i	'sister'
g.	/alli-/	al^{j}l^{j}i, *æl^{j}l^{j}i	'to inform'
h.	/kəci/	kəc^{j}i, *kec^{j}i	'beggar'
i.	/tac^{h}i-/	tac^{jh}i, *tæc^{jh}i	'to get hurt'

Since Hume's argument is based on the incorrect observation that /t/ is not (secondarily) palatalized before a tautomorphemic high front vocoid, Hume cannot explain why Umlaut is blocked across /t/ in /əti/ [ət^{j}i] (*[et^{j}i]) in (61b). We propose the following generalization as to Umlaut blocking:

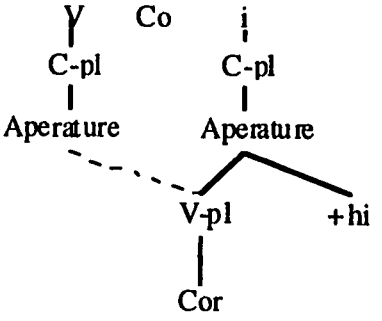
(62) Umlaut blocking
   Umlaut is blocked across a secondarily palatalized coronal consonant.

Like secondary palatalization, which was analyzed in section 5, Umlaut can also be represented as the spreading of the V-place/Cor of a high front vocoid since it forces a preceding back vowel to become a front vowel

[9]Hume 1990 says that optional umlaut takes place in /mati/ 'knot' in the Kyungsang Dialect. However, when I consulted with Kyungsang Dialect speakers, it turned out that umlaut does not take place in /mati/. Umlauted [mæt^{j}i] sounds very odd to them.

before a font high vocoid. Hence, we will represent Umlaut as spreading of the V-place of a high front vocoid to a preceding back vowel.

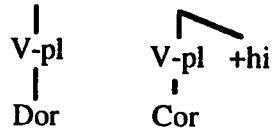
(63) Umlaut



We conclude that Umlaut and secondary palatalization are the same phenomenon. The only difference between Umlaut and secondary palatalization is that the V-place of a high front vowel spreads to a back vowel in Umlaut but it spreads to a coronal consonant in secondary palatalization.

To explain the necessity of Umlaut, we further propose the following constraint, which does not allow a surface sequence of a back vowel and a high front vocoid.

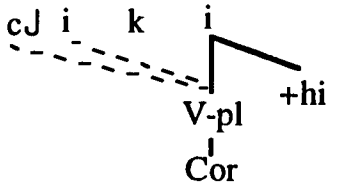
(64) *V Co V (henceforth, *DOR-C0-COR)



A sequence of a back vowel and a high front vocoid is not allowed.

As shown in section 1, primary palatalization is a strictly local phenomenon and only a coronal consonant and a following high front vocoid are involved in primary palatalization. And we analyzed primary palatalization in section 4 via interaction of licensing and redundancy in the sense of IMP 1993b. On the other hand, spreading of the V-place of a high front vocoid is not necessarily local (Hume 1990):

(65) /cuk-i-/ c^{j}ik-i- 'kill-Caus'

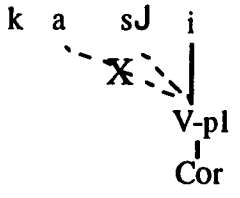


This shows that Umlaut and secondary palatalization can take place simultaneously.

On the other hand, the following examples show a case in which spreading the V-place of /i/ is blocked by secondary palatalization. According to our previous observation, Umlaut is blocked across a secondarily palatalized coronal consonant.

(66) a. /kasi/ kas^{j}i, *kæs^{j}i 'thorn'

b. /tatimi/ tat^{j}imi, *tæt^{j}imi 'fulling block'



We propose that the blocking of the spread of the V-place of a high front vocoid across a secondarily palatalized coronal consonant is due to the conspiracy of the following two constraints:

(67) a. SPREAD[$\overset{\text{V-pl}}{\underset{|}{\text{Cor}}}$][10]

[$\overset{\text{V-pl}}{\underset{|}{\text{Cor}}}$] must be multiply linked (or spread).

b. IDENT-IO[$\overset{\text{V-pl}}{\underset{|}{\text{Cor}}}$]

c. Ranking:

PAL >> SPREAD[$\overset{\text{V-pl}}{\underset{|}{\text{Cor}}}$]

>> IDENT-IO[$\overset{\text{V-pl}}{\underset{|}{\text{Cor}}}$] >> *DOR-C0-COR

[10] I thank Young-mee Cho for suggesting this constraint.

SPREAD[F] constraint requires that a feature F be multiply linked (or spread) in the output (Padgett 1995 and others). SPREAD[$\overset{\text{V-pl}}{\text{Cor}}$] forces [$\overset{\text{V-pl}}{\text{Cor}}$] to be multiply linked. However, spreading the feature [$\overset{\text{V-pl}}{\text{Cor}}$] to a preceding segment compels violation of lower ranked IDENT-IO[$\overset{\text{V-pl}}{\text{Cor}}$].

The basic concept of the proposed constraint ranking is as follows. Consider the following potential candidates, given the input /ani/:

(68) /ani/ [an^{j}i] 'no'

a. a . n i	b. a . n^{j} i	c. æ . n i	d. æ . n^{j} i
|	\ |	\ /	\ | /
V-pl	V-pl	V-pl	V-pl

Candidate (a) violates high ranked PAL and SPREAD[$\overset{\text{V-pl}}{\text{Cor}}$]. And it also violates lowest ranked *DOR-C0-COR due to lack of Umlaut. Candidate (b) receives one violation mark for IDENT-IO[$\overset{\text{V-pl}}{\text{Cor}}$], which is compelled to avoid violation of SPREAD[$\overset{\text{V-pl}}{\text{Cor}}$] and PAL. It also violates lower ranked *DOR-C0-COR due to lack of Umlaut. In this case, spreading of [$\overset{\text{V-pl}}{\text{Cor}}$] of /i/ to /n/ satisfies higher ranked PAL and SPREAD[$\overset{\text{V-pl}}{\text{Cor}}$]. Candidate (c) is worse than candidate (b) since it violates higher ranked PAL. It also receives one violation mark for IDENT-IO[$\overset{\text{V-pl}}{\text{Cor}}$], which is compelled to avoid violation of SPREAD[$\overset{\text{V-pl}}{\text{Cor}}$]. Candidate (d) is also worse than candidate (b) since it receives two violation marks for IDENT-IO[$\overset{\text{V-pl}}{\text{Cor}}$] in comparison with one violation mark for IDENT-IO[$\overset{\text{V-pl}}{\text{Cor}}$] in candidate (b). As a result, the best of the worst candidates is candidate (b).

Hence, the effect of the ranking SPREAD[$\overset{\text{V-pl}}{\text{Cor}}$] >> IDENT-IO[$\overset{\text{V-pl}}{\text{Cor}}$] is to force spreading of [$\overset{\text{V-pl}}{\text{Cor}}$] of a high front vocoid (to a neighboring segment) to occur only once, unless the resulting configuration violates other

higher ranked constraints such as PAL (in the case of multiple spreading of [$^{V\text{-}pl}_{Cor}$] (see the tableau in (71) for the multiple spreading case)).

The following tableau illustrates how the constraint ranking predicts that Umlaut is blocked across a secondarily palatalized consonant:

(69) /kasi/ kasʲi 'thorn'

input	PAL	SPRD [$^{V\text{-}pl}_{Cor}$]	IDENT-IO [$^{V\text{-}pl}_{Cor}$]	*DOR-C0-COR
k a s i V-pl V-pl Do Cor				
a. k a s i V-pl V-pl Do Cor	*!	*		*
b. ☞ k a s i V-pl V-pl Do Cor			*	*
c. k æ s i V-pl V-pl Do Cor			**!	
d. k æ s i V-pl V-pl Do Cor	*!		*	

Candidates (a) and (d) fatally violate PAL. Candidate (b) receives one violation mark for IDENT-IO[$^{V\text{-}pl}_{Cor}$] and another violation mark for lower ranked *DOR-C0-COR. However, candidate (c) receives two violation marks for IDENT-IO[$^{V\text{-}pl}_{Cor}$]. As a result, candidate (c) is optimal.

The following tableau illustrates a case in which Umlaut occurs across a non-coronal consonant:

(70) /aki/ æki (or aki) 'baby'

input	SPRD V-pl [Cor]	IDENT-IO V-pl [Cor]	*DOR-C0-COR
a.	*!		
b. ☞			

In the tableau above, candidate (a) fatally violates SPREAD[$\overset{\text{V-pl}}{\underset{\text{Cor}}{}}$]. However, candidate (b) violates lower ranked IDENT-IO[$\overset{\text{V-pl}}{\underset{\text{Cor}}{}}$] and is optimal.

The following is a case of Umlaut plus secondary palatalization, in which spreading of the V-place of /i/ is not limited to a neighboring consonant or vowel:

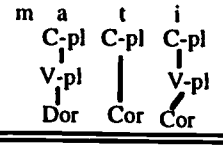
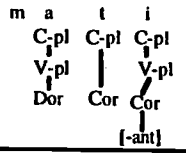
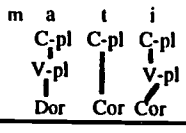
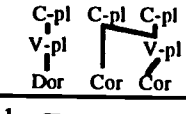
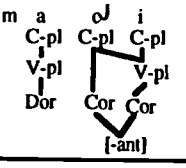
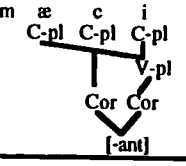
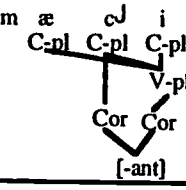
(71) /cuk-i-/ cʲik-i- 'kill'

input	PAL	SPRD V-pl [Cor]	IDENT-IO V-pl [Cor]	*DOR-C0-COR
a.		*!		*
b.	*!		*	
c. ☞			**	

Candidate (b) is eliminated due to fatal violation of undominated PAL. Candidate (a) receives a fatal violation mark for SPREAD[V-pl Cor] whereas candidate (c) receives two violation marks for lower ranked IDENT-IO[V-pl Cor]. As a result, candidate (c) is optimal. This tableau shows that multiple spreading of [V-pl Cor] must take place to avoid violation of highly ranked PAL. Otherwise, the ranking SPREAD[V-pl Cor] >> IDENT-IO[V-pl Cor] would require that spreading of [V-pl Cor] occur only once, as shown early in this section.

We will show a case in which palatalization-blocking of Umlaut takes place across a derived palatal which has also undergone secondary palatalization.

(72) /mat-i/ mac^{j}-i 'the eldest'

input 	PAL	Licen [-ant]	SPRD V-pl [Cor]	IDENT-IO V-pl [Cor]	*DOR-C0-COR	FRON-HI [-ant]
a 	*!	*	*	*	*	
b 	*!	*	*		*	*
c 				*	*	*!
d ☞ 				*	*	
e 	*!	*	*	*	*	
f 				**!	*	

Candidates (a), (b) and (e) are eliminated by a violation mark for undominated PAL, which forces a coronal consonant and a following high front vowel to share the V-place. Candidate (f) receives two violation marks for SPREAD[$\overset{\text{V-pl}}{\underset{|}{\text{Cor}}}$] in comparison with candidates (c) and (d), which receive one violation mark for the same constraint. Candidate (d) is preferred as optimal over candidate (c) since candidate (c) additionally violates FRON-HI [-ant].

Finally, consider the following tableau, in which Umlaut is blocked across the secondarily palatalized [tʲ]. Note that /t/ before a tautomorphemic /i/ is prespecified for [+ant] and is realized as secondarily palatalized [tʲ].

(73) /əti/ ətʲi 'where'

input	LICEN [-ant]	IDENT-IO [+ant]	PAL	SPRD V-pl [Cor]	IDENT-IO V-pl [Cor]	*DOR-C0-COR	FRON-HI [-ant]
a	*!		*	*		*	
b			*!	*		*	*
c		*!			*	*	
d ☞					*	*	*
e					**!		*

Candidates (a), (b) and (c) are eliminated due to at least one violation mark for a highly ranked constraint. On the other hand, candidate (d) is preferred over candidate (e) since the former receives one violation mark for IDENT-IO[$\overset{V\text{-}pl}{Cor}$] whereas the latter, two violation marks for the same constraint.

In this section, we have proposed the following constraint ranking:

(74) Constraint ranking in the Kyungsang Dialect

SPREAD[$\overset{V\text{-}pl}{Cor}$]

>> IDENT-IO[$\overset{V\text{-}pl}{Cor}$]

>>*DOR-Co-COR, FRON-HI[-ant]

7. Summary

We have shown that phonemic primary /t/-palatalization, which is treated as a prototypical case of non-derived environment effect in the framework of Lexical Phonology in the literature, is an independent phenomenon from allophonic secondary palatalization in Korean. Furthermore, we showed that a paradox which arises in the lexical and postlexical dichotomy in LP in the analysis of primary and secondary palatalization can be eliminated in an OT-based approach. We analyzed primary palatalization through interaction between licensing and redundancy of the feature [-ant] in the sense of IMP 1993b. We additionally argued that palatal blocking of Umlaut in Korean is due to secondary palatalization alone, unlike the arguments in the literature which claim that palatal blocking of Umlaut is due to both primary and secondary palatalization. Following Kiparsky, we reintroduced the idea that morpheme-internal idiosyncratic /t/ before /i/ should be underlyingly specified for a "redundant" [+anterior] to explain lack of primary palatalization in the morpheme-internal /ti/ sequence.

In the analysis of Umlaut, we analyzed Umlaut as the same phenomenon as secondary palatalization (i.e., spreading of the V-place of a high front vocoid). Furthermore, we attributed blocking of Umlaut across a secondarily palatalized coronal consonant to the conspiracy of the two constraints SPREAD[$\overset{V\text{-}pl}{Cor}$] and IDENT-IO[$\overset{V\text{-}pl}{Cor}$].

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Exceptional Case Marking in the Xtag System

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1. Introduction

This paper describes an implementation of Exceptional Case Marking (ECM) verbs for the Xtag system[1]. Xtag is a parser based on an implemention of Tree Adjoining Grammar (TAG) extended with a feature-based unification mechanism. A TAG analysis of ECM verbs and raising passives was first set out, in rough form, in Kroch and Joshi (1985). However, the exceptional nature of ECM verbs causes certain problems when actually implementing such an analysis in Xtag, and we describe here the problems encountered and their solution. Furthermore, we extend the earlier analysis to handle verbs that take bare infinitive complements. The Xtag implementation allows for a clean solution to the problem of the lack of a bare infinitive passive.

As a quick review, ECM verbs are those which appear to mark the subject of the infinitival complement with accusative Case, as in (1a), in contrast with control verbs such as in (1b), in which *Bob* is a thematic object of the verb. The passivization of an ECM verb causes the external theta role assignment to be suppressed along with the the exceptional accusative Case assignment. This results in a "raising passive", as in (2a), analogous to a regular raising verb such as in (2b).

(1) a. Van expects [Bob to talk]
    b. Van persuaded Bob [PRO to talk]
(2) a. Bob was expected to talk
    b. Bob seems to talk

Now consider the class of verbs that take bare infinitive complements, as in (3a)[2]. A surprising feature of these verbs is that in the passive, they can no longer take the bare infinitive, but must take a full infinitive, as illustrated in (3bc).

[1]I would like to thank the members of the Xtag project for their advice, and their insistence that I get this work done, and two anonymous reviewers. This work was supported by NSF grant SBR8920230 and ARO grant DAAH04-94-G-0426.

[2]These are like ECM verbs in that the subject of the complement receives Case from the matrix verb while not being theta-marked by the matrix verb, but unlike ECM in that complement is not usually considered to have as large a projection (say, only VP) and so the Case assignment is not so "exceptional".

(3) a. Bob sees the harmonica fall
b. * The harmonica was seen fall
c. The harmonica was seen to fall

In section 2 we give a brief overview of TAG and the associated feature system used in Xtag, with examples of raising and sentential complementation. In section 3 we describe the Xtag implementation of ECM verbs with infinitival complements and of verbs taking bare infinitive complements. Section 4 describes how the passive for both classes is implemented, and how the bare infinitive passive problem is handled. In conclusion, Section 5 discusses how the Xtag implementation compares to some recently proposed analyses in the Minimalist framework.

2. Basics of the Xtag System

The Xtag system is based on the TAG formalism developed in Joshi et al. (1975), Kroch and Joshi (1985), extended with a feature-based unification system as in Vijay-Shanker and Joshi (1991), The XTAG-Group (1995). These references should be consulted for more detail than can be presented here.

TAG was introduced in Joshi et al. (1975) as a formalism with interesting mathematical properties, and it has since (e.g., Kroch and Joshi (1985) and Frank (1992)) been argued that TAG allows linguistically attractive analyses to be stated in natural ways. The essential idea is that TAG allows for recursion to be separated from the specification of a grammar, thus allowing, and requiring, the substantive theory of syntax to be confined to the domain of ELEMENTARY TREES, the primitive elements of the TAG formalism.

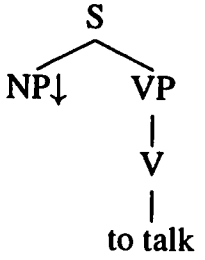
The ELEMENTARY TREES, are of two types: INITIAL TREES and AUXILIARY TREES. In a TAG grammar for natural language, INITIAL TREES are phrase structure trees of simple sentences containing no recursion, while recursive structures are represented by AUXILIARY TREES[3]. Elementary trees are combined by the operations of SUBSTITUTION and ADJUNCTION. Substitution inserts elementary trees into substitution nodes that appear on the

[3]A reviewer asks how this notion of recursion is "linked to GB/minimalist analyses which only have finite rules of phrase structure combined with movement." As will hopefully become clear, adjunction of auxiliary trees allow the elimination of cyclic movement. So instead of a derivation of *John$_i$ seems t_i to be certain t_i to like pizza* with *John* moving successively from each clause, in TAG (and Xtag) there is an elementary tree for *John to like pizza*, with *seems* and *to be certain* both adjoining in. There is no "movement" at all of *John*. This is discussed in more detail shortly.

frontier of other elementary trees. Adjunction grafts auxiliary trees into elementary trees at the node whose label is the same as the root and foot labels of the auxiliary tree.

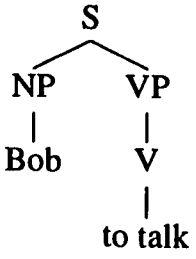
2.1. An Example of Raising in TAG

(4)(a)



(b)

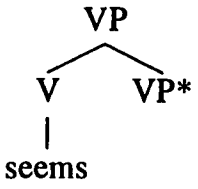
(5)



The trees in (4a) and (4b) are both initial trees. We are assuming a simplified phrase structure for the purpose of explaining the TAG system. Nodes on the frontier of initial trees are marked as substitution sites by a (↓). The tree (4b) substitutes into the NP substitution nodes in (4a) to give the result in (5).

This use of substitution (essentially a tree-substitution grammar) is clearly no big deal, and by itself would be of no interest as a grammar formalism. What makes TAG interesting is the use of the adjunction operation, which can be used to give the effect of movement by "stretching" components of one tree away from the rest of the tree. Exactly one node on the frontier of an auxiliary tree, whose label matches the label of the root of the tree, is marked as a foot node by a (∗). The adjunction operation takes an auxiliary tree and inserts it into the body of another tree at a node of the same label as the foot and root nodes of the auxiliary, as shown in Figure 1.

(6)



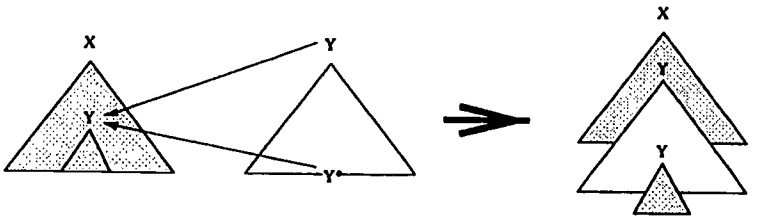
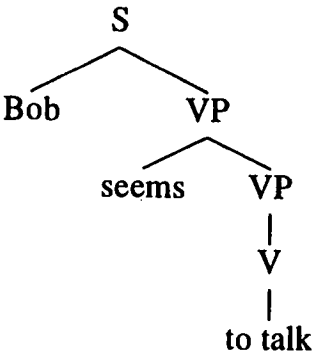


Figure 1: The Adjunction operation

(7)



For example, again with a simplified phrase structure, (6) is a tree for the raising verb *seems* and is an auxiliary tree, with both the root and foot nodes being VP. When (6) is adjoined at the VP node of (5), the result is the tree in (7). There is no operation of "movement" from one tree to another. Furthermore, the operation can be recursive, as in *Bob seems to be certain to talk*. The derivation of this would proceed by having a raising tree for *to be certain* that is roughly the same as the one for *seems* (leaving aside issues of tense), and the tree for *seems* would adjoin into that for *to be certain*, deriving a complex auxiliary tree for *seems to be certain*, which would then adjoin into (5)[4].

This example abstracted away from many necessary components of a grammar. For example, there is no indication of tense, agreement, Case assignment, etc. TAG as a formalism makes no claims about how these are to be handled, and in general has nothing to say about the character of the elementary trees. TAG only provides the machinery to combine elementary trees once they are specified.

[4]This is a simplified description. Technically, TAG only allows adjunction of a single tree into another, not of a complex derived tree into another tree. So a precise description of the derivation consists of two simple adjunctions - *seems* into *to be certain*, and *to be certain* into *Bob to talk*.

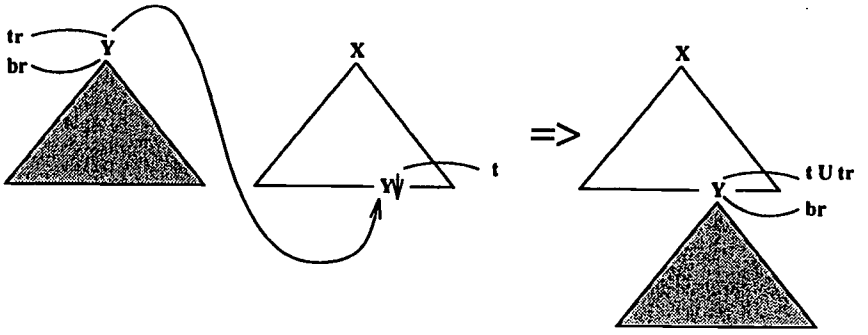


Figure 2: Schemata for feature formation upon substitution
[t=top b=bottom r=root f=foot U=unification]

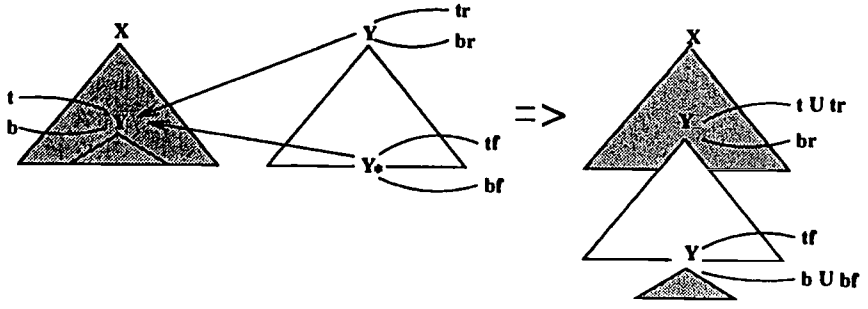


Figure 3: Schemata for feature formation upon adjunction
[t=top b=bottom r=root f=foot U=unification]

The Xtag system takes one particular approach to how these details should be handled. Feature structures are added to the basic TAG formalism by associating a feature structure with each node in an elementary tree. It consists of a top part, which expresses the constraints specified by the structure above the node, and a bottom part, which expresses the constraints specified by the subtree associated with the node. Substitution nodes, however, have only the top features, since the tree substituting in carries the bottom features. When substitution is performed at a node, the features are formed as shown in Figure 2. When adjunction is performed, the node is "split", with the features formed as shown in Figure 3. At the end of a derivation, the top and bottom features of each node must unify.

2.2. Raising in Xtag

We'll now reconsider the previous example as it is derived in the Xtag system, with feature values. Consider the trees in Figure 4. Aside from the features,

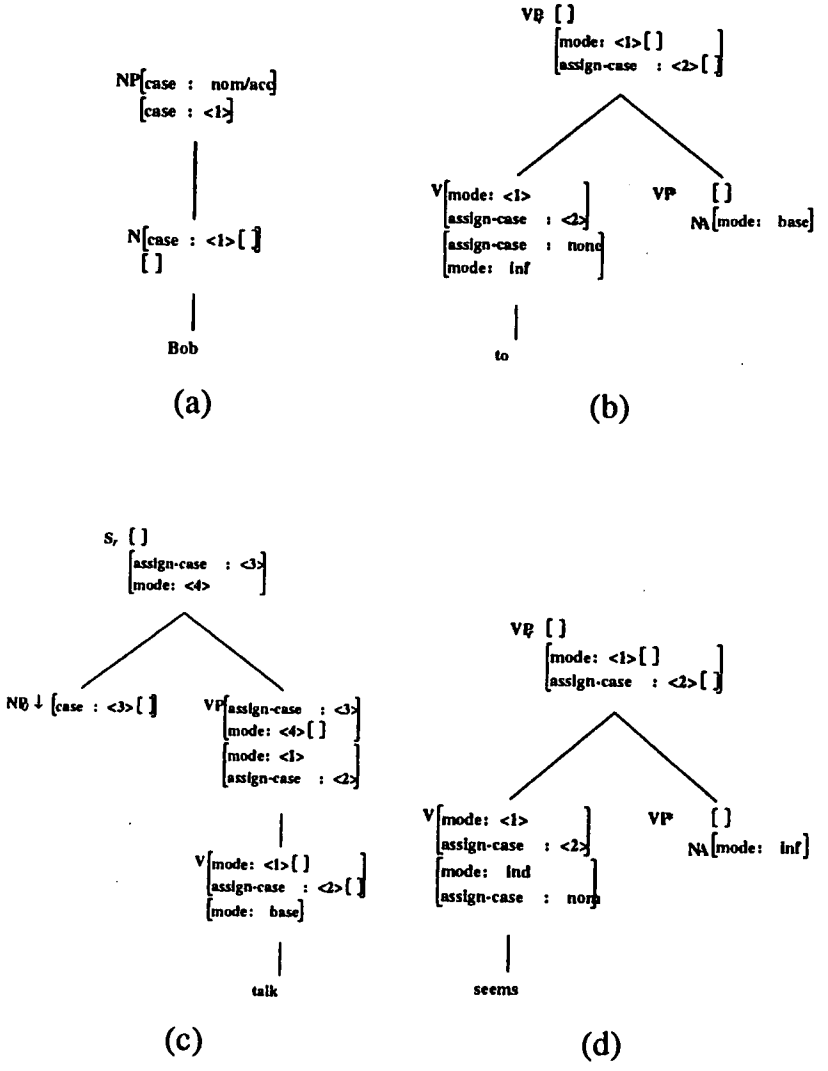


Figure 4: Component trees for *Bob seems to talk*

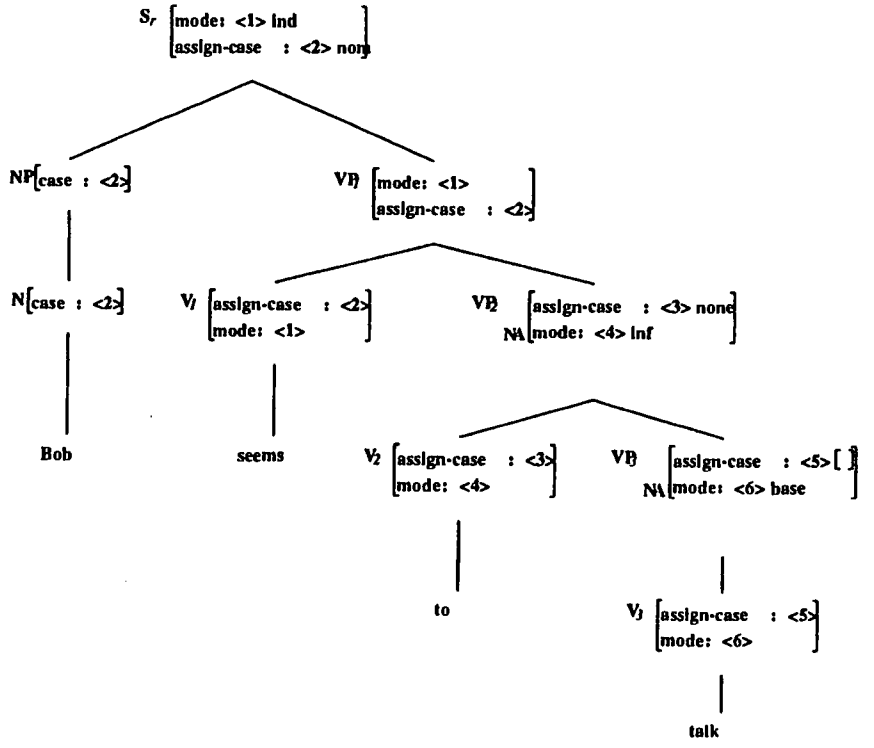


Figure 5: Derived tree for *Bob seems to talk*

the only difference between these trees and the earlier ones is that *to* is now treated as a separate auxiliary tree, instead of being part of the *talk* elementary tree. The derivation proceeds as follows:

1. The tree for *Bob* in Figure 4(a) substitutes into the NP node of the tree for *talk* in Figure 4(c), to produce a tree for *Bob talk*[5].

2. The tree for *to* in Figure 4(b) adjoins into the VP node of the resulting tree to produce a tree for *Bob to talk.*

3. The tree for *seems* in Figure 4(d) adjoins into the VP node of the resulting tree to produce a tree for *Bob seems to talk.*

The resulting tree is shown in Figure 5. Case assignment of the subject is handled by using the <**assign-case**> and <**case**> features. The basic idea is

[5]If the derivation stopped at this point, then a sentence for *Bob talk* would be produced with no unification errors. It is stipulated that every sentence must be indicative or imperative, which is indicated by the <**mode**> feature. In the current example *Bob talk* would have mode <**mode**>=**base**, and therefore fail as derivation.

that Case assigners have an <**assign-case**> feature, and noun phrases come with a <**case**> feature indicating whether they are nominative or accusative. The <**assign-case**> and <**case**> features must unify, thus "licensing" the case of the NP.

The *talk* tree, being uninflected, specifies no value for <**assign-case**>, since by itself it has no case to assign. The *to* tree has a <**assign-case**> value of **none**, which gets unified with the <**assign-case**> value on the top of the VP node in the *talk* tree. At this point, in the tree for *Bob to talk*, the <**case**> feature at the NP node is **none**, and so without any further operations this derivation would crash due to a unification failure. As discussed in more detail below, this corresponds to the licensing of PRO and not lexical subjects in infinitivals. However, when *seems* adjoins in, and unification of top and bottom features takes place, the <**assign-case**>=**nom** value on the V node of the *seems* tree gets percolated to the S_r node of the *talk* tree, which then unifies with the <**case**> value of the NP node to ensure that the subject has case **nom**.

The <**mode**> feature is used to indicate the mode of the sentence built so far. An uninflected verb, such as *talk* in this example, has <**mode**>= **base**, and the adjunction of the *to* tree percolates a value of **inf** for the feature <**mode**>, indicating that it is infinitive. A mode of value **ind** stands for indicative.

2.3. Sentential Complementation in Xtag

Consider the derivation of a sentence with a non-ECM verb with an infinitival complement, as in (8), in which, as shown, we are assuming an analysis with PRO as the subject of the complement.

(8) Bob tries [PRO to talk]

We use the same trees for *Bob*, *to*, and *talk* as in Figure 4, and also the trees for *tries* and *PRO* in Figure 6.

Sentence (8) is derived using the trees in Figures 4 and 6 as follows:

1. The tree for *to* in Figure 4(b) adjoins at the VP node and the tree for *PRO* in Figure 6(a) substitutes at the NP node of the tree for *talk* in Figure 4(c), to produce a tree for *PRO to talk*.

2. The tree for *Bob* in Figure 4(a) substitutes at the NP node of the tree for *tries* in Figure 6(b).

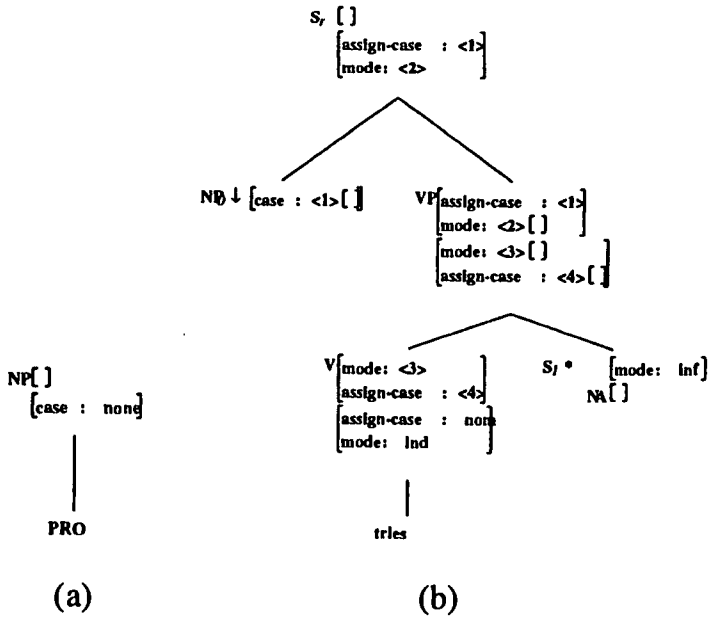


Figure 6: Component trees for *Bob tries to talk*

3. The result of step (2) adjoins at the S root node of the result of step (1).

The derived tree is shown in Figure 7, leaving out this time the feature values.

This derivation illustrates a slightly different case of nominative Case assignment, and also an example of how Case assignment is used to control the distribution of PRO. This latter case will be important for the ECM analysis.

For the subject Case assignment, the finite verb in Figure 6(b) has an **<assign-case>** value of **nom**, and since nothing gets adjoined into the V, VP, or S nodes, unification causes the **<assign-case>** value at the S node to be coindexed with the **nom** value. Since **<case>** at the NP substitution node is unified with that **<assign-case>** feature, then only an NP with nominative Case can substitute into the NP substition node of the *tries* tree. The tree for *Bob* in Figure 4(a) can unify with either the **nom** or **acc** value for the feature **<case>**, and so can successfully substitute in.[6]

The Case assignment for the embedded clause illustrates how the distribution of PRO is handled. As before, the embedded verb *talk* is only of **<mode>=base**, to signify a clause with no inflection, and the inflection is supplied by the adjunction of the *to* tree in Figure 4(b) into the VP node in

[6] A tree for a NP with explicit Case marking would have a specific Case value; e.g., a tree for *him* would have the feature **<case>=acc**.

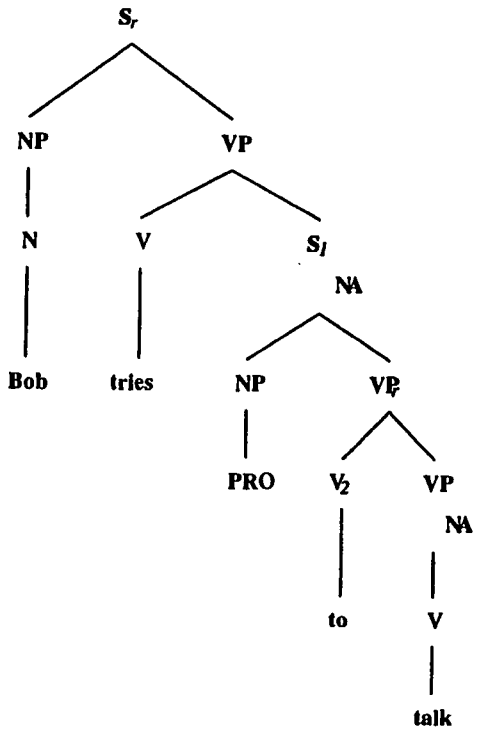


Figure 7: Derived tree for *Bob tries to talk*

Figure 4(c).

The adjunction of the *to* tree passes up a **none** value for the <**assign-case**> feature. This value is eventually unified with the <**case**> feature on the NP node in Figure 4(c), as a result of the rules for feature unification upon adjunction, as illustrated in the previous section, and since nothing else adjoins onto the VP node in the *talk* tree. This means that for an NP to substitute into Figure 4(c), it must be able to unify with <**assign-case**>=**none**. The only such NP which has this assignment is PRO, as shown in Figure 6(a). This ensures that the subject of the infinitival can only be PRO. (Adjunction of the *to* tree also blocks the **base** value for <**mode**> from being passed up, instead passing up a value of **inf**, to indicate that the adjunction of the *to* tree makes it into an infinitival clause.[7])

Note that it is crucial that *to* assign Case **none**, as opposed to not assigning a Case at all, with an empty value for the feature <**assign-case**>. If the latter were the case, then *any* NP could substitute in, since either a **nom** or

[7]Note that the specification of <**mode**>=**base** on the foot node limits this tree to adjoining only onto a VP node with **base** mode.

acc Case value could unify with an unspecified Case assignment value. The use of feature unification thus requires the use of the **none** value, as opposed to saying that PRO receives no Case at all.

Note also that the Xtag system uses a phrase structure that is less articulated than in some other approaches. There is no distinction between IP and CP nodes. Instead, both are just S nodes with feature values used to represent the usual I/C distinction. There are also no single-bar levels. Also, complementizers are not built in as part of the elementary trees, but rather are handled as auxiliary trees that only adjoin if required for a derivation. Thus, in a sense each projection is as minimal as it needs to be. For example, the clause *PRO to talk* in the derivation just considered only projects to an S that is the immediate projection of the embedded verb, with no need for a complementizer with another projection. Since the distribution of PRO is handled by the assignment of Case **none**, this does not cause a problem.

3. ECM Verbs and Bare Infinitives in XTAG

3.1. ECM Verbs in XTAG

Now consider how an ECM verb might be specified. Since it also takes an infinitival sentential complement, it will have the same form as the tree for *tries* in Figure 6(b). Since the features of the foot S node will unify with the S node on the infinitival complement, it will also have an **<assign-case>=acc** feature, which would pass down the Case feature to the NP of the complement via the root of the complement tree. However, this will not work, because at the same time the **<assign-case>=none** value from the *to* tree is unified with the root of the complement, as before, and so the **<assign-case>** value at the root of the complement tree would have to unify both with **acc** from the ECM verb, and **none** from the *to* tree.

This problem was faced earlier in the Xtag system for infinitival clauses with the complementizer *for*, as in *For Mona to drive the train is a good idea*. The solution developed then[8] is used here for the ECM verb problem.

The technique used is to create another tree for *to*, one that allows the unification clash to be avoided. Figure 8 shows the trees for *expects* and *to* that are used in a parse of *Van expects Bob to talk*. The trees for *talk* and *Bob* are the same as before, and the tree for *Van* is of course the same as for *Bob*.

[8]Which, to make sure credit is properly placed, the author of this paper was not involved in.

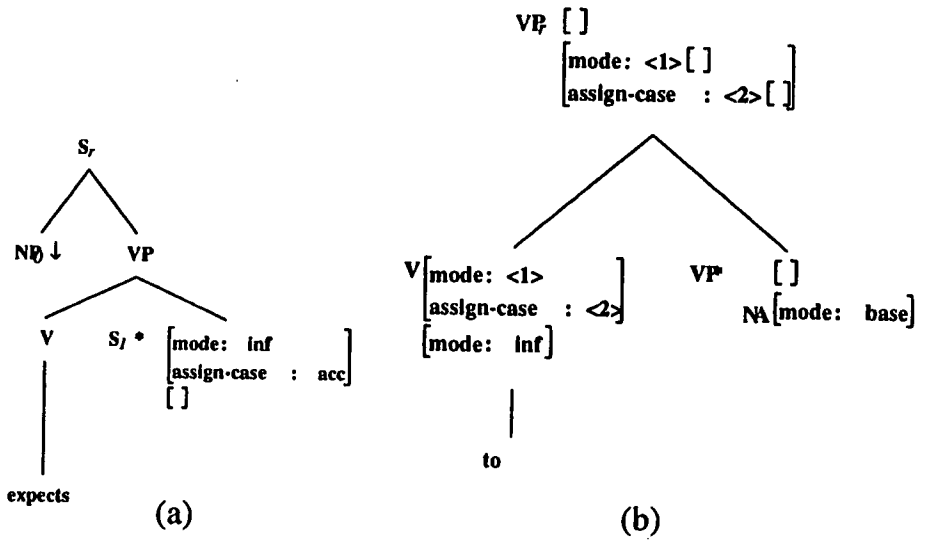


Figure 8: Component trees for *Bob expects Van to talk*

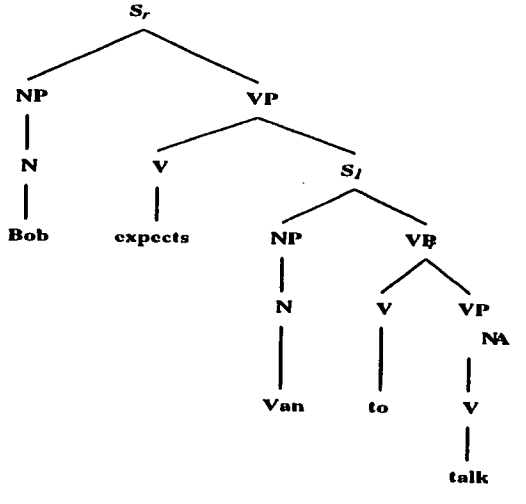


Figure 9: Derived tree for *Bob expects Van to talk*

The structure of the derivation is the same as before, leaving aside of course the Case assignment. The tree for *to* in Figure 8(b) adjoins into the VP node of the *talk* tree, and the tree for *Van* substitutes into the NP node for *talk*, giving *Van to talk.* The tree for *expects* in Figure 8 adjoins onto the root node of the *talk* node, and *Bob* substitutes into the NP node to give the result, as shown in Figure 9.

Unlike before, the *to* tree no longer passes up the **<assign-case>** value from the embedded verb, but instead an unspecified value is passed up. The foot node of the ECM verb has **<assign-case>=acc**, and as desired this will unify with the root node of the complement tree, and therefore with the subject of the complement, thus enforcing an accusative Case on the subject.

Note also that since the ECM tree is an auxiliary tree, and adjoins in, the same tree is used for a sentence in which the subject of the complement is extracted, as in *Who did Bob expect to talk*, with the ECM tree adjoining into a derivation of *who to talk.* For details on how Xtag handles long-distance extraction, see The XTAG-Group (1995).

3.2. Bare Infinitives in Xtag

Verbs with no inflection are selected from the lexicon with a value of **base** for the feature **<mode>**, and the adjunction of a tree for *to* (either of the two trees for *to* discussed above), gives the resulting structure a mode **inf** at the node where the *to* tree adjoins (VP). If no *to* tree adjoins, then the sentence will have no inflection and mode **base**.

Of course, this is exactly the case for bare infinitives, such as *harmonica fell* in *Bob sees the harmonica fall.* Therefore, the trees for verbs that take bare infinitives are straightforward to implement. As shown in Figure 10, the tree for *sees* is just like the earlier ECM tree for *expect* except that the complement is of mode **base**. The overall parse is simpler than the earlier ECM case, since there is no complication with *to* since there is, of course, no *to* in the lower clause. An example derived tree is shown in Figure 11. The base form of the embedded verb leaves the Case of its subject unspecified, but since the root node of the upper verb tree unifies with the root of the lower clause, the lower subject can only be accusative, thus ruling out **John saw he eat* or **John saw PRO eat.*

It's important to note that since the same tree is used for both sets of verbs, the lexical entries for *expect* will select the ECM tree and specify that the S foot node will have the feature **<mode>=inf**, while *see* will also select the ECM tree and specify that it should have the feature **<mode>=base**.

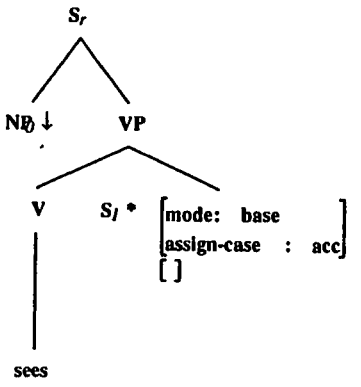


Figure 10: Tree for *sees*

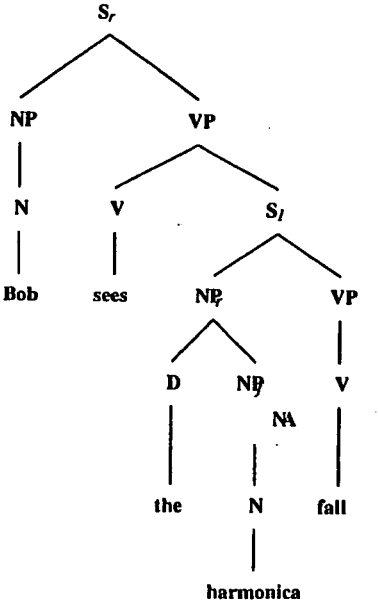


Figure 11: Derived Tree for *Bob sees the harmonica fall*

Furthermore, since Xtag groups together trees belonging to the same categorization frame, both verbs will actually select the entire ECM family of trees. So they will also select related trees that handle other contexts in which ECM verbs occur - for example, subject extraction, as in *who expects Van to talk?*. The crucial point is that for all of the trees in the ECM family, the <**mode**> feature of **inf** or **base** will be placed on the S foot node. A principled exception is the passive tree, as seen in the next section.

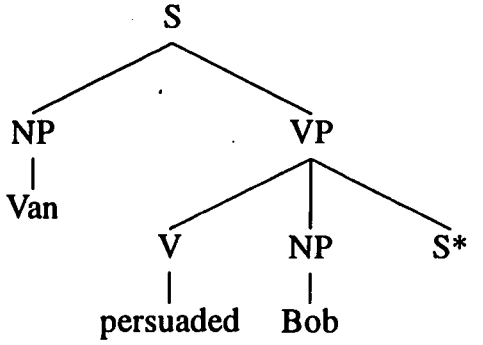
4. Passives and Raising Passives in XTAG

4.1. Passives in Xtag

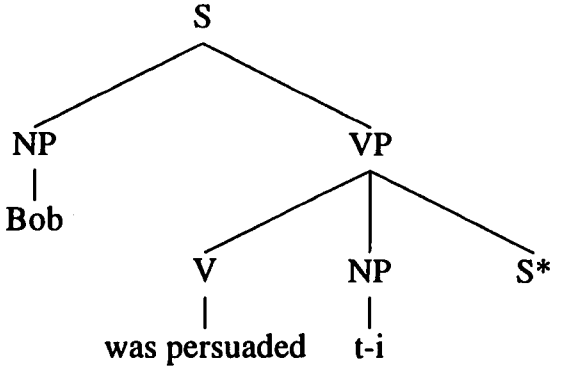
The examples in the previous section illustrate how adjunction allows recursive structures to be separated from the domain of dependencies of a verbal element. A consequence of this is that the elementary trees define the domain of locality over which constraints and thematic roles are specified. One of the interesting aspects of TAG is that transformational-type analyses can be used in TAG, but only as mappings from one elementary tree to another. One important example of this is of course the passive, which is treated as an operation on the tree for the active sentence. For example, the trees for the active and passive sentences in (9ab) are as shown in (10) and (11), respectively.

(9) a. Van persuaded Bob [PRO to talk]
b. Bob was persuaded [PRO to talk]

(10)



(11)



4.2. Raising Passives in Xtag

As discussed in the introduction for (2), the passive of an ECM verb is a "raising passive", and (3) shows that the passive for a verb that ordinarily takes a bare infinitive in its declarative use must take a full, not bare, infinitive.

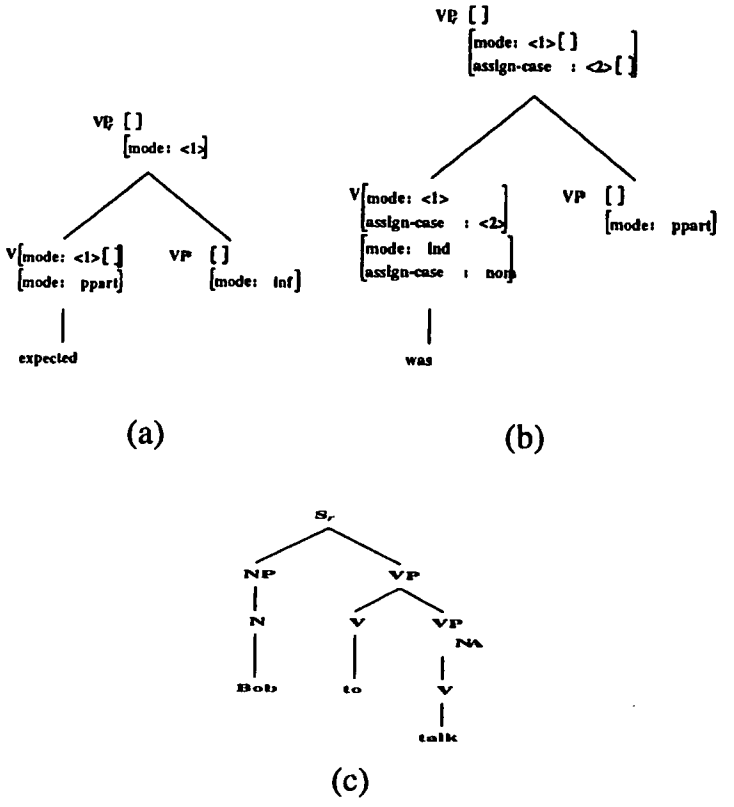


Figure 12: Component trees for *Bob was expected to talk*

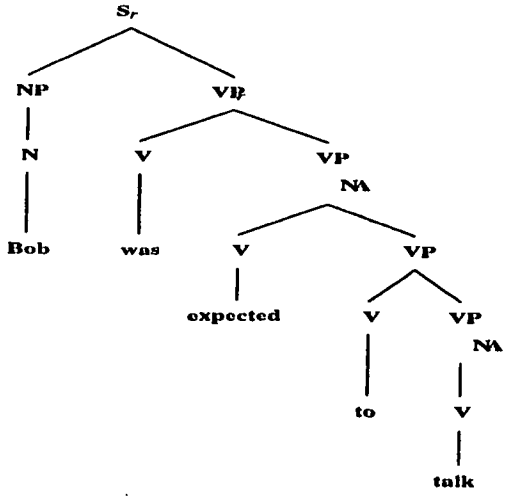


Figure 13: Derived tree for *Bob was expected to talk*

The component trees for *Bob was expected to talk* are shown in Figure 12. As discussed earlier, in TAG a subject is "raised" by the process of adjunction, which results in the raised item getting "stretched" away from the other components of its elementary tree, and the derivation of *Bob was expected to talk* is exactly parallel, except for the minor addition of also needing to adjoin the tree for *was* onto the the tree for *expected* at the VP node. This requirement is handled by some feature values that are peripheral to the topic of this paper and so are not discussed here. The adjunction of the *was* tree onto the root of *expected* tree and of the *expected* tree onto the VP node of Figure 12(c) gives the derived tree in Figure 13.

Now consider the raising passive of one of the verbs that take bare infinitives, such as *sees* in (3). Although verbs like *expects* and *sees* differ on the mode of their clausal complements, they both share the property of not thematically selecting the subject of that complement, which becomes the matrix subject of the corresponding passive sentences. Therefore, the passive versions of *sees* and other verbs that take bare infinitives are *also* VP auxiliary trees, exactly the same in structure as the one for *expected* in Figure 12(a).

Recall that the ECM verbs and verbs that take bare infinitive complements differ only by the **mode** feature on the foot S node, and that this feature is put onto all the trees in the tree family. However, there is no S node in the passive tree, and so the passive remains unaffected by this feature specification. But this is of course exactly the desired situation. All that needs to be done is to specify that the foot node of the passive tree has <**mode**>=**inf**, as shown in Figure 12(a). A derivation of **Bob was seen talk* is ruled out because the <**mode**> value at the VP adjunction site would be **base**, and not **inf**. At the same time, since it's the S node where the difference between the two classes of verbs is located, *Bob sees the harmonica fall* can be derived[9].

5. Conclusion and Comparison to Other Work

We have described an implementation in the Xtag system of the TAG analysis of ECM verbs first set out in Kroch and Joshi (1985). We presented a solution to a problem raised by the ECM analysis for Xtag, and also extended the analysis and implementation to handle verbs that take bare infinitive complements, allowing for a nice account of the problem of the bare infinitive passive.

[9]I am extremely hesitant to regard this as anything more than a nice implementational "trick". See Santorini and Heycock (1988) for arguments that the *to*-infinitive passive bears no syntactic relationship to bare infinitive actives, and are instead related to *to*-infinitive complements that previously existed in English.

As discussed in Section 3, the Xtag system is forced to use an analysis in which the distribution of PRO is controlled by the use of a feature with value **none**, instead of just a lack of assignment. Since noun phrases are drawn from the lexicon with trees already instantiated for Case values that those NPs are compatiable with, then a lack of Case assignment would mean that any NP could appear where only PRO was desired. The assignment of Case **none** to PRO allows the distribution of PRO to be properly handled

It is of interest to note that this technique, undertaken for computational issues brought on by unification, has intriguing parallels to some other current approaches to the distribution of PRO, such as use of the null Case assignment in infinitivals that was independently proposed in Chomsky and Lasnik (1991). This was not done for reasons of unification, but in part for conceptual reasons regarding the apparent movement of PRO in passives of control infinitives such as *Bob tried PRO to be arrested.*

Furthermore, once the move to **null** Case is made, the same consequences follow in both analyses. As described in section 3, the Xtag analysis requires two different trees rooted by *to*, one to be used in ECM constructions, and the other to be used in control constructions. The Chomsky and Lasnik (1991) approach has been similarly refined in recent work, such as that of Boskovic (1995) and Martin (1992)[10]. In this work, the null Case assignment story is modified to handle the case of the difference between ECM and control infinitivals[11]. It is proposed that in complements to control verbs, the INFL has a [+Tense] feature that assigns **null** Case, while complements to ECM infinitivals have only a [-Tense] feature which does not assign Case, thus allowing the subject to move to the matrix clause to get Case checked off in [Spec, AgrO], whether overtly or covertly being a matter of debate. Borrowing from an earlier analysis by Stowell (1982), it is further argued that ECM and control infinitivals have different temporal properties, which I won't go into here, with only the ECM complements being truly "tenseless". The use of null Case assignment allows the CP vs. IP distinction to be done away with to some extent, allowing both control and ECM verbs to select an IP, with the distribution of PRO being controlled not by government, but by Case assignment in the lower clause[12].

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[10]I have not yet seen Martin (1992).

[11]The implications of the null Case assignment to PRO for ECM and control infinitivals do not appear to be discussed in Chomsky and Lasnik (1991).

[12]In Stowell (1982), however, the tense argument of control infinitivals was assumed to be in C, and so if the CP vs. IP distinction for control and ECM complements is assumed, this derives that only control complements have the [+Tense] feature. If both

There is an obvious parallel with the use of *two* to's forced by implementation considerations in Xtag. The *to* in Figure 4b can be seen as the [+Tense] *to*, and the *to* in Figure 8b can be seen as the [-Tense] *to*. Just as with these recent analyses, Xtag is also able to let both ECM and control verbs select a complement of infinitival S (the equivalent of IP).

Under both analyses, there is the need to distinguish ECM from control verbs in terms of whether the complement can license a **null** Case. To some extent, this is taken care of in Xtag by the presence of the **<assign-case>=acc** feature on the foot node of the ECM trees, which would cause an unification clash if the "wrong" *to* was used - that is, the one meant for control clauses. The **<assign-case>=none** value on the embedded verb's tree would conflict with the **<assign-case>=acc** value on the ECM verbs' tree. However, this is not a sufficient solution, since it does not take care of the ambiguity with raising verbs. Consider again the derivation of *Bob seems to talk* shown in Figures 4 and 5. This derivation used the tree for the "control" *to*, the one with **<assign-case>=none**. No conflict arose because the adjunction of the *seems* tree caused its **<assign-case>=nom** feature to percolate up instead of the **<assign-case>=none** feature from the *to* feature. However, there is nothing that prevents the *to* tree with an empty **<assign-case>** feature (the one used in an ECM complement), from also being used, thus resulting in two derivations. So it has to be specified that one or the other should be used. This is roughly equivalent to the need, in a minimalist framework, to specify that the complement of a raising verb has [-Tense], since otherwise it would allow a sentence such as *It seems PRO to be happy*. Presumably this follows from common semantic properties of the raising and ECM complements as opposed to the control complements[13].

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complement types are IP, this account no longer holds, and it is argued that the tense difference is a semantic constraint on the complement.

[13]This indicates that the "wrong" *to* was used in the derivation of *Bob seems to talk*, and that instead the "ECM" *to* should be used. I leave as an open problem for now how this can be accomplished in an unification framework.

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Functional and Pair-List Embedded Questions

Yael Sharvit

This paper proposes an analysis of embedded questions with quantifiers, where a quantified expression in the embedded question takes scope over an indefinite which c-commands it from the embedding clause, as illustrated below:

(1) **Some professor** found out [$_{CP}$ which woman **every student** dated]

(1) has a $\forall\exists$-reading, where professors vary with students. This fact poses a problem for the theory of quantifier scope, for the following two reasons. First, it is genreally assumed that Quantifier Raising (QR) is clause-bounded. This claim is supported by examples such as (2)a, where [every professor] cannot take scope over the indefinite:

(2) a. **Some student** thought that **every professor** was crazy.
b. *[every professor][some student thought that t was crazy]

Secondly, it has has been claimed that questions cannot be quantified into. This claim is supported by the example in (3)a, which cannot be analyzed either as (3)b (with "long" QR) or as (3)d (with "short" QR):

(3) a. John wonders what no man should forget.
b. *[no man] [John wonders what t should forget]
c. $\forall x(man'(x) \rightarrow \neg wonder'(j,\lambda p\exists y[p = \hat{}forget'(x,y)]))$
d. *John wonders[[no man][what t should forget]]
e. $wonder'(j,\lambda p\forall x(man'(x) \rightarrow \neg\exists y[p = \hat{}forget'(x,y)]))$

The problem with (3)c is that it implies that for every man, John does not wonder what he should forget (which clearly is not the meaning of (3)a). The problem with (3)e is that the complement set of *wonder* admits false propositions (see Engdahl (1986) for further discussion).

I propose an anlysis of (1) which is consistent with these two claims. The analysis relies on the assumption that at LF, the embedded question which hosts the quantified expression (and not the quantified expression itself) has the option of QR-ing within the boundaries of its own clause, and adjoining

to a position higher than the indefinite. In this I follow Szabolcsi & Moltmann (1994). My analysis differs from theirs in that it relies on the assumption that the embedded question contains a functional dependency (in the sense of Engdahl (1986), Groenendijk & Stokhof (1984), Chierchia (1991, 1993), and Dayal (1996)). When the embedded question is QR-ed, the resulting LF of (1) is (4), and the interpretation that is "read off" it is roughly as in (5):[1]

(4) [which woman$_j$ every student$_i$ dated t_j^i]$_j$ some professor found out t_j

(5) There is a function f which maps every student x to the question 'which woman did x date', and for every x in the domain of f, there is a professor y such that y found out the answer to the question 'which woman did x date'. (For example, *some professor found out which woman John dated and some profesor found out which woman Bill dated*).

This analysis is shown to be consistent with the standard assumptions regarding quantifier scope.

I begin by discussing Szabolcsi & Moltmann's (1994) solution to the problem, pointing out its strengths and weakensses.

1. A Layered Quantifier Analysis

Szabolcsi and Moltmann observe that (1) has both a ∃∀- and a ∀∃-reading. They paraphrase the ∃∀-reading as: "There is a professor who found out for every student x, which woman x dated"; and the ∀∃-reading as: "For every student x, there is a professor y, such that y found out which woman x dated."

Szabolcsi and Moltmann also observe that (6), where the quantifer in the embedded question is *no student*, and (7), where the embedded clause is a declarative, have a ∃∀-reading, but not a ∀∃-reading:

(6) **Some professor** found out [$_{CP}$ which woman **no student** dated]
∃∀, *∀∃

(7) **Some professor** found out [$_{CP}$ that **every student** dated his best friend's girlfriend]
∃∀, *∀∃

[1] A PWPL reviewer pointed out to me that the ∀∃-reading is somewhat marginal (and improves if *every* is replaced by *each*). I take this to be a dialectal difference, and do not discuss the *every/each* alternation here.

They note that the unavailability of a ∀∃-reading in (7) is consistent with the standard assumption that QR is clause-bounded, but they also note that this contrasts sharply with the availability of this reading in (1). They argue that Clause-boundedness should be maintained, and in order to account for the ∀∃-reading of (1), they propose what they call a "layered quantifier" analysis, according to which it is the entire embedded question which (locally) takes wide scope over the matrix clause (and, as a result, over the indefinite). In this case the embedded question denotes a generalized quantifier over individual questions:

(8) $\lambda R \forall x[\text{student}'(x) \rightarrow R(\text{which woman } y[x \text{ dated } y])]$

If the embedded question is locally QR-ed, it is interpreted as in (8), and when combined with the denotation of the matrix clause, yields the following:

(9) a. [which woman every student dated]$_j$ [some professor found out t_j]

b. $\lambda R \forall x[\text{student}'(x) \rightarrow R(\text{which woman } y[x \text{ dated } y])]$
$(\lambda v[\exists z[\text{professor}'(z) \,\&\, \text{find-out}'(z, v)]]) =$
$\forall x[\text{student}'(x) \rightarrow \exists z[\text{professor}'(z) \,\&\, \text{find-out}'(z, \text{which woman } y [x \text{ dated } y])]]$

Szabolcsi and Moltmann assume that an embedded question inherits the properties of the quantifier it hosts. This accounts for the absence of a ∀∃-reading in (6): We know that decreasing quantifers do not QR from object position (e.g., *some student hates no professor* does not have a ∀∃-reading). It follows that an embedded question which hosts such a quantifier cannot QR either.

The appeal of this proposal is that it preserves Clause-boundedness, and predicts that the set of quantified expressions which support such a reading is limited to those quantifiers which can QR from object position. It is less clear, however, why (7) does not give rise to the ∀∃-reading: If the embedded clause inherits the properties of the quantifier it hosts in principle, then the embedded clause in (7) should be able to QR, and be interpreted as a generalized quantifier over propositions. The authors are well aware of this problem, and explore several possible explanations, all of which require independent assumptions - some better motivated than others.

I would like to suggest a different approach to the problem, which

takes into account a fact that Szabolcsi and Moltmann ignore. Recall that they claim that (1) has one ∃∀-reading. In point of fact, it has two ∃∀-readings: One reading is the pair-list reading, which asserts that a single professor found out that Student A dated Woman 1, Student B dated woman 2, etc. Let us call this reading the "pair-list ∃∀-reading" (and this is the reading that Szabolcsi and Moltmann consider). The other reading is the functional reading, which asserts that a single professor found out what the function which maps every student to the woman he dated is (say, *his best friend's girlfriend*). Let us call that reading the "functional ∃∀-reading". That these two readings are not simply variants of each other is demonstrated by the the fact that (6) lacks a pair-list ∃∀-reading, but does have a functional ∃∀-reading (e.g., "some professor found out that no student dated his best friend's girlfriend").

The approach I am proposing explores the possibility that there is a connection between the two ∃∀-readings available in (1), its ∀∃-reading, and the unavailability of a ∀∃-reading in (7). In other words, I claim that the ∀∃-reading is not obtained via a separate mechansim of layered quantification, but rather that the mechanism which interprets embedded questions in-situ, is the same one which interprets them in the QR-ed position. This mechanism cannot, *in principle*, apply to declaratives, because it relies on the presence of a functional dependency created by wh-movement. Therefore, (7) is predicted to lack a ∀∃-reading.

The goal of the proposed analysis, then, is to preserve Szabolcsi & Moltmann's (1994) predictions, but also to predict the three readings of (1), and the unavailability of a ∀∃-reading in (7). The core idea which is borrowed from their approach is that an embedded clause can undergo (local) QR at LF. The difference between the two approaches is that the current approach is based on functional approaches to constituent questions with quantifiers.

In section 2, I discuss the functional/pair-list distinction in matrix questions. In section 3, I show how the analysis of functional dependencies is applied to questions with quantifiers. Section 4 extends this analysis to the cases exemplified by (1), predicting its three-way ambiguity and the lack of a ∀∃-reading in (7).

2. Functional and Pair-List Questions

The literature on questions with quantifiers (e.g., Engdahl (1980, 1986), Groenendijk & Stokhof (1984), May (1985, 1988), Chierchia (1991, 1993), Dayal (1996), and Bittner (to appear)) recognizes that a matrix question such

as (10) has (in addition to the individual reading, which does not concern us here), a "functional" reading and a "pair-list" reading:[2]

(10) Q: Which woman did every student date?
A: a. His roommate.
b. John, Mary; Bill, Sally...

There is no concensus in the literature as to whether the functional and pair-list readings are two distinct readings, or one is derived from the other. Here I adopt the position taken in, for example, Chierchia (1993) and Dayal (1996), where it is argued that functional and pair-list questions are distinct from each other, and furthermore, neither one is derived from the other. The empirical evidence which supports this view is the following: First, functional readings arise with almost any quantified expression, but pair-list readings typically arise with quantifiers such as *every-NP*, *each-NP*, definite NP's and names, but not with, for example, decreasing quantifiers. This is illustrated by (11), where the quantified expression is of the *no-NP* type. A functional answer is possible here, but a pair-list answer is not:

(11) Which woman did no student date?
a. His girlfriend.
b. *John, Mary; Bill, Sally.

(11) shows that quantifiers such as *no-NP* participate in functional readings but not in pair-list readings. The reader can verify that the same is true of, for example, *most-NP*, *few-NP* and *almost-every/almost-no-NP*.

Secondly, functional and pair/list questions display different uniqueness effects (see Groenendijk & Stokhof (1984)). For example, *his roommate* can be a felicitous answer to (10) even if some student or other dated another woman in addition to his roommate. But *John dated Sally and Bill dated Mary* is not a felicitous answer to (10), in a situation where, say, John dated two women.

A theory of questions which treats functional questions as distinct from pair-list questions can account for both these differences. The Chierchia-

[2]As most authors note, the individual reading can be seen as a case of the functional reading. Thus, *which woman does John love* can be viewed as asking about the function which maps John to the woman he loves.

Dayal approach is one example. They capture the functional/pair-list distinction by assuming that both questions involve functions from individuals to individuals, but that the functional question involves a "natural" function (such as 'mother-of', 'sister-of', etc.), and the pair-list question involves a list of arbitrary pairs.[3]

Following ideas in Groenendijk & Stokhof (1984), and in Engdahl (1986), both Chierchia and Dayal assume that a question such as (10) involves a functional dependency: the wh-phrase binds a doubly indexed trace (which carries a function index - the subscript "f" and an argument index - the superscript "a"). The function index is bound by the wh-phrase (*which woman*) and the argument index is bound by the quantified expression (*every student*):

(12) which woman$_f$ did every student$_a$ date t_f^a

The functional trace is interpreted as $f(x)$, where f is a function from individuals to individuals, and x is an individual, yielding the following interpretation for (12):

(13) What is the function f such that every student$_x$ dated $f(x)$?

The functional answer to this question provides the "name" of a function (as in (10)a). The pair-list answer provides the extension of some function (as in (10)b).

The syntactic motivation behind this analysis is that it predicts a subject/object asymmetry in both functional and pair-list questions. (14), which does not have either a functional or a pair-list reading, illustrates this point:

(14) Which woman dated every student?
  a. *His girlfriend.
  b. *Mary dated John and Sally dated Bill.

Chierchia argues that while the trace of *which woman* is, like any wh-trace, governed by Principle C of the Binding Theory, it contains a pronominal element (i.e., the argument variable), governed by the principles that govern

[3]See Chierchia (1993) and Bittner (to appear) for discussion of the formal distinction between natural functions and pair-lists.

pronouns (in particular, Weak Crossover).[4] This implies that in order for either the functional or pair-list reading to come about, it is necessary that the trace of the wh-phrase be in the scope of the quantified expression at s-structure (as is indeed the case in (12)). Otherwise, neither one of these readings is possible, (as is the case in (14), whose structure is given below):

(15) Which woman$_f$ t_f^a dated every student$_a$?
LF: [which woman]$_f$ [every student]$_a$ t_f^a dated t_a

Neither (14)a nor (14)b are possible answers to (15), because (15) contains a WCO violation.

The subject/object asymmetry, then, is the syntactic motivation for positing a functional dependency in questions with quantifiers. The next section discusses the assumptions underlying the semantic analysis of these questions.

3. The Analysis of Functional/Pair-List Questions

The analysis of questions assumed here consists of three major assumptions: (1) That a well-formed answer to a question is derived by applying the Answerhood operator to the question denotation; (2) That questions with quantifiers involve quantification over functions, introduced by a set of type-shifting operations; and (3) That the question complementizer has more than one lexical meaning. The particular meaning selected in a given question may trigger either standard or non-standard QR.

3.1. Uniqueness Effects in Constituent Questions

According to the classical Hamblin-Karttunen approach to questions (Hamblin (1973), Karttunen (1977)), every constituent question comes with an existence presupposition (see Comorovski (1989) for discussion). For example, *which man came to the party?* presupposes the existence of a man who came to the party. The question itself denotes a set of propositions (which is the set of

[4]See May (1985, 1988) for an alternative approach, based on Pesetsky's (1982) Path Containment Condition. See also Chierchia (1991, 1993), Dayal (1996) , and Sharvit (1997) for arguments against the Path Containment analysis.

possible answers).[5] The existence presupposition is "built into" the question denotation, as follows:

(16) $\lambda p \exists x[man'(x) \& p = \hat{}come\text{-}to\text{-}the\ party'(x)]$

In Dayal (1996), it is argued that in addition to the existence presupposition, a constituent question comes with a uniqueness/maximality presupposition (see Rullmann (1995) for a related approach). *Which man came to the party?* presupposes the existence of a unique man who came to the party. If more than one man came to the party, the presupposition has to be rejected (a question/answer pair consistent with the presupposition that more than one man came is, for example, *which men came to the party? John and Bill*). In addition, a question with a quantifier in subject position and a wh-phrase in object position presupposes that the answer will exhaustively pair each member of the subject term with the unique/maximal relevant member of the object term (see Comorovski (1989)).

Satisfaction of the Maximality principle, according to Dayal, is imposed by the Answerhood operation, which applies to a question denotation and yields the maximal true answer:

(17) $Ans(\lambda p[....p....]) = \iota p'[\check{}p' \& \lambda p[...p...](p') \& \forall p''[(\check{}p'' \& \lambda p[...p...](p'')) \rightarrow p' \subseteq p'']]$

According to (17), a well-formed answer to *which man came to the party*, can be, for example, *Bill came*, which is picked out of the set: {Bill came; John came; Fred came;...}. A well-formed answer to *which men came* (where the wh-phrase contains a plural term), is predicted by Answerhood to list *all* the men that came to the party. A well formed answer to the question *which women does every man like* must list for every man, *all* the women that he likes (satisfying both Maximality and Exhaustivity).

The Answerhood operator plays an important role in Dayal's analysis of embedded questions, which builds on Berman (1991) and Lahiri (1991). According to this view, a question embedded under a verb such as *know* or *find out* is interpreted as the unique/maximal true proposition which is the

[5] According to Karttunen, a question denotes the set of *true* answers. As will be seen shortly, this is captured by the Answerhood operation applied to the Hamblin-type question denotation (i.e., the set of all possible answers).

answer to the question. For example, *John knows which man came to the party* means "John knows the answer to the question 'which man came to the party?'":

(18) know'(j, Ans(λp∃x[man'(x) & p=^come-to-the-party'(x)]))

In the spirit of this anlaysis, I will assume that if an embedded question moves, it leaves behind a trace which is interpreted as Ans(Q) - where *Q* is a variable of type <<s,t>,t> (i.e., a set of propositions). For example, a question such as *what did John find out*, where the complement of *find out* is a trace, can be interpreted as follows:

(19) a. What did John find out t
b. λp∃Q[find-out'(j, Ans(Q))]
Roughly: What is the question that John found out the answer to?

The assumption that Answerhood applies to a question denotation is, of course, a general assumption about questions (and not about functional or pair-list questions in particular). The next two sections are concerned with the interpretation of functional/pair-list questions.

3.2. Type Shifting Operations

Beginning with Engdahl (1986) and Groenendijk & Stokhof (1984), all analyses of functional questions, and related analyses of functional relative clauses (e.g., von Stechow (1990) and Jacobson (1994)) assume some kind of type-shifting mechanism which turns an expression which denotes a property of individuals (such as *woman*) into a property of functions from individuals to individuals:

(20) woman' → λf∀x(x∈Dom(f) → woman'(f(x)))

This operation takes an expression of type <e,t>, and turns it into an expression of type <<e,e>,t>. As we shall see in 3.3, the existence of this type shifting operation is what triggers existential quantification over functions in questions such as *which woman did every student date.*

Generalizing this operation to other semantic types yields a type-shifting mechanism which takes any expression of the general type <X,t>

(where X can be of any semantic type), and turns it into an expression of type $<<e,X>,t>$. This general operation is given below:

(21) $\lambda P\lambda h[\forall x(x \in Dom(h) \rightarrow P(h(x)))]$, where *P* is of type $<X,t>$, and *h* is of type $<e,X>$.

If $X=e$, then *P* is of type $<e,t>$ (e.g., woman'), and *h* is of type $<e,e>$. This is the case in (20), where the operation yields a property of functions from individuals to individuals. But X can have other values. In particular, if $X=<<s,t>,t>$ (i.e., a set of propositions), then *P* is of type $<<<s,t>,t>,t>$, and *h* is of type $<<e,<<s,t>,t>>$ (i.e., a function from individuals to sets of propositions - or from individuals to questions). We will use this particular instance of the general type-shifting operation in the analysis of embedded questions.

The second type-shifting mechanism which we will make use of takes a function of the general type $<e,X>$ and turns it into a function from possible domains (type $<e,t>$) to $<e,X>$-type functions:

(22) $\lambda h'\lambda P\iota h[Dom(h)=P \ \& \ \forall x(x \in Dom(h) \rightarrow h(x)=h'(x))]$

For example, (22) can take a function of type $<e,e>$ (such as the 'mother-of' function) and turn it into a function from possible domains to $<e,e>$-type functions:[6]

(23) mother-of'
$\lambda x\iota y[mother\text{-}of\text{-}x'(y)]$ (Type: $<e,e>$)

(24) $\lambda P\iota h[Dom(h)=P \ \& \ \forall x(x \in Dom(h) \rightarrow h(x)=\iota y[mother\text{-}of\text{-}x'(y)])]$
(Type: $<<e,t>,<e,e>>$)

(24) denotes a function which maps the set of men to the function from men to their mothers, the set of women to the function from women to their mothers, etc.

But (22) can also take a function from individuals to questions (i.e.,

[6]This type-shifting operation is introduced and motivated in Sharvit (1997), where it is claimed that "natural" functions are, in fact, of type $<<e,t>,<e,e>>$, and that pair-list functions are of type $<e,e>$. Space limitations prevent me from going into the motivation for this operation.

a function of type $<e,<<s,t>,t>>$) and turn it into a function from possible domains to functions from individuals to questions. For example, if we take a function which maps every individual to the question "who does he love", then (22) turns this into a function which maps the set of men to the function which maps them to the relevant question, the set of women to the function which maps them to the relevant question, etc. It is this instance of (22) which will be relevant to us in the analysis of embedded questions with quantifiers.

3.3. Ambiguous Comp and Two Types of QR

According to what has become by now an assumption common to many theories of questions, the +wh-Comp in a question introduces a variable of type $<s,t>$ (i.e., a proposition) and the wh-phrase introduces an existential quantifier which binds an individual variable. Accordingly, (25) is interpreted as in (26):

(25) [who] [Comp [t left]]
(26) $\lambda p \exists x[p = \hat{}\text{leave}'(x)]$

The discussion of functional and pair-list questions has led some authors to propose that either [who] or Comp (or both) can also introduce existential quantification over functional variables. In particular, Dayal (1996) proposes that Comp displays a lexical ambiguity, and that the functional/pair-list ambiguity of, say, *which woman does every man love* is due to a lexical ambiguity of Comp. Pursuing this idea, I adopt the translation that Dayal assumes for "pair-list" Comp, but I use a different translation for "natural function" Comp. I assume that in a question that contains a functional dependency, Comp is translated as one of the following expressions:

(27) $\lambda F \lambda F' \exists f[f \in G \ \& \ \check{}F'(f) \ \& \ p = \hat{}\check{}F(f)]$
(28) $\lambda K \lambda P \lambda F \exists f[\text{Dom}(f) = P \ \& \ F(f) \ \& \ p = \cap \lambda p' \exists y[P(y) \ \& \ p' = \hat{}\check{}K(f, y)]]$

The first meaning of Comp is the one which yields the natural function reading of *which woman does every man love*. It is an expression which takes two properties of functions (*F* and *F'*) and yields an expression which existentially quantifies over functions which belong to the contextually restricted set *G* (the set of salient natural functions - 'mother-of', 'sister-of',

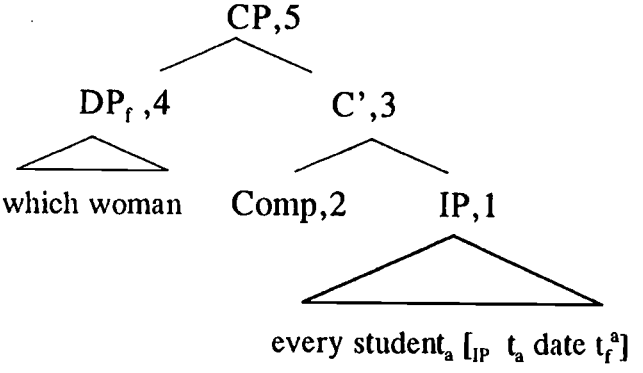
etc.). A well-formed answer is, for example, *every man loves his mother*.

The expression in (28) (Dayal (1996), with minor modifications), is the meaning of Comp that yields the pair-list reading of *which woman does every man love*. This expression is designed to account for the fact that a well-formed answer to a pair-list question is an exhaustive "list" of propositions (for example: *John loves Mary; Bill loves Sally; and Tom loves Susan*). It does so by introducing a function whose domain is fixed by the variable *P*, and by intersecting the propositions obtained for each member of *P*. Fixing the value for the domain of the function is done by extracting a set out of the quantified expression. This requires that the quantified expression (in this case, *every man*) move to a position where its meaning (or its derived meaning - the set that is extracted out of it) can combine directly with the meaning of Comp.

This leads us to posit two types of QR: (a) standard QR - the familiar QR which results in adjunction to IP. This operation takes place if (27) is selected as the meaning of Comp, and the meaning of the quantifier does not combine directly with (27); (b) non-standard QR, which results in adjunction to a position higher than Comp. This operation takes place if (28) is selected as the meaning of Comp, and the derived meaning of the quantifier combines directly with (28).

We now turn to the actual derivations. The full derivation of the natural function reading of *which woman did every student date* is given below:

(29) a.



b. [Comp] = $\lambda F \lambda F' \exists f[f \in G \ \& \ \check{}F'(f) \ \& \ p = \hat{}\check{}F(f)]$, and standard QR applies to [every student]

c.
1. $\forall x(\text{student}'(x) \rightarrow \text{date}'(x, f(x)))$
1'. $\lambda f[\forall x(\text{student}'(x) \rightarrow \text{date}'(x, f(x)))]$
2. $\lambda F \lambda F' \exists f[f \in G \ \& \ \check{}F'(f) \ \& \ p = \hat{}\check{}F(f)]$

(by (27))

3. $\lambda F \lambda F' \exists f[f \in G \ \& \ \check{}F'(f) \ \& \ p = \hat{}\check{}F(f)]$
$(\hat{}\lambda f[\forall x(\text{student}'(x) \rightarrow \text{date}'(x, f(x)))])$
$\Rightarrow \lambda F' \exists f[f \in G \ \& \ \check{}F'(f) \ \&$
$p = \hat{}\forall x(\text{student}'(x) \rightarrow \text{date}'(x, f(x)))]$

4. woman'

4.' $\lambda f[\forall x(x \in \text{Dom}(f) \rightarrow \text{woman}'(f(x)))]$

(by (20), (21))

5. $\lambda F' \exists f[f \in G \ \& \ \check{}F'(f) \ \& \ p = \hat{}\forall x(\text{student}'(x) \rightarrow$
$\text{date}'(x, f(x)))](\hat{}\lambda f[\forall x(x \in \text{Dom}(f) \rightarrow$
$\text{woman}'(f(x)))])$
$\Rightarrow \exists f[f \in G \ \& \ \forall x(x \in \text{Dom}(f) \rightarrow \text{woman}'(f(x)))$
$\& \ p = \hat{}\forall x(\text{student}'(x) \rightarrow \text{date}'(x, f(x)))]$

5'. $\lambda p \exists f[f \in G \ \& \ \forall x(x \in \text{Dom}(f) \rightarrow \text{woman}'(f(x)))$
$\& \ p = \hat{}\forall x(\text{student}'(x) \rightarrow \text{date}'(x, f(x)))]$

Let us briefly go through the derivation. Node #1 is translated as the proposition in Line #1, and in Line #1' *f* is abstracted over, to yield a property of functions. Node #2 is translated as "natural function" Comp, and it takes Line #1' as its argument. Node #4 is interpreted, via (20), as a property of functions (I assume, with Dayal (1995) that the basic translation of [which woman] is simply woman'). This expression serves as the second property required by [Comp] (to fix the range of the function), yielding the expression in Line #5. Abstracting over *p* in Line #5' yields a set of propositions, which contains quantification over the the salient "natural" functions which are restricted by the free variable.

It is important to note that the domain of the function in Line #5 is not specified, but rather determined pragmatically. As the following example shows, this domain need not be restricted to the set of men:

(30) Q: Which woman does every professor love?
A: The woman that every student hates (namely, his mother).

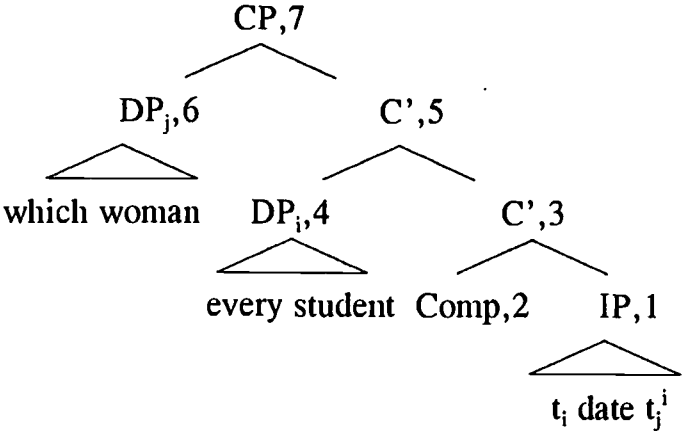
If the domain were restricted by the quantified expression, the answer in (30) would be impossible. On the other hand, in some cases the quantified expression does determine the value of the domain, as the following example (due to a PWPL reviewer) shows:

(31) Q: Which woman did every male student bring to the party?
A: His spouse.

The 'spouse' function is allowed, even though it is not a uniformly woman-valued function. In this case, the domain of the function is pragmatically restricted to (married) males (but not necessarily to male students). We conclude from this discussion, that although the domain of the function need not always be constrained by the quantified expression, it may sometimes be, depending on the context.

Let us now turn to the derivation of the pair-list reading of *which woman did every student date*. This reading comes about when (28) is selected as the meaning of Comp, triggering non-standard QR, which adjoins the quantified expression to C'. This is done in order to fix the domain of the function. Building on various ideas in Groenendijk & Stokhof (1984), Chierchia (1993), Szabolcsi (1993), and Dayal (1996), let us assume that the domain is determined as the unique minimal witness set (UMWS) of the quantified expression. According to Barwise & Cooper (1981), a witness set is a subset of the common noun in a generalized quantifier, which is a member of the quantifier. A minimal witness set does not have subsets that are also witness sets. So, for example, the UMWS set of [every man] is the set of men. As Dayal proposes, by adjoining the quantified expression to a position higher than C', we can "feed in" its extracted UMWS into the meaning of Comp. This non-standared (though local) QR is the syntactic operation which enables the domain of the function in a pair-list question to receive its value. The full derivation is given below (where 'ιW(QP)' stands for the UMWS of QP):

(32) a.



b. [Comp] = $\lambda K\lambda P\lambda F\exists f[Dom(f)=P \;\&\; F(f) \;\&\; p=\cap\lambda p'\exists y[P(y) \;\&\; p=\hat{}\check{}K(f, y)]]$, and non-standard QR applies to [every student].

c.

1. $date'(x, f(x))$
1'. $\lambda x\lambda f[date'(x, f(x))]$
2. $\lambda K\lambda P\lambda F\exists f[Dom(f)=P \;\&\; F(f) \;\&\; p=\cap\lambda p'\exists y[P(y) \;\&\; p=\hat{}\check{}K(f, y)]]$ **(by (28))**
3. $\lambda K\lambda P\lambda F\exists f[Dom(f)=P \;\&\; F(f) \;\&\; p=\cap\lambda p'\exists y[P(y) \;\&\; p'=\hat{}\check{}K(f, y)]](\hat{}\lambda x\lambda f[date'(x, f(x))])$
$\Rightarrow \lambda P\lambda F\exists f[Dom(f)=P \;\&\; F(f) \;\&\; p=\cap\lambda p'\exists y[P(y) \;\&\; p'=\hat{}date'(y, f(y))]]$
4. $\iota W[\lambda P\forall x(student'(x) \rightarrow P(x))]$
$\Rightarrow$ $student'$
5. $\lambda P\lambda F\exists f[Dom(f)=P \;\&\; F(f) \;\&\; p=\cap\lambda p'\exists y[P(y) \;\&\; p'=\hat{}date'(y, f(y))]](student')$
$\Rightarrow \lambda F\exists f[Dom(f)=student' \;\&\; F(f) \;\&\; p=\cap\lambda p'\exists y[student'(y) \;\&\; p'=\hat{}date'(y, f(y))]]$
6. $woman'$
6'. $\lambda f[\forall x(x\in Dom(f) \rightarrow woman'(f(x)))]$ **(by (21))**
7. $\lambda F\exists f[Dom(f)=student' \;\&\; F(f) \;\&\; p=\cap\lambda p'\exists y[student'(y) \;\&\; p'=\hat{}date'(y, f(y))]](\lambda f[\forall x(x\in Dom(f) \rightarrow woman'(f(x)))])$
$\Rightarrow \exists f[Dom(f)=student' \;\&\; \forall x(x\in Dom(f) \rightarrow woman'(f(x))) \;\&\; p=\cap\lambda p'\exists y[student'(y) \;\&\; p'=\hat{}date'(y, f(y))]]$
7'. $\lambda p\exists f[Dom(f)=student' \;\&\; \forall x(x\in Dom(f) \rightarrow woman'(f(x))) \;\&\; p=\cap\lambda p'\exists y[student'(y) \;\&\; p'=\hat{}date'(y, f(y))]]$

Node #1 is interpreted as a relation between individuals and <e,e>-type functions (Line #1'). Node #2 is interpreted as "pair-list" Comp, which needs a relation, a property of individuals (to fix the domain of the function), and a property of functions (to fix its range). The relation is supplied by Node #1.

The UMWS of *every man* (i.e., the set of men) fixes the domain of the function (Line #5). Node #6 fixes the range (Line #7). The variable *p* is abstracted over at the CP-level, to yield a set of propositions.

Dayal's analysis of pair-list Comp is an extension of Chierchia's (1993) Absorption mechanism, which derives similar results without moving the quantified expression. The difference between Chierchia's semantics for pair-list readings and Dayal's is that each answer in the latter spells out the graph of a function. So if John and Bill are the men in the domain, and Mary and Sally are the women, Chierchia has {{John loves Mary, John loves Sally, Bill loves Mary, Bill loves Sally}} as the denotation of the question. A possible answer is the conjunction of a subset of this set (with the result that Uniqueness and Exhuastivity are not predicted). For Dayal, the question denotation is as above. A possible answer is picked out of this set by the Answerhood operation (with the result that both Uniqueness and Exhaustivity are predicted).

The two possible readings of *which woman did every student date* are repeated below:

(33) **Functional interpretation**:

a. $\lambda p \exists f[f \in G \ \& \ \forall x(woman'(f(x))) \ \& \ p = \hat{} \forall x(student'(x) \rightarrow date'(x, f(x)))]$

b. "What is the woman-valued function *f* such that every student *x* dated *f(x)*?"

c. Possible answers: Every student dated his girlfriend; Every student dated his roommate; Every student dated his favorite neighbor; etc.

(34) **Pair-list interpretation**:

a. $\lambda p \exists f[Dom(f) = student' \ \& \ \forall x(student'(x) \rightarrow woman'(f(x))) \ \& \ p = \cap \lambda p'[\exists y(student'(y) \ \& \ p' = \hat{} date'(y, f(y)))]]$

b. "What is the woman-valued function *f*, whose domain is the set of students, and for every *x* in the domain of *f*, *x* dated *f(x)*?"

c. Possible answers: John dated Mary and Bill dated Sally; John dated Mary and Bill dated Mary; John dated Sally and Bill dated Sally; John dated Sally and Bill dated Sally.

What emerges from this analysis is that (a) a funtional question involves quantification over natural functions (i.e., contextually salient functions such

as 'mother-of', 'sister of', etc), whereas a pair-list question involves quantification over sets of arbitrary pairs; (b) the domain of a natural function is determined pragmatically, whereas the domain of a pair-list function is determined semantically (by UMWS extraction).[7]

The different properties of natural and pair-list functions account for the two differences between functional and pair-list questions discussed in section 2. First, notice that we predict the following uniqueness effect: applying the Answerhood operation to (33)a yields the unique/maximal relevant propsition. For example, *every student dated his girlfriend.* This answer is felicitous even if some student or other dated another woman besides his girlfriend. As long as the function which maps that student to the other woman he dated is not in the set *G*, there is no danger of violating the uniqueness requirement imposed by Answerhood.

Applying Answerhood to (34)a also yields the relevant unique proposition, for example: *John dated Mary and Bill dated Sally.* But this answer cannot be felicitous in a situation where John dated some other woman, because the above proposition will fail to be unique.

Secondly, notice that the assumption that the domain of a pair-list function is fixed as the UMWS set of the quantified expression predicts that only quantified expressions which have a UMWS can support pair-list questions: *every man*, *each man*, *the man*, *John*, etc. Any quantifier which does not have a UMWS (e.g., *most men*, *three men*, *few men*) do not support pair-list questions (*no man* has the empty set as its UMWS, but can be ruled out on pragmatic grounds). This prediction is largely borne out, as the following example shows:

(35) Which woman do most men love?
  a. Their mother.
  b. *John, Mary; Bill Sally.

[7]The analysis is also applied to wh-phrases which contain an anaphoric or pronominal element which is interpreted as bound by the quantifier (see above references for details):

(1) Which woman that **he** liked did **every man/no man** see?

(2) $\lambda p \exists f[\forall x(x \in Dom(f) \rightarrow woman'(f(x)) \& like'(x, f(x))) \& \forall x(man'(x) \rightarrow see'(x, f(x)))]$

(3) $\lambda p \exists f[\forall x(x \in Dom(f) \rightarrow woman'(f(x)) \& like'(x, f(x))) \& \forall x(man'(x) \rightarrow \neg see'(x, f(x)))]$

While *their mother* is a good answer to (35), the pair-list answer is not. The same is true for *few-NP*, *almost-no-NP*, *almost-every-NP*, etc.

Recall that quantifying into questions is disallowed (see (3) and the discussion following it). For functional questions, this is predicted by the analysis in (29), because [every student] does not move past the question operator. However, the analysis of pair-list questions assumes that the quantified expression moves to a position higher than Comp. This amounts to quantifying-in, and may pose a problem. But as Chierchia (1993) claims, Absorption (and, by extension, non-standard QR) is a special kind of quantifying into questions, which is highly restricted, and where the quantified expression does not combine directly with the rest of the sentence (rather it is the witness set extracted from it which combines with the rest of the sentence). The result is that we maintain the prediction that (3)c and (3)e are not possible readings of (3)a.

We can now return to the issue of embedded questions (as in *some professor knows which woman every student dated*) . We will argue that the $\forall\exists$-reading is triggered by the functional dependency in the embedded question. But before turning to to the actual analysis, let us go over the basic assumptions:

A. Answerhood applies to a question denotation to yield the unique/maximal true proposition (section 3.1);
B. Functional and pair-list questions involve functional dependencies. In a pair-list question, the domain of the function is determined as the UMWS of the quantified expression;
C. There is a type-shifting operation which turns an expression of type $<X,t>$ into an expression of type $<<e,X>,t>$ (section 3.2);
D. There is a type-shifting operation which turns an expression of type $<e,X>$ into an expression of type $<<e,t>,<e,X>>$ (section 3.2).

4. Embedded Questions

The goal of this section is to account for the three-way ambiguity of sentences such as (1), repeated here:

(36) Some professor found out [which woman every student dated].

Our analysis predicts the following readings:

(37) **Functional ∃∀-reading**:
Some professor found out the answer to the functional question 'which woman every student dated'.

(38) **Pair-list ∃∀-reading**:
Some professor found out the answer to the pair-list question 'which woman every student dated'.

(39) **∀∃-reading**:
For every student *x* there is a professor *y* such that *y* found out the answer to the question 'which woman *x* dated'.

4.1. ∃∀-Readings

Readings (37) and (38) are obtained by applying the Answerhood operator directly to the denotation of the embedded question in-situ:

(40) a. Some professor found out [Ans(functional "which woman every student dated")].

b. $\exists y[\text{professor}'(y) \,\&\, \text{find-out}'(y, \text{Ans}(\lambda p \exists f[f \in G \,\&\, \forall x(\text{woman}'(f(x))) \,\&\, p = \hat{}\forall x(\text{student}'(x) \rightarrow \text{date}'(x, f(x)))]))]$

(41) a. Some professor found out [Ans(pair-list "which woman every student dated")]

b. $\exists y[\text{professor}'(y) \,\&\, \text{find-out}'(y, \text{Ans}(\lambda p \exists f[\text{Dom}(f) = \text{student}' \,\&\, \forall x(\text{student}'(x) \rightarrow \text{woman}'(f(x))) \,\&\, p = \cap \lambda p'[\exists y(\text{student}'(y) \,\&\, p' = \hat{}\text{date}'(y, f(y)))]]))]$

As we have seen before, the pair-list reading involves extracting a UMWS out of the quantified expression. Such is the case in (41), which contains an embedded pair-list question. We therefore predict the pair-list ∃∀-reading not to be available in *some professor found out which woman no student dated* (and as the reader can verify, also with other quantified expressions which do not have unique minimal witness sets). However, the functional ∃∀-reading (which does not involve extracting a unique minimal witness set) is available with *no student*, *most students*, *few students*, *almost-every/no-student*, etc. For example, *some professor found out which woman almost no student dated*, can imply, under this reading "some professor found out that almost no

student dated his best friend's girlfriend".

4.2. The ∀∃-Reading

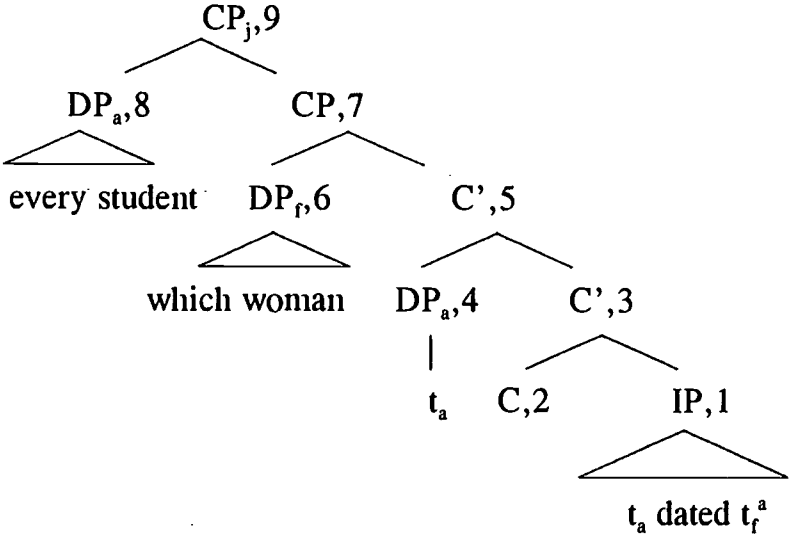
In order to account for the ∀∃-reading, I follow Szabolcsi & Moltmann (1994) in assuming that an embedded question which contains a quantified expression inherits its properties, and can optionally move by standard QR:

(42) [which woman every student dated] [some professor found out t]

In addition, I assume that the trace of the embedded question is interpreted as Ans(Q). The intuitive idea behind this proposal is that the raised question is interpreted as a function from students to questions, and that the IP (namely, [some professor found out t]) is interpreted as a predicate of functions from individuals to questions. The IP denotation is predicated of the raised question denotation.

Suppose we interpret the raised question as a pair-list question. Recall from section 3.3, that a pair-list reading involves moving *every student* to a position higher than C' (see (32)). Let us assume that (43) is the structure of the raised pair-list question:

(43)



Since this is the pair-list interpretation, we must assume that Comp is interpreted as "pair-list" Comp (i.e., as in the corresponding (32)). But notice a difference between (43) and the corresponding (32): Here *every student* is adjoined to C', and then to CP, leaving behind a trace. In other words, instead

of assuming one local movement of the quantified expression (as in the matrix question case), in the embedded question case I assume that two movements take place within the same local domain. Each one of these movements results in fixing the domain of a function. Following is the full derivation of (43):

(44)

1. date'(y, f(y))

1'. $\lambda y \lambda f[date'(y, f(y))]$

2. $\lambda K \lambda P \lambda F \exists f[Dom(f)=P \ \& \ F(f) \ \& \ p=\cap\lambda p' \exists y[P(y) \ \& \ p'=\hat{}\check{}K(f, y)]]$

3. $\lambda K \lambda P \lambda F \exists f[Dom(f)=P \ \& \ F(f) \ \& \ p= \cap\lambda p' \exists y[P(y) \ \& \ p'=\hat{}\check{}K(f, y)]](\hat{}\lambda y \lambda f[date'(y, f(y))])$
$\Rightarrow \lambda P \lambda F \exists f[Dom(f)=P \ \& \ F(f) \ \& \ p=\cap\lambda p' \exists y[P(y) \ \& \ p'=\hat{}date'(y, f(y))]]$

4. x

4'. $\lambda y[y=x]$

5. $\lambda F \exists f[Dom(f)=\lambda y[y=x] \ \& \ F(f) \ \& \ p=\cap\lambda p' \exists y[y=x \ \& \ p'= \hat{}date'(y, f(y))]]$

6. woman'

6'. $\lambda f[\forall x(x \in Dom(f) \rightarrow woman'(f(x)))]$
(by (21))

7. $\lambda F \exists f[Dom(f)=\lambda y[y=x] \ \& \ F(f) \ \& \ p=\cap\lambda p' \exists y[y=x \ \& \ p'= \hat{}date'(y, f(y))]](\lambda f[\forall x(x \in Dom(f) \rightarrow woman'(f(x)))])$
$\Rightarrow \exists f[Dom(f)=\lambda y[y=x] \ \& \ \forall x(x \in Dom(f) \rightarrow woman'(f(x))) \ \& \ p=\cap\lambda p' \exists y[y=x \ \& \ p'=\hat{}date'(y, f(y))]]$
$\Rightarrow \exists z[woman'(z) \ \& \ p=\hat{}date'(x, z)]$

7'. $\lambda x \lambda p \exists z[woman'(z) \ \& \ p=\hat{}date'(x, z)]$

7". $\lambda P \iota k[Dom(k)=P \ \& \ \forall x(x \in Dom(k) \rightarrow k(x)=\lambda p \exists z[woman'(z) \ \& \ p=\hat{}date'(x, z)])]$
(by (22))

8. $\iota W(\lambda P[\forall x(student'(x) \rightarrow P(x))])$
$\Rightarrow$ student'

9. $\lambda P \iota k[Dom(k)=P \ \& \ \forall x(x \in Dom(k) \rightarrow k(x)=\lambda p \exists z[woman'(z) \ \& \ p=\hat{}date'(x, z)])](student')$
$\Rightarrow \iota k[Dom(k)=student' \ \& \ \forall x(x \in Dom(k) \rightarrow k(x)=\lambda p \exists z[woman'(z) \ \& \ p=\hat{}date'(x, z)])]$

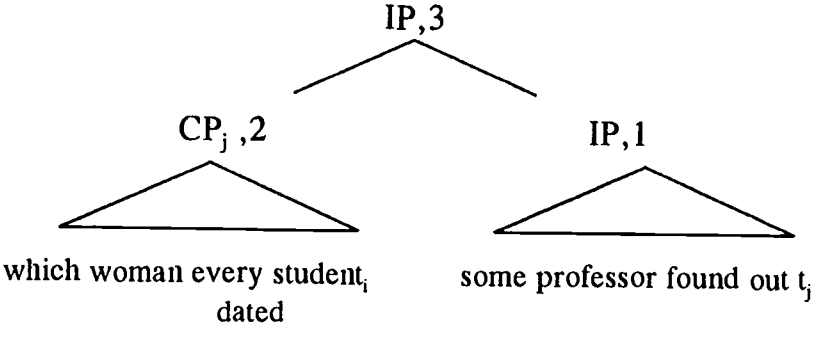
Node #1 denotes a proposition. The variables *y* and *f* are abstracted over,

yielding a relation which is of the right type to combine with the Comp denotation in Node #2. Node #4 is interpreted as a singleton set, which fixes the domain of the function introduced by Comp. Node #6 fixes the range of that function. Turning to Line #7, it asserts the existence of a function whose domain is a singleton set, and whose range is a woman, and the single member of the domain dated a member of the range. It follows, therefore, that there exists a woman that the individual denoted by x dated. This expression contains two free variables (x and p) which are abstracted over to yield a function from individuals to sets of propositions (i.e., from individuals to questions). In order for this expression to be able to combine with *every student,* we apply the type-shifting operator in (22) to yield a function from possible domains to functions of the same type. This expression combines with the UMWS of *every student*, yielding a function from students to questions.

Notice that the transition from Line #7 and Line #7', and then to 7", are the crucial steps here. These are the steps which enable us to build a function from individuals to questions. Without having a free individual variable in Line #7, this step would be impossible, and the reading would be predicted not to exist.[8]

Now, (43) is a subtree which represents the moved constituent in *some professor found out* ***which woman every student dated***. The meaning of this subtree can now combine with the rest of the sentence:

(45)



The trace of the moved embedded question is interpreted as Ans(Q), in accordance with the assumptions in Section 3.1, so that the full IP is

[8]These two movements cannot take place in a matrix question, because of an independent principle requiring a matrix CP to denote a proposition or a set of propositions.

interpreted as: "some professor found out Ans(Q)". By abstracting over *Q*, we get a property of questions (i.e., λQ[some professor found out Ans(Q)]). This expression cannot combine with the denotation of the moved CP (which is a function from individuals to questions). In order to combine the two, we need to apply the type shifting operation in (21) to the IP denotation, to yield a set of functions from individuals to questions:

(46) $\lambda Q[....Ans(Q)...] \rightarrow \lambda k[\forall x(x \in Dom(k) \rightarrow \lambda Q[...Ans(Q)..](k(x)))]$

The full derivation of *some professor found out which woman every student dated* is given below:

(47) 1. $\exists y[professor'(y) \ \& \ find\text{-}out'(y, Ans(Q))]$

1'. $\lambda Q \exists y[professor'(y) \ \& \ find\text{-}out'(y, Ans(Q))]$

1". $\lambda k[\forall x(x \in Dom(k) \rightarrow \exists y[professor'(y) \ \& \ find\text{-}out'(y, Ans(k(x)))])]$ **(by (46))**

2. $\iota k[Dom(k) = student' \ \& \ \forall x(x \in Dom(k) \rightarrow k(x) = \lambda p \exists z[woman'(z) \ \& \ p = \hat{} date'(x, z)])]$ **(Line #9 in (44))**

3. $\lambda k[\forall x(x \in Dom(k) \rightarrow \exists y[professor'(y) \ \& \ find\text{-}out'(y, Ans(k(x)))])](\iota k[Dom(k) = student' \ \& \ \forall x(x \in Dom(k) \rightarrow k(x) = \lambda p \exists z[woman'(z) \ \& \ p = \hat{} date'(x, z)])])$

"The unique function *k* whose domain is the set of students, and which maps every *x* in its domain to the question "which woman did *x* date", is such that for every *x* in the domain of *k*, there is a professor which knows the answer to *k(x)*."

In node #1, the trace of CP is interpreted as Ans(Q), which is of the right type to combine with *find out*. By applying the type-shifting operation in (21) to the IP denotation (#Line 1'), we get a set of functions, which is of the right type to combine with the function denoted by Node #2.

Notice that the anlaysis correctly predicts that any expression which has a UMWS supports such a reading. The universal quantifier appears in Line #1" independently of the particular expression in the subject position of the raised question.

In addition to predicting that only quantifiers which have a UMWS can support such readings, we make the following prediction. Embedded declaratives (as in *some professor found out that every student dated his*

roommates, see (7) above) do not exhibit scope interactions (or do not have a ∀∃-reading), because in order for such a reading to come about, we would need to QR the embedded declarative, and interpret it as a function from individuals to propositions. But the basis for such a reading, as we have seen above, lies in the presence of a functional dependency. Since a declarative sentence does not contain wh-movement, it cannot contain such a dependency. As as a result, there is no way to form a function from individuals to propositions.

At this point the reader may wonder whether an embedded question can undergo non-standard QR, yielding a ∀∃-reading for (48)a:

(48) a. Which professor found out who every student dated.
b. [who every student dated] [which professor found out t]

Clearly, we do not want the theory to make this wrong prediction. And in fact it does not, because non-standard QR is not free: it is triggered by "pair-list" Comp, and results in C'-adjunction (below the wh-phrase), and not CP adjunction (above the wh-phrase).

The reader may also wonder whether the raised question can be interpreted as a functional question, giving rise to something like: "The unique natural function *h* which maps every *x* in its domain to the question 'which woman did *x* date', is such that for every *x* in the domain of *h*, there is a professor which knows the answer to *h(x)*." Clearly, we do not want to predict this interpretation (one reason being that the domain of the function has to be restricted to the set of men). In fact, we predict this reading to be impossible, for the following reason. Recall that the crucial step is the transition from Line #7 to Line #7'. This step is what enables us to construct a function from individuals to questions. By looking at the representation of the functional reading of the matrix question in (29), we can see that there is no source for a similar interpretation, because there is no node where we can abstract over a free individual variable to yield a function from individuals to questions. The conclusion is that a raised embedded question is never interpreted as functional.

5. Summary and Open Questions

The proposed analysis of scope interactions in embedded questions succeeds in preserving the insights of the Chierchia-Dayal analysis of matrix functional

and pair-list questions, and the insights of the Szabolcsi & Moltmann (1994) analysis of embedded questions by predicting the following:

(a) Standard QR is clause-bounded. Whether it is a "bare" quantified expression (such as *every man*) which moves, or a clause containing a quantified expression (such as an embedded question), the movement is always local;

(b) Quantifying into questions is possible only under the circumstances created by non-standard QR/Absorption;

(c) The subject/object asymmetry exhibited by matrix functional questions is preserved in embedded questions, due to the presence of a functional trace;

(d) There are two $\exists\forall$-readings for embedded questions with a c-commanding indefinite: functional and pair-list. This is done by interpreting the embedded question in-situ, via the Answerhood operator;

(e) The $\forall\exists$-reading is possible only with an embedded question, not with an embedded declarative. This is because a declarative sentence does not contain a functional dependency.

An important difference between the two theories is that under the current approach, the availability of a $\forall\exists$-reading is contingent upon the quantifier having a UMWS. Under the Szabolcsi & Moltmann approach, it is the inherited properties of the embedded question which determine whether it can QR or not. However, notice that nothing in the current theory excludes the possibility that the alternative is correct. Indeed, it would be interesting to see what the relationship between the two classes of quantifiers is, and whether there is cross-linguistic variation.

In particular, it would be interesting to see if the two theories can be combined, in order to solve the following problem. The UMWS hypothesis establishes a one-to-one correspondence between the availability of a pair-list $\exists\forall$-reading and a $\forall\exists$-reading. In other words, if the quantifer in question has a UMWS set, both these readings should be possible, and if it doesn't, then both should be impossible. This prediction is largely borne out. In particular, it is borne out for the class of quantifiers which are argued in Groenendijk & Stokhof (1984) not to induce pair-list readings (namely, *no*, *few*, *most* and indefinites). However, as noted in Szabolcsi (1993), and further discussed in Szabolcsi & Moltmann (1994), in point of fact there is no such one-to-one

correspondence. This becomes evident when one examines quantifiers such as *more than* and *less than*. As an example, consider the following contrast:

(49) a. Which woman did more than five boys date?
*pair-list

b. I know which woman more than five boys dated.
pair-list

c. Some student knows which woman more than five boys dated.
$\exists\forall$-pair list - OK
$\forall\exists$ - not OK

The Szabolcsi & Moltmann approach, which assigns the $\forall\exists$-reading a "layered quantifier" analysis, and does not relate the in-situ interpretation to the raised interpretation, can deal with this surprising contrast better than the proposed analysis. This is so because neither reading is dependent on the other. Ideally, insights from both approaches should combine to provide a unified account.

Finally, it is worth pointing out that the theory can account for the following contrast (where a quantifier is embedded in the wh-phrase):

(50) Which woman that every student$_i$ liked did he$_i$ date?
(51) *Which woman that no student$_i$ liked did he$_i$ date?

Every student can "escape" the relative clause boundary, but *no student* cannot (contrast these examples with the ones in Footnote 7). I refer the reader to von Stechow (1990), Jacobson (1994), and Sharvit (1997) for possible analyses of relative clauses with quantifiers. In particular, in Sharvit (1997) it is argued that relative clauses, like questions, are ambiguous between a "pair-list" reading and a "functional" reading. The pair-list reading involves the percolation of the index of [every man] to the node of the DP which contains it (because [every man] moves to Comp to fix the domain of the function). The functional reading does not involve such index percolation, because the quantifier does not move to Comp. Now, in (50), if the relative clause is interpreted as a pair-list function, the percolated index of *every man* can bind the pronoun *he* in the question. But in (51), the relative clause cannot have a pair-list interpretation at all (becuase, as we know, *no-NP* does not support pair-list readings) so *he* cannot be bound. The contrast between (50) and (51) is therefore predicted.

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The Perfect, Contingency, and Temporal Subordination

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1. Introduction

Much confusion has arisen from restrictions on adverbial use with the present perfect in English which don't seem to apply to the simple past or past perfect:

(1) a. Jake has watered the garden {today/recently/*yesterday/ *on Sunday}.
b. Jake watered the garden {today/recently/yesterday/on Sunday}.
c. Jake had watered the garden {that day/recently/the day before/ on Sunday}.

This has led to a number of proposals that single out the present perfect for special treatment, introducing new concepts specially devised to handle the contrast of the present perfect with the simple past and past perfect. For instance, two varieties of the EXTENDED-NOW theory (Bennett & Partee (1978), McCoard (1978), Vlach (1993)) propose that the present perfect introduces a timespan which contains the event and which either runs up to or includes *now*. Any adverbial modifier used with the present perfect must be able to modify this extended-now timespan. CURRENT-RELEVANCE theories (Twaddell (1968), Comrie (1976)) claim that the event must have some relevance to *now* in order for the present perfect to be used. These approaches in general make reasonable predictions about the present perfect, but they suffer from two problems: they are not easy to formalize, and they offer little in the way of explanation for the odd behavior of the present perfect or a connection between it and the rest of the language.

Two notable exceptions are Moens & Steedman (1988) and Klein (1992). Moens & Steedman suggest a general concept, which they call CONTINGENCY, and associate it with a number of different constructs in the language, including the perfect. Contingency is essentially a logical dependency that can be asserted to hold between two eventualities or times. This relation can be indicated indirectly, as when we recognize a cause-and-effect sequence through world knowledge, or directly, as with a *when*-clause or the perfect. Their proposal is that events can evoke not only the time during which the event proper occurred, called the CULMINATION, but also the PREPARATORY PROCESS of the event, during which preconditions for the event may be

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brought about, and the CONSEQUENT STATE, during which effects of the event may be located. The perfect in this analysis takes a culmination as input and yields its consequent state, which is contingent on the event. This approach is a variant of current-relevance, in that the consequences of the event must still hold, and therefore be relevant, at speech time, but it connects to a broader linguistic phenomenon and provides a mechanism for the effect.

Moens & Steedman assume that temporal adverbials here indicate that the time is part of the contingency base: that there is some relevant consequence to the event's having occurred at that particular time, and only under such circumstances will such an adverbial be felicitous. This would seem to indicate that the adverbial is interpreted at the VP-level rather than the sentence-level (as in Hitzeman (1993)). It is not entirely clear why it is required to be part of the input to the perfect, rather than, say applying to the consequent state, since after all, timespan and point adverbs can apply to states. No doubt it has to do with how *now* relates to the state, but this is not spelled out. This approach is a welcome one in that it proposes a general concept that handles cases other than just the present perfect, and in that it can explain many pragmatic elements of the perfect, but it appears to need a bit of fleshing out in order to address our adverb question.

Klein (1992) also proposes a general concept to handle the present perfect, though of quite a different sort. He proposes a constraint to hold across the board, which can account for the apparent idiosyncrasies of present perfect, as well as other linguistic constraints. This constraint assumes something similar to Reichenbach's (1947) reference time and event time, except that reference time is translated into TOPIC TIME, and represents the time for which a claim is made, rather than a time the event gets related to. Klein suggests that the present in general introduces *now* as the topic time, while the perfect locates the situation time before topic time. The P-DEFINITENESS CONSTRAINT prohibits having both topic time and situation time assigned to independent known timepoints. Since *now* is a known timepoint, then according to the p-definiteness constraint, no other known timepoint is allowed to modify the situation time in which the event occurs, for any present tense. Adverbials that do not contain a directly-known (i.e. not relativized or derived) point in time are admissible with the present perfect. These include relative temporal locations such as *recently* and *since March*. With the past perfect, a known topic time is not necessarily introduced; rather, the topic time may be derived from context outside of the clause. This means that if there is no overt modifier for the topic time in the sentence, the past perfect's situation time is free to be modified by known-time adverbials, as well as relativized temporal

adverbials. Thus, he can rule out

(2) *At seven, Chris had left at six.

I will give an account of the perfect which incorporates all the ideas described above, and which generalizes beyond the perfect. The analysis uses Spejewski & Carlson's (1992) fleshed-out variant of contingency, called TEMPORAL SUBORDINATION. The details of this account show how extended-now, current relevance, and most of the effects of p-definiteness can all be incorporated in one representation of the present perfect, all fitting within a general theory of temporal relations, and with the adverbial constraints easily accounted for. The one thing that doesn't fall out from my analysis is the badness of example (2) above, but Klein also offers a pragmatic explanation for it, having to do with odd inferences that arise, and this seems to me to be sufficient.[1] In addition, a set of pragmatic effects on adverbial modification from Katz & Spejewski (1994) can be explained:

(3) a. My house has blown up {??today/??this year}.
b. ??Bill Clinton has been president.
c. Wade has walked the dog {today/??this morning}.
(if he usually walks her some other time of day)

Further data, involving the relation of events in subsequent sentences or clauses to those in the perfect sentence, is also predicted by the analysis.

I will not spend a great deal of time on the differences between the present perfect and the past perfect, because I assume that these are due to the ambiguity of the past perfect form between a past-of-perfect and a past-of-past reading (after McCawley (1973), 259–268). The distinction can be illustrated by (4), where (4a) indicates a time in the non-adjacent past (past-of-past reading) and (4b) is a past-of-perfect, indicating a timespan connected to the past reference time. There are situations in which the past perfect can be used felicitously, but the present perfect can not or gives a different meaning (5) and (6).

(4) a. Jake had not watered the garden the day before.
b. Jake had not watered the garden since the day before.

[1]According to Klein (1992), this sentence implies that there could be some time other than seven at which Chris could have left at a time other than six.

(5) a. Jake regretted the events of the night before. He had called his boss a jerk and deleted some computer files.
b. Jake regrets the events of last night. He called/??has called his boss a jerk and deleted some computer files.

(6) a. How had you broken your nose?
b. ??How have you broken your nose? (both from Michaelis, 1994)

There are a number of possible sources for these differences; I assume they are due to this being a past-of-past reading, and I will not investigate them further in this paper. The majority of this paper will concentrate on the present perfect, since it is not ambiguous in this way; however, the past-of-perfect reading can be handled by the analysis laid out in this paper.

In the next section, I will briefly lay out a general theory of temporal relations, which I refer to as a theory of temporal subordination. In section 3, I will show how the perfect can be accommodated by this theory and the adverbial constraints accounted for, and in section 4 I will show how discourse data is predicted by the theory.

2. The Temporal Subordination Theory

The semantic theory of temporal subordination, as laid out in Spejewski & Carlson (1992) and Spejewski (1994), proposes two general kinds of temporal relation that can hold between two eventualities. The relation called TEMPORAL SUBORDINATION indicates that two eventualities occur at approximately the same time, and that there is some import to this temporal proximity. Examples are given in (7). The other relation, TEMPORAL COORDINATION, indicates that the events either occur in distinct time periods or no import is accorded to their occurring simultaneously, as in example (8). The relations are discussed in more detail below.

(7) a. Jimmy filled the bucket with water. He used the garden hose.
b. When Einstein wrote his first famous theory, he was working as a patent office clerk.

(8) a. Jimmy filled the bucket with water. He used it to water the geraniums.
b. Jimmy watered the flowers. Rosalyn walked the dog.

2.1. The Two Kinds of Relation

The temporal subordination relation incorporates Moens & Steedman's (1988) notion of contingency, which I have described as a perceived dependence between two eventualities. Temporal subordination applies to the cases in which there is *temporal* dependence, such that one event occurs within the time introduced for another event. Typical examples of subordination are events related by event decomposition, *when*, or sentence-final *then*, or non-discourse-initial states, but not necessarily cause-and-effect events.

Since contingency is an asymmetric temporal relation, it is represented using an asymmetrical temporal structure. First, each event is inserted within a REFERENCE TIME (following e.g. Partee (1984), Hinrichs (1986), Kamp & Reyle (1994)). The reference time for an event will contain the event, and may extend beyond the event. We can represent this diagrammatically as in (9), so that if a temporal diagram is considered to be a tree,[2] the daughter relation indicates that the daughter is contained within the parent.

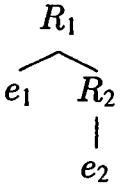
(9)

In the subordination theory, the reference time is a discourse object which represents a hearer's interpretation of the time during which the event is likely to have occurred, given the context of the discourse, or a time throughout which the state is likely to have held, given the discourse. Because the reference time reflects the hearer's interpretation, it is dynamic and may be underspecified. A hearer may use world knowledge (for instance, how long a particular event typically takes), discourse knowledge (such as why two events would be mentioned in sequence), or linguistic knowledge (understanding of temporal terms) in setting up the reference times.

For temporal subordination, the reference time for the subordinate event, here e_2, is inserted within the reference time for the superordinate event, e_1.

[2]Technically, the diagrams used here are graphs.

(10) Jimmy filled a bucket with water. He used the garden hose.



e_1: Jimmy fill a bucket
e_2: Jimmy use a garden hose

Notice that this structure does not require that the events themselves be overlapping; it simply says that the second event is constrained to be within the time introduced for the first event. The reason for this is illustrated by some *when* sentences from Ritchie (1979):

(11) When they built the fifth bridge, . . .
a. . . . they took several bids.
b. . . . they used the best materials.
c. . . . they had a gala opening.

Here there is a clear linguistic marker (*when*) indicating that two events are to be interpreted with temporal contingency, but we can understand the main-clause event as occurring before, during, or after the *when*-clause event. Moens & Steedman (1988) explain this effect by saying that this construction allows the events to introduce preparatory and consequent stages. The reference time in the temporal subordination approach could be considered as a vehicle through which this is possible.

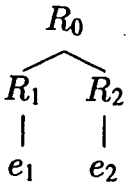
The representation in (10) is equivalent to a Discourse Representation Theory (DRT) structure (Kamp & Reyle (1993)), and can be implemented with the same model. The set in (12) is a simplified set of predications that could represent the subordination structure for sentence (11c). Using the tree-type diagrams simply clarifies the relationship structure.

(12) e_1: Town build bridge
$e_1 \subseteq R_1$
$R_2 \subseteq R_1$
e_2: Town have gala opening
$e_2 \subseteq R_2$

For the coordination relation, one more assumption is introduced: that the discourse itself introduces a reference time R_0, which serves as the overall timespan for the events of the discourse to be contained within. The

coordination relation indicates that there is not temporal contingency between two eventualities, and this can be represented as in (14), where each reference time is inserted directly within R_0. The formula $R_1 < R_2$ indicates our understanding that the time containing e_1 is before the time containing e_2. The set of relations can also be represented in DRT formulas.

(13) Jimmy filled a bucket with water. Then he watered the geraniums with it.



$R_1 < R_2$
e_1: Jimmy fill bucket
e_2: Jimmy water geraniums

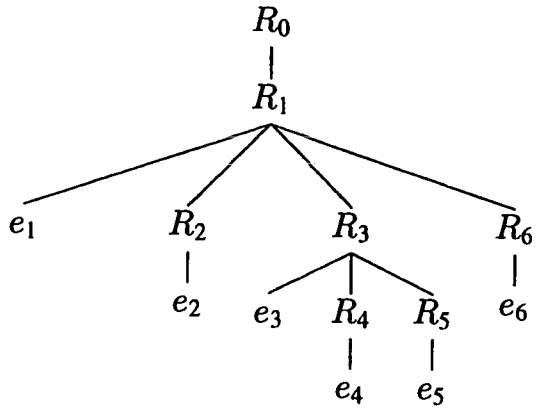
The relations work just the same for states as they do for events, though states will surround their reference times, rather than being contained within them. Both kinds of relation specify the relationships among reference times, not eventualities, and so the general relations can be specified in the same way, independent of the type of eventuality.

2.2. The Temporal Structure of Discourse

Entire discourses can be represented as combinations of subordination and coordination. In (14), the first sentence gives an overall event which the rest of the discourse describes in more detail, and so all of $e_2 - e_6$ will be subordinate to e_1. However, there is also a further breakdown of e_3, with the next two events directly subordinate to it.

(14) a. Edmond did a beautiful job of landscaping the yard (e_1). He put fruit trees in the back yard (e_2). In the front yard he made a flower garden (e_3). In it he planted both cultivated and wild roses (e_4), and then he installed a fountain in the middle (e_5). In the side yard he put a wonderful herb garden (e_6).

b.



$R_4 < R_5$

The formula $R_4 < R_5$ indicating the actual temporal ordering of two reference times is specified by the word *then* relating events e_4 and e_5. For the rest of the event pairings, we have neither linguistic information nor world knowledge to indicate in what order any of the events were performed, so there are no other ordering formulas. However, we do have world-knowledge information indicating subordination/coordination distinctions, for instance that $e_2 - e_6$ are all subordinate to e_1.

This theory attempts to model how a hearer or reader processes temporal relationships among events as a discourse unfolds. The modeling task involves two kinds of relationships: the relationships of the way the events are understood to have occurred, and the order in which the events are presented in the discourse. In our model, eventualities and their reference times are incorporated into the tree left-to-right *as they appear in the discourse*, and not as they occur temporally. This manner of incorporation makes it very easy to make predictions about how a new eventuality may be related to existing ones. It turns out that the *right-frontier* idea from rhetorical relations (Polanyi (1988), Webber (1991), Lascarides & Asher (1991,1993)), works here as well. It claims that when a structure like the temporal trees is built for discourse relations, a new node may only be added as the daughter of a node that is on the right frontier. The right frontier in our case includes any reference time which is the rightmost reference time in the tree at its structural level. This turns out to be equivalent to any reference time which has not had a subsequent reference time coordinated with it or with any of its ancestors (other than the global reference time). In diagram (14), nodes R_0, R_1, and R_6 are on the right frontier, and therefore are possible insertion sites. This means that the next eventuality added to this discourse may be incorporated as a daughter of any one of these reference times. The next eventuality could thus elaborate

on s_6 or e_1, or it could begin a new independent temporal line as a daughter of R_0. The notion of insertion sites will be important in section 4 for predicting what kinds of discourse continuations are possible after an eventuality has been introduced in the perfect.

2.3. Temporal Adverbs

There are three ways that temporal adverbials are incorporated into a discourse structure, according the kind of adverbial. A **frame** adverbial, such as *yesterday, next month,* or *within the hour*, introduces a timespan that contains one of the available reference times in the discourse.

(15) Yesterday, I took my niece to the playground.

$R_{yesterday}$
|
R_1
|
e_1

Durative adverbials, such as *for an hour* or *from midnight til two*, specify how long an eventuality lasted. Following Binnick (1991), duratives specify a feature of the event rather than the reference time. Durative adverbials do not seem to introduce a new site for future events to be located, and so they do not introduce a new reference time. Instead, they introduce a predication on the event, as shown in (16):

(16) Lizzy skated for an hour.

R_0 — e_1:Lizzy skate
|
R_1 — one-hour(e_1)
|
e_1

In a few cases, it is clear that an adverbial is not meant to locate the eventuality in a specific temporal location, but rather it may be considered a modifier on the event type itself. These are what I call **indefinite** adverbials, where it doesn't matter which particular date the event occurred on, but only a particular property of when the event occurred, such as the following example, similar to one in Klein (1992):

(17) Lucy was criticized by her pastor because she worked on (a) Sunday.

Here the adverbial is part of the event itself, so the event in the *because* clause is *Lucy work on a Sunday.*

Summarizing the main points of the theory of temporal subordination:

1) There are two temporal relations: subordination and coordination.
2) If a is subordinate to b, then a's reference time is within b's reference time.
3) If a is coordinated with b, then a's reference time is a sister of b's reference time.
4) Temporal orderings among reference times may be specified.
5) A new node may be inserted as the daughter of any reference time on the right frontier of the temporal tree for the discourse.
6) Frame adverbial reference times serve as parents of other reference nodes.

3. Temporal Subordination and the Perfect

This basic theory of temporal relations applies fairly easily to the case of the perfect in English, handling both adverbial use and the semantics of the aspect, as well as making predictions about the effect that the perfect has on the introduction of subsequent eventualities in the discourse.

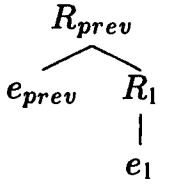
3.1. Analysis of the Perfect

The perfect can be treated as a case of temporal subordination, where the event is subordinated to some time derived from the discourse. Years of research on the present perfect has made it clear that there is some dependence relation (current relevance) indicated by the present perfect between the time of utterance and the time of the eventuality introduced, and also that these times are temporally related (extended-now). This gives us temporal proximity and contingency, the two notions we need in order to identify temporal subordination. Analyses based on Reichenbach (1947) propose a three-time relation for the perfect. All these pieces are part of temporal subordination. Looking at the past perfect makes it clear that the event introduced in the perfect is subordinate to an already-established time. With the past perfect, a temporal reference has been set up independently beforehand, and the new eventuality is located only with respect to that time. Assuming parallelism, the present perfect event

must then be subordinate to the speech situation, which I call *now*, and which is introduced by the present tense.

The representation of the perfect as subordination is fairly straightforward, if we add one formula as the special contribution of the perfect. Taking the general scheme of temporal subordination, the past perfect could be represented as in (18), where e_{prev} is a previously-introduced event, whose reference time serves as the location for the event e_1 introduced by the past perfect.

(18)



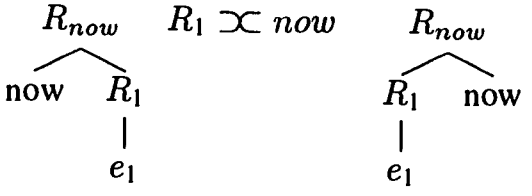
$R_1 \supset\!\subset e_{prev}$

The symbol $\supset\!\subset$ means 'abuts' (from Kamp & Reyle (1993). The ordering formula $[R_1 \supset\!\subset e_{prev}]$ is added to the general structure of subordination as the special contribution of the English perfect. This specification will account for some of the constraints on adverbial use, and also part of the semantics of the perfect. Notice that the formula specifying the abutting does not add any new structure to the representation of discourse. The representation for the perfect relies on structure that has been established for the overall theory, which is meant to handle many different kinds of cases. The kind of information that is added by the perfect is exactly the same kind of information that is added by a temporal modifier such as *then*. *Then* picks out the coordination structure, rather than the subordination structure, and adds its own contribution that the new reference time come after the one it is coordinated with. The analysis of the perfect here exactly follows the analysis of other temporal specifiers under this theory. No new theoretical constructs are needed in order to handle this aspect.

With the present perfect, the event is subordinated to *now*, or the speech event. This is similar to Vlach's 'speech situation', which includes relevant properties of the speech time. The reference time introduced by *now*, which I have labelled as R_{now}, is a contextually-determined time that contains *now*. R_{now} is similar to some versions of the 'extended-now' as a timespan that includes *now* and also contains the event (Bennett & Partee (1978), McCoard (1978)). Vlach (1993)) also allows for a time which contains the event and extends all the way up to *now* without containing it. With the constraint we have added that R_1 abut *now* for the present perfect, R_1 instantiates this

notion. The present perfect can be represented by either of the following diagrams, depending whether you prefer to follow the standard representation or to incorporate temporal iconicity. In this case, both items are introduced at once, so there is no necessary order to their inclusion, and some people may find it easier to think about the temporal relations by referring to the diagram on the right.

(19)

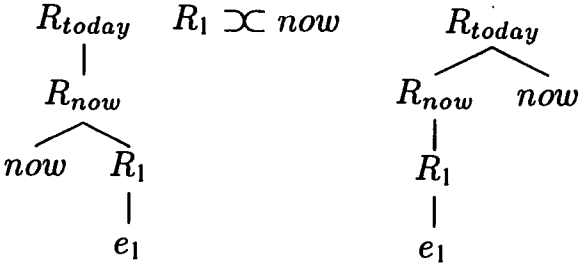


3.2. Adverbials and Semantics

With the general structure identified for the perfect, we can look at the way adverbials are constrained by this analysis. Recall that under the theory of temporal subordination, frame adverbials surround a reference time. With the perfect, we have two reference times introduced, providing two possible locations for adverbial attachment. But each reference time has constraints built into it, and any adverbial that modifies that time must accord with the constraints.

Containing R_{now} Any adverbial that contains the reference node R_{now} will also have to contain *now*, since R_{now} contains *now*. There are a number of adverbials that can contain *now*, if they are uttered at appropriate times. These include *today, this morning, now, this year*, and so forth. All of these adverbials are acceptable with the present perfect, and their use is represented in (20):

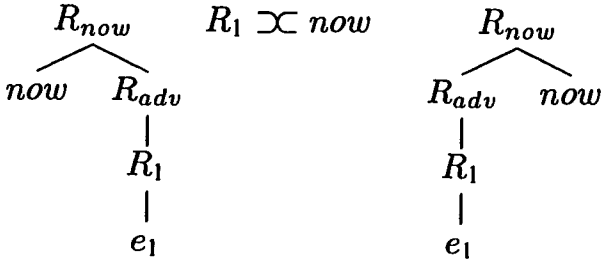
(20)



Containing R_e If an adverbial is to contain R_1 instead, then it must match the constraints on R_1, which are that they contain the event and also abut *now*. Any

adverbial time containing the event and not *now* must abut *now*. (If it contained *now*, then it would also contain R_{now}.) Any adverbial defined as abutting *now* (or the established past referent, for the past perfect) can surround R_1, and is acceptable with the present perfect. This class of adverbials includes *recently, just, ever, never, not yet, already, before (now/then), since Thursday, in the last hour* and so on, and their use is represented in (21)[3]:

(21)



Unacceptable adverbials We now turn to an adverb that is not acceptable with the present perfect, and see how this analysis rules it out. Taking an adverb like *yesterday*, we recognize that it is defined as abutting the day containing *now* or speech time, but crucially not as abutting or containing *now* itself. Of the two candidate reference times, only R_1 does not contain *now*. But R_1 is constrained to abut *now*, and not *the day containing now*. The meaning of *yesterday* does not allow it to abut *now*, and so it cannot contain R_1. The same argument holds for any adverbial that picks out a specific time before *now*, such as *at noon, on Thursday, before yesterday*, or *this morning* if it is no longer morning. An adverbial like *this past week* will be acceptable or not, according to whether an individual interprets the phrase to mean 'the seven days prior to now' or only a calendar week.

(22) John has practiced {*yesterday/*today at noon/*two days ago/ *after Sunday/since Sunday}.

Some adverbials that do not work with the perfect may be very similar to ones that do, except that they differ in whether they include the discourse-established time marker in their meaning, or whether they abut the marker. An adverbial like *after Thursday* is not acceptable, because it does not explicitly

[3]A subset of this class has been discussed for Modern Greek by Psaltou-Joycey (1993). She describes a group of adverbials that indicate a more or less definite point in the past beginning a temporal interval which extends up to some reference point. The speech moment serves as the reference point for use with the present perfect.

relate to *now* or e_{prev}, while *since Thursday* is acceptable because it does. *Two days ago*, while explicitly related to *now*, does not indicate a time that abuts *now*, and so it can not be used with the present perfect, whereas *in the past two days* can. (*Two days before* can be used with the past perfect syntactic form, but only for the past-of-past reading, and not the perfect.)

Indefinite adverbials If an adverbial does not fit the constraints on the reference times, then it cannot be used to modify the reference time. This does not necessarily mean that it cannot be used in a present perfect sentence, but if it is, then it cannot modify either of the two reference times set up by the perfect. There are some cases, as noted in Klein (1992), in which an adverbial such as *on Sunday* appears in a present-perfect sentence but does not specify a definite time location for the event:

(23) 'Why is Chris in jail?' 'He has worked on Sunday, and working on Sunday is strictly forbidden in this country.'

This is one of those cases in which the adverbial does not anchor the event in time, but rather gives a specification on the *type* of timespan in which the event occurred. Here the adverbial would not take the usual meaning of the phrase *on Sunday* as being the most recent or upcoming Sunday, and it would not modify either of the perfect's reference times, but rather would be incorporated into the event at a lower structural level. It cannot take the definite referent that it would normally take, but must be interpreted as indefinite reference to **a** *Sunday* or **some** *Sunday*.

A similar constraint against definite reference is imposed on *when*-clauses that modify a perfect, for similar reasons. In order for a *when*-clause to felicitously modify an event carrying a perfect reading, the *when*-clause must indicate only a general *type* of eventuality (indefinite), as in (24), and not specify a particular actual event or time (definite), as in (25):

(24) a. I have driven in Toronto when it was snowing.
b. I have been at the racetrack when a car overturned.

(25) a. ??I have driven in Toronto when they had that big blizzard.
b. ??I have been at the racetrack when Numero Uno died.

This constraint is not derived from the *when*-clause itself, since these *when*-clauses are acceptable in a simple past sentence:

(26) a. I drove in Toronto when they had that big blizzard.
b. I was at the racetrack when Numero Uno died.

Rather, it is the combination of the definite *when*-clause with the perfect. The *when*-clause is acting as an adverbial here and is ruled out just like the other types of definite adverbials, by failing to abut *now*. I believe that the examples in (24) are acceptable because the indefinite *when*-clauses can be incorporated into the event type as well as the adverbs above. This raises interesting questions about the difference between an event type and an actual event, or about indefinite versus definite events, and it is not possible to handle them satisfactorily here. What I have done here is to treat any mention of a necessarily unique event or time as definite reference, and potentially ambiguous event descriptions or times as indefinite.

This section has covered what kinds of adverbs can be used with the perfect in general, based on mainly semantic constraints, but also bringing in some world knowledge about uniqueness or repeatability of events. In the next section we will look at further constraints on adverbs, which rely on more intimate pragmatic knowledge about events and the perfect.

3.3. Adverbials and Pragmatics

Something unusual happens when the present perfect is felicitously modified with a temporal adverbial. A presupposition seems to arise in these cases about the expected timeframe for the event. Without modification, the event may have happened anywhere in the past, as long as there is still some effect of it, although there may be an implied recency timeframe. With an adverbial, there has to have been a reason for specifying the timeframe within which the event occurred. The most obvious reason for this would be that the effects of the event can be voided, and we want to indicate that the event took place within a recent enough time that the effects are not yet voided. For instance, a dog should be walked every day, and the effects of walking the dog only last about a day, and then he needs to be walked again. Similarly, bills need to be paid every month, garbage needs to be taken out every few days, and so on. Part of the semantics of the perfect is that the speech time is in the 'consequent state' of the event, to use Moens & Steedman's term. In order to be in the consequent state of an event of dog-walking, we must be in a time less than a day after the event. The only adverbials, then, that will be appropriate for the present perfect with such an event will be ones that specify times of a day or less. For bills it will be a month.

Furthermore, if we have knowledge about where within that cyclic timespan the event typically occurs, that knowledge will also affect adverbial use. Suppose we know that John typically walks his dog every morning. Then we can say (27a) with *today* or *this morning*, but not with *this evening*, EVEN IF JOHN ACTUALLY WALKED HER IN THE EVENING TODAY, RATHER THAN IN THE MORNING. Similarly, we can say (27b) only with an adverb that is not smaller than our expectation time for the event (Katz & Spejewski (1994)). If we don't have particular knowledge about where in the month Kay pays her bills, then we cannot use a timespan smaller than a month.

(27) a. Wade has walked the dog {today/this morning/??this evening}.
b. Has Kay paid her bills {this month/??this week/??today}?

Since the effects of a person being born or dying typically do not get voided, most sentential adverbials modifying a particular birth or death or similar singular event in the perfect will be odd. (28b-d) could be acceptable under unusual conditions, using the intensional reading of *President*, or in a situation where my house frequently blows up, but under normal circumstances they would be strange.

(28) a. Our first child has been born {??today/??this year/ ??recently}.
b. The President has died {??today/??this year/??recently}.
c. Someone has killed the President {??today/??this year/??recently}.
d. My house has blown up {??today}.

The perspective taken in describing an event will affect its appropriateness in the perfect. An event often has a number of different effects, for instance one effect on the agent, another on the patient, and so on. These different perspectives may be considered in determining whether one is in the consequent state of an event. For instance, suppose we have an event of Juan walking Maria's very rambunctious dog. With respect to the dog, the consequent state may last only a day, but for Juan, it may last the rest of his life. The answer to the question *Has Juan walked Maria's dog?* may continue to be yes for far longer than the answer to *Has someone walked Maria's dog?* This is related to the well-known Einstein/Princeton examples, where the effects on Einstein cease to exist when he does.

(29) a. ??Einstein has visited Princeton.
b. Princeton has been visited by Einstein.

3.4. States

States in the perfect are subject to the same adverbial constraints as events in the perfect: up-to-*now* and including-*now* adverbials are fine with states, and definite past adverbials do not work with states, nor do pragmatically-conflicting adverbials.

(30) a. Kent has lived in Prague {*for two years/since 1989*}.
b. The telephone has been ringing *all morning*.
c. I have been very happy {*this week/today/ *yesterday*}.

(31) a. ?The president has been mortally ill *this week.*
b. I have been with Frank *when he lost his temper.* [indefinite]
c. ??I have been with Frank *when Kennedy died.* [definite]

States in the perfect also seem to behave more like events than they do otherwise. Normally, states are considered to surround their reference times. Now if the state surrounds its reference time, and the reference time abuts *now*, then the state must also abut or surround *now*. But in the perfect the state is not required to abut or span *now*:

(32) I have been in the White House (before).

Unlike the simple aspect, the perfect aspect introduces a state with a bounded beginning, and a possibly-bounded end. This makes perfect sense, if the point of using the perfect is to inject the notion of a consequent state: if there is a consequent state, then the trigger has already happened, although states, being homogeneous, could continue on into the future and still have an effect now. Because of this and the adverbial effects, I assume that in the perfect the state is contained in its reference time. This means that the state may be ended by speech time, but it isn't prohibited from continuing on, since we could be talking about a subinterval of the state's duration. However, in using the perfect, the speaker implies a lack of knowledge of whether the state is still true.

The interpretation of states in the perfect involves implicatures based on the containment structure. The state is contained in its reference time,

and the normal interpretation of this is strict containment, so that the state is normally inferred to have ended before *now*, or at least to be of unknown status. Adverbs can interfere with this inference: if an explicit frame adverbial is used, the state is contained within the adverbial time, which may either end at *now* or continue through it, with the state understood to have ended or not, respectively. If an explicit durative adverbial is used, then the state is understood to hold throughout that time, which must abut *now*. This leads to the inference that the state still holds at *now*. (33a) is fine with no adverbial, since Nixon's presidency is over, but (33b) is odd without modification while Clinton is still president, in which case the simple present is sufficient, whereas using the perfect implies that the state no longer holds. Given current history, the (ambiguous) adverbial in (33a) can only be read as framing the event, and in (b) as the duration of the event. (34a) with no adverbial makes no claim that anyone still is a member of the party, but when a durative adverbial is added, it does. If we use a state that is difficult to imagine ending, then its use in a perfect without adverbial modification is very strange, as with (35); for an intrinsic property of an individual, as in (35b), we also can't have it start after the individual came into being, although possibly at that point.

(33) a. Nixon has been president (since 1960). [frame only]
b. Clinton has been president ??(since 1993). [durative only]

(34) Everybody has been a member of the Communist Party (for the last 5 years). [durative]

(35) a. John has liked ice cream ??(since he was a baby).
b. Jackie has been Spanish ??{??since 1990/??for two years/ since the day she was born}.

3.5. Negated Perfects

A negated perfect has different implications from a negated simple past. Katz & Spejewski (1994) point out that (36a) implies that I still have the chance to see the movie, whereas (36b) carries no such implication, and may even imply the reverse.

(36) a. I haven't seen that movie.
b. I didn't see that movie.

This is accounted for under a uniform interpretation of negation by the perfect having two reference times, and the simple past having only one. Event negation can be defined simply as that there is no event of the given type within the reference time introduced by mention of the event. For a simple past, there is a reference time strictly in the past of *now*, and the negation is interpreted as holding throughout the past reference time (37a). For a negated present perfect, illustrated in (37b), the event reference time abuts *now*, and negation will hold throughout that reference time. However, there are two reference times for a perfect, and both are relevant for the interpretation. With the reference time for *now*, which contains *now*, the event has not been negated, except for the part containing R_1. Since reference times are defined as times during which an interpreter believes that is possible for an event to occur, then it is still possible for the event to occur sometime within R_{now}, but only at a time which is after *now*.

(37) (a) R_1 (b) R_{now} $R_1 \asymp now$

$\neg\, e_1$ R_1 now

$\neg\, e_1$

3.6. Other Modifiers

Besides the constraints on temporal adverbials, the perfect seems to shun most kinds of other event modifiers as well, unless the modifier is a particularly relevant part of the event:

(38) a. I have gotten married (??this morning).
b. I have gotten married (??in Tennessee).
c. Jill's baby has been born (?by Caesarean).
d. John has killed the President (?with a hand grenade)!
e. The President has been killed (?with a hand grenade)!

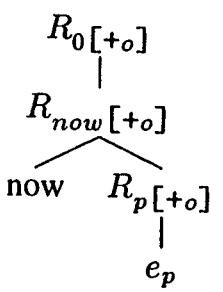
Under normal circumstances an utterance like (38b) would be infelicitous, even if I got married in Tennessee. However, if I have gotten married several different times, and the issue of weddings in Tennessee came up, then it could be felicitous. Similarly, if there were a particular reason, say a prophecy, to associate a hand grenade with the President's killing, then those sentences could be more felicitous.

These examples illustrate a counterpoint to the examples of adverbs incorporated into event types. In those, an adverb like *Sunday* was considered to be part of the event type if it was relevant to the contingency relation. Here, it looks like we want to say that unless a modifier is relevant to contingency, it should not be part of the event type. In these cases, it seems to be the occurrence of the bare event that is relevant, and not its manner of execution, and so the manner adverbials should not be included in the event type. Since most of these modifiers have nowhere else to attach syntactically, they are not felicitous in the utterance.

4. Discourse Predictions of the Analysis

Having looked at a number of sentence-internal issues, we move on to the bigger picture of the use of the perfect in discourse. The constraints on where to attach new events into a temporal discourse structure also hold for the perfect, and this allows us to predict what kinds of sequences we can have in a discourse subsequent to a perfect. Recall that the *reference* nodes along the right frontier are referred to as 'open nodes', and that a new event can only be attached as the daughter of an open node. (Since *now* is not a reference node, the ordering between *now* and R_p doesn't matter.) Suppose we have a discourse in which the most recently incorporated event was in the present perfect. We will then have just added two new reference nodes to the structure, and they will both be on the right frontier, since they will be descendents of a node on the right frontier. Leaving out any previous events, the structure would look like (39), with open nodes marked with '[+o]':

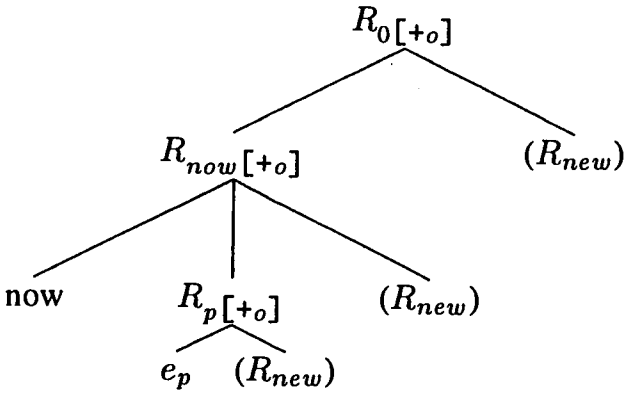
(39)



$R_p \supset\subset now$

From this structure, we can predict what kinds of relations are possible for the next event introduced in the discourse. A new event's reference time must be the daughter of a currently-open node. The diagram below indicates the potential incorporation sites for the new event's reference node:

(40)



$R_p \supset\subset now$

The interpretations for these different positions indicate how the new event is related to the present-perfect event. If the new reference time is a daughter of R_0 (or of any open reference node between R_0 and R_{now}), then the eventuality has been understood as being temporally independent from the eventuality that was introduced in the perfect; i.e. it is not subordinate to it, and it is also not subordinate to *now*. If the new reference time is inserted under R_{now}, then a special claim is being made: that the new event is subordinate to *now*; since I know of no other case of subordination to *now*, this event (probably) must be in the present perfect as well. Finally, if the new node is attached to R_p, then the new event is subordinate to the previous present perfect event, for instance as an event decomposition. An event which is in the present perfect must be attached at either R_{now} or R_p, because it will be subordinate to *now*, and an event which is not in the present perfect must not be attached to R_{now}. It is possible for an event that is attached to R_p not to be in the present perfect, as we see in (41d), because a reference node contained in R_p need not abut *now*. Each of these readings are predicted by the general temporal subordination theory, and below we can see examples of each reading, with the attachment site given after each.

(41) a. The president has insisted on his innocence all along. The committee decided it needed proof. [R_0]
b. Jason has washed the dishes. He has put away the leftovers. [R_{now}]
c. Sandy has prepared a feast for dinner. She has made crepes and souffle. [R_p]
d. Sandy has prepared a feast for dinner. She made crepes and souffle. [R_p]

We can also see a case that is ruled out by the theory: a case in which the second event is subordinate to *now* but overtly sequenced with the first event:

(42) ??Josh has picked up the book. (Then/Next) he has carried it to the table.

Here both the first and the second perfect must introduce a reference time that abuts *now*. If they both abut *now*, then these reference times must thus be in some kind of containment relation with each other. However, the interpretation that the events are sequenced can only be represented by having the reference times be sequenced with each other, and this gives an incompatible set of constraints. This means that no adverbial may modify the second in a sequence of present perfects if it indicates any kind of relation other than containment between the reference times.

Because a present perfect structure contains *now*, there are also constraints on where a new present perfect structure can attach onto an existing discourse structure. It can be a sister to anything, but it can only be the daughter of a reference time that can contain *now*, which means it can only be subordinate to something in the present tense—either a simple present or another present perfect.

(43) a. When he gets/has gotten angry, Sam has put his fist through walls.
b. *When he got angry, Sam has put his fist through walls.

Other, more obvious discourse sequences are ruled out by the meaning of the perfect rather than by discourse principles . For instance, since the present perfect must be used in the consequent state of the event, one cannot subsequently supersede that state:

(44) ??Bill has left for Paris. He is in his office.

5. Summary

Interpreting the English perfect within the theory of temporal subordination accounts for a number of apparent idiosyncrasies of the English perfect as being instead predictable elements of a general theory of temporal relations in discourse. This analysis casts the perfect as a case of temporal subordination,

where subordination forces the reference time of one event to be interpreted within the time introduced by another event or situation. For the present perfect, the event being introduced is subordinate to *now*, which means that the event is understood to occur within a timespan containing *now*, and for the past perfect the event occurs within a timespan introduced by a previous event in the discourse. The unique contribution of the English perfect is that the reference time containing the event must abut *now* or the previously-established time. This constraint appears to be missing in some other languages, even when the perfect seems to require subordination, as with Spanish.

The interpretation of temporal frame adverbials as containing a reference time, along with the perfect's interpretation, account for many constraints on temporal modification of the perfect. A frame adverbial must contain the event and also either contain or abut *now*. Another facet of adverbial constraint is accounted for by the pragmatic nature of reference times as times during which events are expected to occur.

The theory of temporal subordination also predicts what kinds of discourse sequences can occur before or after a perfect, and what kinds of interpretations they can have, based on both linguistic and pragmatic factors.

Elements of other analyses of the perfect fall out directly from the analysis given here. For instance, the two different forms of the 'extended-now' are manifest as the reference time of the event and the reference time for *now*; the idea of 'current relevance' is inherent in the subordination dependency structure between the event and *now*; Klein's p-definiteness constraint falls out from the containment relation between the two reference times; and the Reichenbachian **E, S,** and **R** are present as *e*, *now*, and R_1.

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