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PROSODY AND SEGMENTAL EFFECT
SOME PATHS OF EVOLUTION FOR WORD STRESS

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ABSTRACT

This study reports on a significant negative association found in a cross-linguistic sample between the degree of predictability of word stress from a word boundary and the extent to which stress has segmental effects. In other words, in a given language the less predictable stress is from the word boundary, the more likely that the language will have vowel reduction in unstressed syllables, vowel lengthening in stressed syllables, and consonantal changes restricted to stressed or unstressed syllables. These findings are interpreted as part of a major diachronic tendency for stressed and unstressed syllables to become more differentiated in terms of duration as a cumulative effect of phonetic change, which in turn leads to the deletion of unstressed syllables, which renders stress unpredictable in some cases. A model of phonological representation that best accounts for the unidirectionality of this strong tendency is one in which stress, even while it is still predictable, is considered an inherent part of the word, and phonetic changes have a permanent and cumulative effect on lexical representation.

1. Prosodic types

A full prosodic typology of the languages of the world will be a complex matter, with several parameters interacting. The first major distinction might be between tone and stress languages, where two factors distinguish the polar types: (i) in tone systems, pitch is the primary or only phonetic variable, while in stress systems a combination of pitch, intensity and duration characterize the prominent syllable; (ii) in tone languages there are typically few restrictions on the combination of tones within a word, or

on the number of high tones per word, while in typical stress languages there is only one, or a maximum of two, prominent syllables per word.

Within these two major types — tone and stress — a number of other distinctions can be made. Our discussion will be focused on stress and on two major classificatory distinctions that can be made among stress languages: the first is between demarcative stress and morphologized and/or lexical stress. By demarcative we mean stress reckoned from either the beginning or end of a word in a regular way, that is, lacking or having very few surface exceptions. By morphological or lexical stress we mean stress patterns that are idiosyncratic and require lexical representation, or stress which is predictable only at an abstract level or with the mention of morphological categories or boundaries.

The second parameter that is of interest in this paper concerns segmental processes conditioned by stress, that is, processes such as vowel reduction in unstressed syllables, vowel lengthening in stressed syllables and consonantal changes conditioned by stress or the lack of it. These processes have the effect of producing an asymmetry between stressed and unstressed syllables, which in turn produces certain rhythmic effects. One possible interpretation of this parameter is in terms of the distinction between syllable-timed and stress-timed languages: languages which have segmental processes that differentiate stressed and unstressed syllables are also those that have been categorized as stress-timed languages, while those lacking such processes are regarded as syllable-timed.

We hypothesized and found support in a cross-linguistic sample for an association between these two parameters: the predictability of stress and segmental effects, which we understand as a diachronic tendency in the way demarcative stress develops over time. In particular, we present evidence that the loss of predictability of demarcative stress and an increasing segmental effect of stress or stresslessness develop together over time. We argue that the growing segmental effect of stress which is the result of the development of duration as a correlate of stress eventually leads to the loss of predictable demarcative stress.

2. Diachronic scenario: From intonation to word stress.

Just as there are multiple grammaticization paths of any given grammatical category (such as future, past, etc.) so there are several paths by which

stress may develop. Proposals in the literature for which there seems to be some evidence include the development of stress from a pitch accent system, the development of stress from a rhythmic regularity, such as lengthening the penultimate syllable, and the development of stress from intonational patterns. It is the latter source that gives rise to our hypothesis about the relation between predictability of stress and segmental processes, so that is the path that will be outlined here. The other possibilities will be discussed again later in the paper.

Hyman (1977) argues that lexical or unpredictable stress develops diachronically from grammatical stress — morphological or demarcative — and further proposes that demarcative stress derives from the grammaticization of intonation patterns. The diachronic scenario that we propose takes demarcative stress to be the source of both morphological and lexical stress in most cases.[1] Our diachronic proposal, then, is based on and extends Hyman's. In the following we outline some of the main points he makes.

Using a large cross-linguistic sample of more than four hundred languages, Hyman investigated the relative frequency of the position of demarcative stress. Three hundred of the languages he investigated had a dominant demarcative stress pattern and the number of languages with main stress on the initial, second, penultimate and ultimate syllables are given in Table 1. Table 1 also shows the distribution of demarcative stress types in the sample we used, the Gramcats sample (Bybee, Perkins and Pagliuca 1994). Our sample is much smaller than Hyman's, consisting of seventy-six languages, with twenty-six having regular demarcative stress, but it has been constructed so that each case is relatively independent of every other case. In other words, Hyman's sample contains many languages that are closely related to one another, e.g. twenty-one Turkic languages and thirteen Mayan languages which all have final stress, while our sample controls for genetic bias and includes, e.g. only one Turkic language and only one Mayan language. Despite these sampling differences, the relative distribution of the types is similar in the two samples. The issue that concerns Hyman the most — the asymmetry between second-syllable stress, which is quite rare, and penultimate stress, which is quite common — is raised by the data in both samples.

Hyman notes that demarcative stress is most effective as an identifier of word boundaries if it falls close to the boundary from which it is predicted.[2] Thus it is to be expected that initial and final stress would be common, that antepenultimate stress placement would be found in only a few languages in his sample, and that stress on the third syllable of the word is not found at

Table 1: The position of demarcative stress in two samples

dominant stress	number of languages Hyman's sample		Gramcats	
initial	114	38%	11	42%
second-syllable	12	4%	2	8%
penultimate	77	26%	9	35%
final	97	32%	4	15%

all. The most puzzling fact from this point of view is the high frequency of penultimate stress in the languages of the world, especially in view of the fact that this high frequency is not mirrored in the distribution of second-syllable stress.

Hyman seeks an explanation for these facts in the way that word stress arises in the languages of the world. A language without a word stress pattern which is also not a tone language will nonetheless have intonation contours and perhaps an alternating stress that is determined from utterance boundaries.[3] A language with pitch accent or tone may have intonation contours that are partially independent of the word-level prosodic system. Hyman proposes that word stress develops when intonation patterns that have the utterance as their domain are reinterpreted as having the word as their domain. Thus demarcative stress results from what Hyman calls the "grammaticization" of intonation.

Cross-linguistically the prominent pitch change for normal statement intonation tends to be a high-low pattern at the end of the phrase, and in some languages there is also a higher pitch at the beginning of utterances (Bolinger 1978). Utterance-initial high pitch can be reanalyzed as word-initial stress. The final high-low pattern can be distributed over the final syllable of a word, yielding final stress, but if it is distributed over the last two syllables of a word, penultimate stress results. Since final intonation usually involves both a rise and a fall, but the initial pitch is level, the final intonation contour can be naturally positioned over two syllables, with the pitch rise on the penultimate, but initial intonation has no way of assigning prominence to the second syllable.[4]

How does this "grammaticization" of intonation occur? Hyman refers to the process as grammaticization because he views demarcative stress as grammatical. Our view is that the process by which intonation attains the status of word-level stress is a process of lexicalization. The stored memory

representation of a word is a cluster of tokens of the word as actually used, weighted for frequency (Miller 1994, a proposal compatible with the maximally redundant representations of Bybee 1985, 1988 and Langacker 1987). Since phonetic details are not abstracted away, it is possible that pitch and rhythmic properties of tokens are also represented. If a particular prosodic pattern for a word is particularly frequent, that pattern could become dominant in the representation of the word. If the prosodic pattern for many words mirrored the utterance-initial or utterance-final intonation, that intonational pattern could spread to the representation of other words, creating a regular demarcative stress pattern based on the initial or final intonation pattern.

This proposal is quite speculative, but it does provide a possible source for demarcative stress, which moreover, provides an explanation for the frequency of initial, final and penultimate stress.

3. From demarcative to morphological or lexical stress.

Hyman (1977) also argues that demarcative stress is the source of lexical stress; we argue in addition that demarcative stress is the source of morphological stress. Consider first the properties of a language with regular demarcative stress, such as Turkish (Lewis 1967). Almost all words have final stress, even though this means a different suffix is stressed according to the morphological formation:

(1) *odá*
'room'
odadá
'in the room'
odadakí
'that which is in the room'
odadakilér
'those who are in the room'

The stress in Turkish is based on the final word boundary and is completely independent of the internal morphological composition of the word. Lexical and morphological exceptions are few.

Compare now Spanish, where a relatively general penultimate stress pattern is overridden in certain morphological categories, yielding cases where stress differentiates one morphological category from another:

(2)

cánto	*cantó*
sing:1SG:PRES:IND	sing:3SG:PRET:IND
cánte	*canté*
sing:1&3SG:PRES:SUBJ	sing:1SG:PRET:IND

Morphologized stress is typical of Spanish verbal paradigms, but there are also some cases of morphological and lexical stress among nouns and adjectives.

Latin stress was demarcative and predictable in all word classes. The penultimate syllable carried the main stress unless it was an open syllable with a short vowel (a light syllable) in which case the antepenultimate was stressed. The stress position, then, depended upon the phonemic vowel length contrast. In the development of the Romance languages, this vowel length contrast changed from having pure duration as its correlate, to being manifested as a difference in vowel height. This change reduced the predictability of the Latin pattern. Also, the loss of vowels following the stressed syllable has further obscured the original pattern, as shown in (3):

(3)

Latin	Spanish
pópulus 'people'	*puéblo*
amáre 'to love'	*amár*
civitátis 'city'	*ciudád*

The most important point to observe about the difference between Latin and Romance languages such as Spanish, is that in almost all cases, the stress is on the same syllable in Spanish as it was in Latin, even though syllables have been lost in the evolution to Spanish. Thus despite the changing segmental properties of the word, the stress strongly adheres to the syllable it has always occupied. In particular, note that when final vowels are lost, stress does not shift back one syllable to the penultimate position. Rather, the loss of the vowel renders the stress less predictable.

In contrast to these examples, however, stress shift did occur under morphological conditions in the verbs, indicating a shift from demarcative stress to morphological stress in verbs.[5]

(4) *cantar* 'to sing'. Imperfect:

	Old Spanish	Modern Spanish
1SG	*cantába*	*cantába*
2SG	*cantábas*	*cantábas*
3SG	*cantába*	*cantába*
1PL	*cantàbámos*	*cantábamos*
2PL	*cantabáis*	*cantábais*
3PL	*cantában*	*cantában*

Note that in the Old Spanish paradigm, the stress is as inherited from Latin — completely penultimate. There is strong support of a penultimate pattern throughout the history of Spanish, so a shift in the first and second persons plural of the Imperfective from the penultimate to the antepenultimate syllable demonstrates quite conclusively that stress had been morphologized in verbs by this time (Hooper 1976). Based on the more frequent singular forms and the third person plural, a generalization can be made that in the Imperfect the stress falls on the first vowel after the stem. In other words the base for this aspect is *cantába,* with the stress considered an inherent part of the aspectual form. The less frequent first and second plural forms are remade on the basis of this form, with the stress remaining as it is in the base (Bybee 1985).

Further evidence that stress is not predictable or demarcative in Spanish anymore comes from a study by Aske (1990). Aske estimates that among Spanish nouns and adjectives, stress is 95% predictable; that is, 95% of Spanish nouns and adjectives follow the rule that words ending in vowels are stressed on the penultimate syllable, while words ending in consonants are stressed on the last syllable. Despite this high degree of predictability, Aske found significant effects of lexical schemas when asking subjects to pronounce novel words fitting two phonological profiles.

First, words ending in *-en,* such as *orígen, imágen, abdómen.* In this group, 62% of familiar words have penultimate stress and 38% have final stress. Words ending in other V's + *n* overwhelmingly have final stress. Aske had his subjects read sentences in which novel words were placed in noun and adjective positions, and he recorded the stress placement the subjects supplied for these "words". The subjects gave words ending in *-en* final stress 55.6% of the time and penultimate stress in 43.5% of the cases, even though they gave words ending in other vowels plus *-n* final stress 96.8% of the time. The results show that the most general pattern for stress

in nouns and adjectives is not always the productive one, rather there are local generalizations or low-level schemas that can take precedence over the more abstract generalizations (Langacker 1995). Such lexical effects can only occur if stress is included in the lexical representation of Spanish words.

The second case tested by Aske was based on words ending in *-ico* and *-ica*, which overwhelmingly have antepenultimate stress: *república, crónica, música,* going against the general pattern, which predicts penultimate stress for words ending in vowels. Aske's subjects gave 83.3% antepenultimate stress for adjectives and 63.4% for nouns ending in *-ico* or *-ica*. Again, a local generalization with a very specific phonological profile overrides the more general pattern, showing the degree of lexicalization of Spanish word stress.

The modern Germanic languages tend to have stem-initial stress. This stress pattern may have derived from a demarcative pattern in which the first syllable of the word was stressed. With the addition of prefixes to stems, the original demarcative pattern was obscured, and, not being productive, did not shift stress onto the prefix. Thus we regard stem-initial stress, no matter how regular, as not being demarcative, since it is influenced by lexical and morphological factors.

4. The diachronic hypothesis

Specific diachronic developments, particularly in Romance languages, suggest a trend by which demarcative stress becomes lexicalized and morphologized, that is, loses its predictability. Our hypothesis is that the loss of predictability results from the gradual development of segmental effects associated with stress — vowel reduction in unstressed syllables, vowel lengthening or diphthongization in stressed syllables, and consonantal changes. Even small phonetic differentiations between stressed and unstressed syllables render the stress more entrenched on a particular syllable, and less likely to change if conditions in the word change, such as by the addition of a suffix.

The basic hypothesis that we will test proposes this relation between segmental effects and the loss of predictability of stress. We propose in addition that these particular observable segmental effects are the result of the development of duration and magnitude of gesture as correlates of stress, since pitch and intensity, which are the correlates of stress that derives from

intonation, are much less likely to produce segmental effects. The diachronic scenario we propose is that syllable prominence that is realized by high pitch comes gradually to be accompanied by the increased magnitude of the gestures comprising that syllable. In languages such as Modern English, with many segmental processes conditioned by the position of stress, it has been shown that gestures producing stressed syllables are larger than those producing unstressed syllables (Browman and Goldstein 1992) and that the effect of stress on, for example, aspiration can be traced to the greater magnitude of the glottal opening gesture in stressed syllables. But even in languages where pitch is the primary correlate of prominence, e.g. Japanese, under emphatic phrasal accent, an increase in syllable duration has been observed (Beckman and Pierrehumbert 1986). Thus we propose that there is a tendency to gradually increase the magnitude and duration of the gestures in prominent syllables, leading eventually to a regular relation between magnitude of gesture and the position of prominence (stress), which in turn leads to segmental effects.

Using the Romance languages, and in particular Spanish, as our example once again, we find cases of segmental processes conditioned by stress. A vowel quantity system that was independent of stress is replaced by a vowel quality system that is sensitive to stress. Vowel reduction in unstressed syllables occurs in the form of the neutralization of *ĭ* and *ŭ* with *ē* and *ō* respectively. Certain unstressed vowels were deleted altogether (see examples in (3)). Short mid vowels, *ĕ* and *ŏ* diphthongized under stress (Latin *mĕntis* becomes Spanish *miente* 'mind' and *pŏpulus* becomes *pueblo* 'people').

Similar changes have occurred in Germanic languages, such as English. With the breakdown of a vowel quantity system that was independent of stress, massive vowel reduction and deletion in unstressed syllables has occurred, along with the lengthening of stressed syllables, which resulted in the series of diphthongizations of tense vowels in Early Modern English that is described as The Great Vowel Shift. Parallel changes are observable in German and Dutch. American English also manifests consonantal changes conditioned by stress. The most salient of these is the flapping of /t/ and /d/ after a stressed vowel and before a syllabic, but actually many English consonants undergo minor permutations in this context (Hoard 1971; Kahn 1976).

Our claim, then, is that such segmental changes render stress unpredictable by two means. First, the increasing segmental differentiation of stressed and unstressed syllables makes moving the stress (to retain predictability) more difficult because the resultant deformation of the syllables creates

changes other than just a change in the position of stress. Then when affixes are added to words, the stress may not shift to accommodate the changed positional status of the syllables of the word. Second, the deletion of unstressed syllables, in particular, those after the stress in languages with penultimate stress, renders the stress position less predictable. Under these conditions, stress may become associated with certain morphological formations more than with word boundaries, and it may become associated with particular lexical items.

As the stress remains on the same syllable in a word over time, the effects of stress accumulate in the lexical representation. The rhythmic and prosodic characteristics of the language gradually change because the shapes of words have changed. Stress becomes more and more associated with a particular syllable of the word and does not change even if the number of syllables in the word changes. Thus unpredictable stress develops *because* stress has affected the segmental structure of the word. The segmental effects of stress will begin to appear while the stress pattern is still largely predictable.

5. Other diachronic possibilities

In the next section we will formulate a synchronic hypothesis to test on a cross-linguistic sample, but before moving on to that point, we need to mention some alternative diachronic scenarios, because the sequence of developments we have been discussing are not always completely linear. A non-exhaustive list of some alternatives follows:

One possibility is that a language can change from one demarcative stress pattern to another. Hyman (1977) attributes this type of change to the tendency of heavy syllables to attract stress. A regular demarcative system may be altered when the stress shifts off a light syllable and on to an adjacent heavy one. This may account for the shift from word initial stress in Proto-Italic and Umbrian to (ante)penultimate stress in Classical Latin. Word-initial stress, viewed from the end of the word, is equivalent to penultimate stress in words of two syllables and to antepenultimate stress in words of three syllables (*réficit* 'repair', *réfectus* 'repaired'). If, in such words, the initial stress is attracted on to the second syllable when it is heavy, penultimate stress results (*réfectus* becomes *refĕctus* 'repaired'). Four-syllable words with the first three syllables short were the last to change,

according to Kent (1940:66), who reports that in Plautus an initial accent remained in *fácilius, séquiminī, céciderō, múlierem*, etc. Changes in these words would follow the generalization that stress is reckoned from the end of the word rather than from the beginning. Hyman proposes a similar reinterpretation for Altaic languages which show both initial and final stress. We propose, however, that such shifts in demarcative stress are possible only if stress has not yet begun to affect the segments of the word. They take place at a stage in which the length of a syllable can affect the placement of the stress; they are no longer possible when the position of stress affects the duration of syllables.

A second possibility is that a language with pitch accent or tone can develop an independent system of demarcative stress and lose its pitch accent or tone system. A pitch accent system is one in which pitch is the primary correlate of prominence and there are significant constraints on the pitch patterns for words, usually tending towards a high-falling pattern in each word in the languages we have examined. We would also classify as pitch accent systems those in which pitch contrasts may be found in accented or unaccented syllables. The Slavic languages apparently descended from a common language that had a pitch accent system. In some of these, for instance, Polish, Czech and Slovak, a regular demarcative stress has developed and replaced the pitch accent system (see Section 9). Similarly, some Bantu languages with tone (e.g. Mwera and Setswana) have a lengthened penultimate syllable which can be interpreted as a stressed syllable if the system of tonal contrasts gradually erodes (cf. Harries' 1950 description of Mwera).

Third, a pitch accent system can move directly into a stress accent system by the loss of tonal contrasts and the development of correlates of prominence other than pitch. Since the location of the prominent syllable in a word in a pitch accent system is not usually predictable, a change from pitch accent to stress accent will lead to an unpredictable stress (e.g. as in Russian, see Section 9). Clements and Goldsmith 1984 report a similar development for stress from tone in some Bantu languages.

A language that develops stress from any of these sources will begin to show segmental effects of stress if duration and magnitude of gesture are the correlates of stress. In a regular demarcative system these segmental changes will lead to the development of exceptions to the demarcative rule.

6. The synchronic hypothesis

One way of testing a diachronic hypothesis is to look for the synchronic patterns predicted by the hypothesis across a large number of languages. Our diachronic hypothesis predicts that there will be a significant association of segmental effects of stress and lack of predictability of stress from word boundaries. We outline now the way we proceeded to test this hypothesis on a cross-linguistic database.

As a database, we used a sample of languages assembled for a cross-linguistic study of grammaticization patterns (Bybee, Perkins and Pagliuca 1994). The seventy-six languages of this sample, the Gramcats sample, were selected randomly within genetic groups, as established by Voegelin and Voegelin (1978). Access to information about these languages came through reference grammars and scholarly articles describing the languages. Since the languages and associated written materials were originally selected for a morphological study, for some of the languages we did not have adequate information about phonological properties. In those cases we substituted a closely related language, or, in some cases we were forced to simply omit certain languages. See Appendix A for a list of the languages included in the study, as well as comments on omissions and substitutions.

For a broad cross-linguistic study it is appropriate to use written reference material, but it should be recognized that there are limitations on what can be learned, and there exist various sources of error. We found, however, that enough information was available on the sample languages to test our hypothesis. First, most linguistic descriptions are reliable in designating the prosodic type of a language as using stress or tone or both. Second, most descriptions include statements concerning whether or not stress is predictable, and if so, what the rules for stress assignment are. Third, most descriptions lay out phonetic and phonological alternations in some detail, so that it is possible to determine if segmental processes are affected by the position of stress. However, very few descriptions mention whether the phonetic correlates of stress are pitch, duration or loudness. While it is an important part of our hypothesis that an increasing use of duration as a correlate of stress leads to the loss of predictability of stress, we could not test this hypothesis directly. Instead, we must infer from the lengthening of stressed vowels and the reduction of unstressed ones that duration is an important correlate of stress.

The coded information that we will report on here can be divided into three parts:

(1) *Stress vs. Tone.* First, it was necessary to distinguish languages that use stress from those that use tone. From this point on, languages that use tonal contrasts were excluded from the study, since they are not relevant to the hypothesis.

It is well known, however, that languages do not divide neatly into those that use stress and those that use tone. Thus it is necessary to clarify further where we draw the line between languages to be included in the study and those to be excluded. First are languages that are described as tone languages and make no use of stress. Second, we found languages that are described as having phonemic tone and phonemic stress with no significant interaction between the two (Tucano, Sorensen 1969). Third, there are languages with phonemic tone and a predictable, demarcative stress (Mwera, Harries 1950). Fourth, there are languages that are described as having both pitch and stress that interact in a very constrained way, but that do have pitch contrasts in stressed or unstressed syllables (Jivaro, Turner 1958; Karok, Bright 1957). All of these types of languages are excluded from the study on the grounds that they use pitch contrastively and so could not develop demarcative stress from intonational pitch patterns.

While the last of these types might be classified as "pitch accent" languages, we do include in the study other languages that might also be called "pitch accent", specifically those that use pitch as a correlate of stress, but do not have pitch contrasts in stressed or unstressed syllables. It is necessary to include these in the study, since our hypothesis is that languages which have pitch as the sole correlate of stress do not have segmental changes conditioned by stress. Thus we predict that these latter "pitch accent" languages will not have segmental changes. Using these criteria, forty-two languages were included in the study.

(2) *Predictability of stress.* Our hypothesis concerns the surface predictability of stress from a word boundary, which we will refer to simply as "predictability", a matter that is usually reported in reference grammars for languages that have it. Since we assume that there are varying degrees of predictability, and since our hypothesis concerns the gradual loss of predictability, we distinguished four degrees along a scale of predictability:

1. stress is unpredictable
2. stress is unpredictable though a few patterns are discernible
3. stress is predictable but there are exceptions
4. stress is totally predictable with no exceptions

Of course, any such division is arbitrary, and decisions about what category a language belongs in is heavily dependent upon the way predictability and exceptions were described in the reference material. One reason for using a large number of languages is to minimize the impact of such sources of error in the data.

The number of languages coded in each of these four categories is shown in Table 2. We also noted whether or not the language made morphological use of stress, which would be relevant in categories 1 and 2. For categories 3 and 4 we noted the position of stress in the word, and the results for these categories are reported in Table 1 above.

Table 2: *Number of languages coded for each degree of predictability of stress from a word boundary*

predictable	4	3	2	1	unpredictable
	7	19	7	9	

(3) *Segmental effects.* In principle, any segmental effect associated with stress is of interest to our study, but we did begin with certain expectations based on what is generally known about the effects of stress on vowels and consonants. In particular, we expected to find vowel reduction in unstressed syllables, vowel lengthening and diphthongization in stressed syllables, and some consonant changes, though their exact nature was more difficult to predict.

Vowel reduction. We looked in general for processes affecting vowels in unstressed syllables or a subset of unstressed syllables, such as final unstressed syllables, and counted as reduction any process that neutralizes contrasts in unstressed syllables, or any process that centralizes, unrounds or shortens vowels. It is known also that reduction can involve raising (as in Brazilian Portuguese). We also counted deletion as reduction.[6]

Vowel lengthening. We expected to find languages with lengthening of stressed vowels.

Diphthongization. Based on knowledge of sound changes in Germanic and Romance languages, we expected to find languages with diphthongization of vowels in stressed syllables. No clear cases emerged in the sample, however, probably because of a lack of historical information. The simple presence of diphthongs in the language could not reasonably be interpreted as due to the diphthongization of simple vowels.

Consonant changes. We hypothesized that consonant changes conditioned by stress or the lack of it could include lengthening, spirantization, sonorization, and many other possible changes.

7. Segmental changes and predictability of stress

Our hypothesis predicts that we will find segmental processes conditioned by the position of stress in languages with unpredictable stress and a lack of such processes in languages with predictable stress. We are not expecting to find a strict categorical association, but rather a statistical one because we recognize that there are certain factors that will detract from a categorical association. These factors can create situations that detract from the associations we seek in both of the possible directions:

First, we expect there will be some languages that still have predictable stress despite having developed segmental correlates of stress. The reason for this is that the segmental changes due to stress are what eventually create exceptions to predictability; therefore, the segmental changes should be observable prior to the development of unpredictability. In some cases, a high level of segmental change due to stress may occur without the development of unpredictability because the language type provides no source for exceptions. For instance, if stress is word-initial, deletion of unstressed vowels will not disturb the predictability of stress. If, further, the language is suffixing, morphological change will also fail to disturb the predictability of stress.

Second, there will be cases in which stress is unpredictable but no segmental changes have occurred. This situation will occur when a pitch accent has been converted to a stress accent. If pitch continues to be the main correlate of accent, no segmental processes will accrue. And even where duration and magnitude of gesture are developing as the correlate of stress, it will take some time before segmental changes become salient

enough to be noted in descriptions of the language.

Given the synchronic nature of the database, it is not possible to systematically rule out all sources of error. Thus we seek a statistical association, not an absolute one.

7.1 *Vowel reduction*

The data indicate that vowel reduction conditioned by suprasegmental phenomena (as opposed to reduction/assimilation processes triggered by segmental material) overwhelmingly occurs in languages with stress systems versus those with phonemic tone systems. In fact, the most common phonological process conditioned by stress (or, in this case, the lack of it) is vowel reduction. Vowel reduction in unstressed syllables was reported in twenty-one of the stress languages of the sample.

Table 3: Vowel reduction in languages with predictable vs. unpredictable stress

predictable	4	3	2	1	unpredictable
	2/7	6/19	7/7	6/9	
	29%	32%	100%	67%	

Pearson χ = 11.865, (DF = 3), p = .008 p < .01

Among the languages with the most unpredictable stress, three do not have vowel reduction reported. These three languages are all reported as having pitch as the correlate of stress. They are: Basque (Bizkaiera and Gipuzkera dialects), Chacobo (Andean-Equatorial) and Tojolabal (Mayan). Where pitch is the main correlate of the accent, vowel reduction is not expected, since according to our hypothesis, segmental effects are expected where duration has become a correlate of stress. We hypothesize that in these languages unpredictable accent has developed out of a system of contrastive pitch, rather than from a demarcative stress (see the discussion of Slavic in Section 9).

The results as reported in Table 3 support the hypothesis that vowel reduction and unpredictable stress develop together. These same facts can be expressed as a cross-tabulation, as in Table 4, where "predictable" includes those languages classified as 3 and 4, and unpredictable includes those classified as 1 and 2 on the predictability scale.

Table 4: Relation between predictability of stress and vowel reduction

	Predictable	Unpredictable
Vowel reduction	8/26 31%	13/16 81%
No vowel reduction	18/26 69%	3/16 19%

Pearson χ = 10.096, (df = 1), p = .002
Continuity Correction x = 8.178, p = .004 p < .01

The results as reported in Tables 3 and 4 are highly significant. Implicational universals are often reported in tables such as Table 4, but in this case there is not a single, unidirectional implication, say, "unpredictable stress implies vowel reduction" because the opposite relation is also supported by the data: "vowel reduction implies unpredictable stress." The causal relation we are proposing is that segmental effects of stress, such as vowel reduction in unstressed syllables, make it more difficult for stress to shift to remain predictable. Since this condition may exist before any overt signs of loss of predictability emerge, we fully expect to have cases in which stress appears predictable, but segmental changes are already in progress.

Dividing the languages as in Table 4, into "predictable" and "unpredictable" stress, we can make further generalizations about stress and vowel reduction in these languages. For the thirteen languages with unpredictable stress and vowel reduction, it appears that generally all phonemic vowels undergo reduction in the appropriate environment. The exceptions are Abkhaz, where the analysis includes only two phonemic vowels, /a, ə/, and only /a/ reduces, Tigre, where all vowels except /a/ reduce because this vowel has contrastive length, and Nimboran, which has only limited vowel reduction. In contrast with this situation, only three of the eight languages with vowel reduction and predictable stress have all vowels undergoing reduction (Rukai, Norwegian, Buriat). In the other five languages only a subset of vowels reduce: for two languages (Gugada, Alyawarra) only short vowels reduce; in Nakanai, high vowels are affected; in Tohono O'odham, only back vowels reduce; and in Uigur, only the broad vowels /a, ä/ reduce (raise), even though there are seven other vowel phonemes in this language (Nadzhip 1971:47). These facts are consistent with the diachronic hypothesis that the differentiation of stressed and unstressed syllables occurs gradually over time, as the stress pattern also becomes less predictable. It further

suggests that vowel reduction begins or is more apparent at first in a subset of the vowel inventory.

In addition, there are marked differences in the features involved in vowel reduction in the languages with predictable vs. unpredictable stress.

Table 5: *Number of mentions of phonetic processes involved in vowel reduction in languages with predictable vs. unpredictable stress*

Process	Predictable stress	Unpredictable stress
Deletion	4	7
Laxing/weakening	4	5
Centralization	3	6
Shortening	1	4
Devoicing	1	1
Lowering	0	2
Raising	1	0

Several aspects of Table 5 are consistent with our hypothesis.[7] The most often reported correlate for reduction in languages with predictable stress is laxing or weakening, a description that we would expect where a phonetic reduction has not progressed very far. Centralization, or reduction to schwa, is also reported in this group of languages. These same processes are also reported for the languages with unpredictable stress, and in addition, shortening is often mentioned. An interesting difference between the languages with predictable stress and those with unpredictable stress is that shortening appears to be a much more noticeable property of unstressed syllables in the latter type. This observation is expected under our hypothesis that duration is an important correlate of stress in languages in which demarcative stress has become unpredictable.

7.2 *Vowel lengthening*

A growing asymmetry between stressed and unstressed syllables should be reflected not just in the reduction and shortening of vowels in unstressed syllables, but also in the lengthening and perhaps diphthongization of vowels in stressed syllables. Thus we predict a relation between the unpredictability of stress and the presence of lengthening phenomena in stressed syllables. We consider vowel lengthening first.

Table 6: *Vowel lengthening in languages with predictable and unpredictable stress*

predictable	4	3	2	1	unpredictable
	0/7	2/19	4/7	2/9	
	0%	11%	57%	22%	

Pearson $\chi = 9.189$, (df = 3), $p = .027$ $p < .05$

Table 6 shows that in our sample vowel lengthening has been reported in languages with some degree of unpredictability of stress and it does not occur at all in the languages with the most predictable stress. While our hypothesis predicts that vowel lengthening should be more frequent in languages with less predictable stress (the languages under 1) than in the next category up (2), in fact it appears that the lowest degree of predictability has given us a heterogeneous grouping. As we mentioned above, Category 1 includes languages which have unpredictable stress with pitch as a correlate (apparently having developed from a tonal or pitch accent system), in addition to languages whose unpredictable stress has developed in the way outlined here. Despite this, the associations in Tables 6 and 7 are statistically significant.

Table 7: Relation between predictability of stress and vowel lengthening

	Predictable	Unpredictable
Vowel lengthening	2/26 8%	6/16 37%
No vowel lengthening	24/26 92%	10/16 63%

Pearson $\chi = 5.707$, (df = 1), $p = .0169$
Continuity Correction $\chi = 3.938$, $p = .048$ $p < .05$
Fisher's Exact Test (one-tailed) $p = .0247$

Expressed as in Table 7, our data show that vowel lengthening in stressed syllables is a rarely reported phenomenon, much rarer than vowel reduction, as indeed, all phonetic reduction is in general more common than strengthening. This fact suggests an implicational generalization, that languages with vowel lengthening also have vowel reduction, a generalization that does, in fact, hold in our data:

Implicational universal I

The presence of vowel lengthening in stressed syllables implies the presence of vowel reduction in unstressed syllables.

The synchronic implication suggests a diachronic hypothesis: that noticeable vowel reduction occurs before noticeable vowel lengthening.

As mentioned above, we also expected to find reports of the change of a stressed simple vowel into a diphthong in languages with unpredictable stress. The basis for this expectation is the presence of diphthongization as a diachronic process in European languages developing unpredictable stress: Spanish and French diphthongized stressed mid vowels that were lax (formerly short Latin vowels); English, Dutch and German have diphthongized high, tense vowels in stressed position. We regard this not so much as a lengthening process in itself, but more the result of a lengthening process: as steady-state vowels are drawn out in stressed position, their quality does not remain even, but rather the different gestures involved in producing the particular quality may change their timing relations.

In our examination of the forty-two languages included in this study, we did not, however, find evidence of diphthongization processes. Apparently the process is not common. Given how few the reports of vowel lengthening were, if diphthongization is the result of lengthening, then, diphthongization must also be uncommon. Moreover, the fact that our materials were largely synchronic means that we could not tell if diphthongs present in a language were the result of diphthongization in stressed syllables, or had arisen in some other way. However, in our survey of Slavic languages, we did find diphthongization reported for mid vowels in Russian and in northern dialects of Ukrainian, both languages with unpredictable stress (see Section 9).

7.3 *Consonant changes*

While the knowledge that unstressed vowels tend to reduce and stressed ones tend to lengthen is an established part of common understanding of the interaction of vowels with stress, there is no such generally-agreed upon pattern for the interaction of stress and stresslessness with consonants. Part of the reason for this is presumably that consonant changes conditioned by stress are less common than vowel changes conditioned by stress. In addition, the exponents of pitch, length and loudness are primarily realized on the vowel and thus have less noticeable effects on surrounding consonants.

However, consonantal effects do occur and we have attempted to categorize the ones we have found. Since our hypothesis that stress affects segments when one of the correlates of stress is duration, we will try to understand the consonantal processes we have encountered in terms of magnitude and duration of gestures and the timing relations among them.

First, consider the consonant changes we found in our sample of forty-two languages, distributed according to the degree of predictability of stress, as shown in Tables 8 and 9. Note that the distributions shown in the tables are not statistically significant, due to the low numbers of reported consonant changes and their fairly even distribution in categories 1, 2 and 3.

Table 8: *Consonant changes in languages with predictable and unpredictable stress*

predictable	4	3	2	1	unpredictable
	0/7	2/19	3/7	2/9	
	0%	11%	43%	22%	
Pearson $\chi = 5.573$, (df = 3), p = .134					p > .05

Table 9: Relation between predictability of stress and consonant changes

	Predictable stress		Unpredictable stress	
consonant changes	2/26	8%	5/16	31%
no consonant changes	24/26	92%	11/16	69%
Pearson $\chi = 3.958$, (df = 1), p = .047				
Continuity Correction $\chi = 2.443$, p = 1.18			p > .05	
Fisher's Exact Test (one-tailed) p = .061				

The numbers and percentages in Tables 8 and 9 are similar to those found in Tables 6 and 7 respectively, but only two languages — Maithili and Tigre — in the unpredictable category have both vowel lengthening and consonant changes. In the predictable category, 3, however, the languages are the same: out of the nineteen languages classified as having fairly predictable stress, only two, Tohono O'odham and Norwegian, have vowel lengthening and consonant changes conditioned by stress.[8] In the class of unpredictable stress, nine different languages have either vowel lengthening

or consonant changes or both (see Appendix B).

Our data also indicate a clear implicational relation between vowel reduction and the consonantal changes. Vowel reduction is the most common type of stress-related phenomenon and clearly precedes both vowel lengthening and consonant changes conditioned by stress. Thus in addition to the implicational generalization formulated above, we have the following:

Implicational universal II
The presence of consonant changes conditioned by stress in a language implies the presence of vowel reduction in unstressed syllables.

Because only seven cases of consonant changes conditioned by stress emerged in the Gramcats sample of languages, we were not able to learn much about the nature of such changes from that systematic sample. To supplement it, we examined a convenience sample — that is, all the consonantal changes conditioned by stress in any language that we could get information about.[9] Even expanding the corpus in this open-ended way did not yield many cases of consonant changes conditioned by stress, forcing us to conclude that such changes are simply not common. However, based on the cases that we have examined, we can propose three categories of consonant mutations based on the position of stress: (i) changes in voicing or voice onset timing; (ii) lengthening of stops after a stress; (iii) general weakening of consonants in unstressed syllables.

Changes in voice onset timing. Aspiration of voiceless stops at the beginning of a stressed syllable is found in English and Island Carib, both of which have unpredictable stress. In Calabrian dialects of Italian, which like Spanish, has relatively unpredictable stress, voiceless stops are aspirated after sonorants and this aspiration is stronger in stressed syllables (Falcone 1976). In Swahili, some speakers aspirate voiceless stops at the beginning of stressed syllables and deaspirate formerly contrastive aspirated stops in unstressed syllables (Contini-Morava 1996). Swahili has predictable penultimate stress, but it is associated with increased duration. A related case might be the devoicing of voiced stops contiguous to a stressed vowel in Tohono O'odham. Tohono O'odham has fairly regular initial stress, but given the number of segmental processes associated with the position of stress, we suspect that it is ripe to become less predictable.

Aspiration is the result of a delay in the onset of voicing until after the release of the stop closure. The extent of this delay is related to the magnitude and duration of the glottal opening gesture, with a larger gesture creating a longer delay and hence stronger aspiration. Thus aspiration of voiceless stops in stressed syllables corresponds to a greater magnitude of glottal gesture.

The voicing of voiceless stops and sonorants in unstressed syllables is the result of the reduction and eventual loss of the glottal opening gesture as unstressed syllables reduce. Voicing in unstressed syllables is reported as an historical rule in Acehnese, where velars and palatals became voiced in an unstressed syllable if the next syllable-onset was voiceless (Durie 1985). Welsh voiceless sonorants are voiced intervocalically in unstressed syllables (Nicholas Kibre, p.c.). Karo (Ramarama, Brazil) has morphophonemic alternations attesting to a voicing of voiceless stops at the beginning of unstressed syllables (Gabas 1989). In Tohono O'odham voiced stops are fully voiced around unstressed, voiced vowels (Hale 1959). In American English, voiceless stops have less aspiration before unstressed vowels, and some even appear to be fully voiced, such as the alveolar flap that developed from /t/ in this position (Hoard 1971).

Not all of these languages have unpredictable stress. Acehnese has very predictable word-final stress despite also having marked differences between stressed and unstressed syllables, which include a reduced inventory of vowels in unstressed syllables, diphthongs in stressed syllables and other consonant reduction processes. However, Acehnese is a prefixing language, so that no mechanisms exist for exceptions to the final stress rule to arise. Welsh presents a much more complex and unusual case: it is described as having regular penultimate stress, but pitch and duration phenomena are dissociated, with some duration processes and pitch movement occurring on the last syllable, which was formerly the stressed syllable. American English stress is not predictable, and Karo stress is predictable only with reference to tone and the voicing of certain syllable-initial consonants.[10]

The lengthening of stops after a stress may serve to close the preceding stressed syllable and increase its duration. Such lengthening occurs in Norwegian word-finally after a short stressed vowel. In Norwegian stress is usually on the first syllable, though many exceptions occur. In Island Carib (with unpredictable stress) a voiced consonant is lengthened following the stress (*dúna* [dun:ə] 'water'). In Welsh also a consonant is lengthened after the stressed vowel. In West Germanic there is evidence that a consonant was lengthened after a stressed short vowel and before a palatal glide and in some cases before a liquid (Gothic *satjan*, Old Saxon *settian*; Old Norse *epel*, Old English *æppel*). Vennemann (1988) attributes this type of lengthening

to the closing of the preceding, stressed syllable. Thurgood (1993), in a cross-linguistic study of the distribution of geminate consonants, finds that long consonants are frequently if not exclusively preceded by a stressed vowel in the following languages: Delaware, Somali, Egyptian Arabic, Tiwa, Karok, Goajiro, Moroccan Arabic, Luiseño, Hopi, Tzeltal, Maltese Arabic, Icelandic and Hindi-Urdu. While we were not able to find detailed information about stress in all languages on this list, the information we do have shows that none of these languages has stress predictable from a word boundary; some of the languages have pitch contrasts along with stress (e.g. Karok), but most of them show a strong influence of heavy syllables on stress (Hindi-Urdu, Egyptian Arabic, Maltese, Luiseño, Guajiro).[11]

General weakening of consonants in unstressed syllables is a more miscellaneous category which includes the loss of segments and features in unstressed position. In the history of Maithili geminates were lost at the beginnings of unstressed syllables (Jhā 1958:193). In Acehnese a nasal consonant in an unstressed syllable can be denasalized if the nearest consonant to the left or the right is nasal (*namiet* > *lamiet* 'slave'). This never happens in stressed syllables. Similarly, in Island Carib, nasalization is stronger in stressed than in unstressed syllables (p. 239). In Nicobarese (unpredictable stress) [ər] is lost when unstressed: /poytərɔʔ/ > [poytɔʔ] 'be great (of sound)' (Braine 1970:81). In Finnish with word-initial stress, /t/ is deleted at the beginning of an unstressed syllable: /kálata/ > [kálaa] (Keyser and Kiparsky 1984).[12]

One of the best known historical changes of consonants conditioned by stress (or accent), Verner's Law, does not fit any of these patterns. The law was formulated to explain the development of PIE voiceless stops into voiced and voiceless fricatives in Germanic. If the position of the accent (which is presumed to be a pitch accent) in Sanskrit is taken into account, then the generalization is that the fricatives are voiced if preceded by an unaccented vowel. This generalization holds even if the fricative precedes a stressed vowel. In some cases, then, Verner's Law runs counter to the tendencies we have uncovered, the tendency for consonants to be voiceless in stressed syllables and voiced in unstressed ones. Furthermore, the sound change described by Verner's Law must have occurred before the Germanic stress accent on the first syllable developed, since its conditioning has to be reckoned from the position of the accent as it occurs in Sanskrit. It thus would represent a very unusual example of a consonant change conditioned by pitch. Usually a discrepancy between a reconstructed sound law and well-attested synchronic or diachronic changes leads us to question the reconstruction. Accordingly, we believe that the tendencies we have documented here make it very unlikely that the changes described by Verner's Law are correctly regarded as consonant changes conditioned by stress.

To conclude this section on our findings regarding the relation between segmental effects and the predictability of stress, we will summarize our results. First, we find that vowel reduction is the most common process associated with the position of stress in the languages of our sample. Moreover, we find a strong association of vowel reduction with less predictable stress. Vowel lengthening in stressed syllables and consonant changes conditioned by stress are much less common, but where they do occur, they are also associated with less predictable stress and occur only in languages that have vowel reduction. Our hypothesis is diachronic in nature, that is, we are claiming that it is the development of duration (and the consequent segmental changes) that causes stress to become unpredictable. Since we tested the hypothesis on a synchronic sample, we expected to find, and did find, languages where segmental effects are already present, but stress is still predictable.

8. Morphological conditioning

As we mentioned earlier, the loss of predictability of stress from a word boundary is likely to give rise to the morphological use of stress. Thus we expect to find an association in our data between unpredictable stress and morphological conditioning for stress. This expectation is borne out, as can be seen in Tables 10 and 11: eleven out of the sixteen languages we classified as having unpredictable stress had some morphological conditioning of stress, that is, local generalizations based on morphological categories (see the discussion of Spanish in Section 3). These data show that the development of morphological conditioning parallels the development of stress-conditioned segmental processes as a language moves from having more predictable to less predictable stress. The distributions shown in Tables 10 and 11 are statistically significant.

Table 10: Distribution of morphological conditioning in languages with predictable vs. unpredictable stress

predictable	4	3	2	1	unpredictable
	0/7	7/19	6/7	5/9	
	0%	37%	86%	56%	

Pearson $\chi = 11.373$, (df = 3), p = .01 $p < .05$

Table 11: Relation between morphological conditioning and predictability of stress

	Predictable stress	Unpredictable stress
morphological conditioning	7/26 27%	11/16 69%
no morphological condition	19/26 73%	5/16 31%

Pearson $\chi = 7.076$, (df = 1), p = .008
Continuity Correction $\chi = 5.47$, p = .019 $p < .05$

9. The Slavic languages

Another way to test the validity of the diachronic hypothesis is to consider the development of a group of closely related languages. We have already mentioned certain developments in the Romance and Germanic languages where stress is becoming less predictable and segmental effects are also developing. Another interesting case within the Indo-European phylum is presented by the Slavic languages, some of which now have predictable stress while some have unpredictable stress (or accent). A brief survey of these languages shows that despite a different diachronic trajectory than the one we have considered so far, the relation between predictability of stress and segmental changes still holds.

Late Proto-Slavic is presumed to have had pitch contrasts in accented syllables, and the placement of this accent is not predictable from the word boundary (Carlton 1991). While most of the daughter languages have, by one route or another, replaced this pitch accent system with a stress system, without pitch contrasts, Serbo-Croatian continues the use of pitch contrasts in accented syllables. Thus, while Serbo-Croatian has unpredictable accent

placement, it does not have segmental processes associated with the accent. It does, however, also continue the Proto-Slavic system of vowel length contrasts.

With some modifications, Belorussian, Bulgarian, Russian and Ukrainian have maintained the position of Proto-Slavic accent, but replaced it with stress, having lost the pitch contrasts in accented syllables. Thus these four languages must be regarded as having unpredictable stress. It is interesting for our hypothesis that even though these languages did not develop their unpredictable stress out of predictable stress, they have lost pitch as the primary correlate of stress and are developing segmental processes conditioned by stress. All four have vowel reduction or neutralization in unstressed syllables (Comrie and Corbett 1993), and Russian and northern dialects of Ukrainian have diphthongization of mid vowels in stressed syllables (Shevelov 1993:950). In addition, lengthening of stressed vowels is reported for Ukrainian (Shevelov 1993:950). These languages appear to represent cases of an accent whose primary correlate was pitch being replaced by stress with duration as a correlate, resulting in segmental changes conditioned by the position of the stress. Colloquial Slovene dialects have also replaced the pitch accent with stress, but have also shifted the place of stress in a number of cases. With vowel lengthening and diphthongization in stressed syllables and reduction in unstressed ones, stress is now "predictable" in the sense that the stress falls on the single long vowel of a word, or if the word lacks a long vowel, on the final vowel (Priestly 1993). This is, of course, not the type of predictability we are concerned with here, and thus we have classified Slovene as a 2 in Table 12.

Other languages in this family lost the pitch accent system but developed predictable demarcative stress (perhaps by the lexicalization of intonation patterns). Czech and Slovak have stress on the first syllable of words; Polish on the penultimate and Macedonian on the antepenult (Carlton 1991; Comrie and Corbett 1993). Czech and Slovak maintain regular stress placement and do not have vowel reduction or other segmental changes related to the position of stress. Macedonian is reported to have vowel reduction, but it is also reported to have lexical exceptions and the morphological use of stress, leading to contrastive stress. Polish has a similar repertoire of exceptions, but does not have vowel reduction (Comrie 1976). Polabian, with less predictable final or penultimate stress, also had reduction and neutralization of vowels in unstressed syllables. Sorbian also has initial stress, but it is described as very strong, causing reduction of vowels in unstressed syllables. As we would predict, there are exceptions to the initial

rule in Sorbian: "foreign words almost always have an anomalous stress" (Stone 1993:610).

These facts are summarized in Table 12 where it can be seen that there is a strong tendency, just as in our world-wide sample, for vowel reduction to be associated with unpredictable stress.

Table 12: Relation of predictability of stress to vowel reduction in Slavic languages

predictable	4	3	2	1	*unpredictable*
Vowel Reduction:		Macedonian Sorbian	Polabian Slovene	Belorussian Bulgarian Cassubian (north) Russian Ukrainian	
No VR:	Czech Slovak	Polish		Serbo-Croat	

A comparison of Polish and Macedonian in Comrie (1976) supports our diachronic hypothesis. The Polish and Macedonian stress systems seem to be quite similar, except that Polish has penultimate stress and Macedonian, antepenultimate. According to Comrie, the number and types of exceptions in the two languages are quite similar. However, Macedonian has vowel reduction and Polish does not. Our diachronic hypothesis would predict, then, that Macedonian is positioned to develop less predictable stress. Apparently this process has begun as predicted. Comrie reports that tendencies for change in the two languages are quite different. Polish tends to generalize penultimate stress by shifting the stress in loan words such as *república* to *republíka*. In Macedonian the usual type of change from the standard is for words with irregular stress, e.g. *konsumátor, konsumatórite* 'consumer (singular and plural)' to generalize on the same vowel through the paradigm, giving e.g. *konsumátorite*, even though such a form creates a further deviation from antepenultimate stress. Thus while Polish stress tends to remain demarcative, Macedonian stress is moving to a further lexicalization of stress patterns, just as our hypothesis would predict from the fact that it has vowel reduction.

Proto-Slavic also had phonemic vowel length which has now been lost in most of the daughter languages. The only languages that have maintained

the use of phonemic vowel length are the ones which either maintain the pitch accent (Serbo-Croatian, Slovene) or the ones that have developed a predictable demarcative stress (Czech and Slovak). It appears here, just as in the Germanic and Romance languages, that phonemic vowel length is incompatible with unpredictable stress. This hypothesis will be explored further in the next section.

10. Vowel length and stress

It has been observed that phonemic vowel length distinctions and unpredictable or phonemic stress do not often appear in the same language (Hyman 1977:54; Jakobson and Halle 1956:481; Trubetzkoy 1939:196–197). From a diachronic perspective we can observe that in the Romance and Germanic branches of Indo-European, the replacement of vowel length contrasts with vowel quality contrasts has taken place concurrently with the increased loss of predictability of stress. Hyman (1977:54) interprets this generalization as related to the use of duration as a correlate of stress: "the presence of a vowel length contrast obstructs the use of duration as a strategy in the realization of stress." Our interpretation is somewhat different because we see that diachronically the presence of vowel length contrasts does not prevent duration from developing as a correlate of stress. Instead, our hypothesis is that the development of duration as a correlate of stress eventually obliterates vowel length contrasts by first shortening vowels in unstressed syllables and then lengthening vowels in stressed ones.

Since this generalization concerning the relation of vowel length to stress is often repeated but never backed up by data, we checked the Gramcats database to see if the relation holds for these languages. We found sixteen languages that are reported to have vowel length contrasts. Three of these are tone languages of Africa (Kanakuru, Krongo and !Xóõ), two are tone languages of Asia (Laotian and Cantonese, with only one vowel, /a/, contrasting length), one is a language with pitch contrasts in stressed syllables (Karok), and eight are languages with predictable stress (Alyawarra, Buli, Buriat, Gugada, Kui, Latin, Tohono O'odham and Zuni). Only two languages are reported to have phonemic vowel length and unpredictable stress. In Tigre there is only one vowel length contrast, between /a/ and /a:/. Nicobarese has somewhat unpredictable stress, vowel length, as well as vowel reduction in unstressed syllables.

It appears that there is a very strong tendency not to have unpredictable stress and phonemic vowel length in the same language. The languages that do have both are probably in the process of losing their vowel length contrasts as a result of the development of unpredictable stress.

11. Syllable-timed vs. stress-timed languages

Fifty years ago Kenneth Pike suggested that English rhythm was "stress-timed" by which he meant that the temporal intervals between stresses were very nearly equal. One consequence of this rhythmic spacing is that unstressed syllables may be severely reduced, depending upon how many occur between stresses, and stressed syllables may be lengthened, especially if no unstressed syllables intervene. He further makes the observation that other languages, especially Spanish for example, are "syllable-timed" because each syllable, whether stressed or not, is approximately the same length. There are some who would propose that all languages fall into one or the other rhythmic type. Subsequent work measuring the duration of stressed and unstressed syllables in different languages shows that Pike's impressionistic generalizations were close, but not quite accurate. Delattre (1966) showed that there are differences in duration between Spanish stressed and unstressed syllables, but the difference is not as great as that of English or French (see also Auer and Uhmann 1988). As we would predict, the data show that there are not two strict types, but a continuum along which languages may differ from one another.

The synchronic continuum reflects a diachronic one by which the correlate of stress gradually changes from being primarily pitch to duration or pitch with duration. The effects of duration are seen in vowel and consonant changes sensitive to the position of stress. These effects tend to accumulate over time so that the asymmetry between stressed and unstressed syllables grows greater the longer duration is the main correlate of stress. Thus we would claim, as Auer and Uhmann (1988) do, that the stress-timed/syllable-timed typology consists of clusters of phonological properties that tend to occur together. Those that we have tested empirically in this paper are:

For stress-timed languages:
unpredictable stress
vowel reduction
lack of phonemic vowel length
lengthening and diphthongization in stressed syllables
consonant changes conditioned by stress.
morphological use of stress

For syllable-timed languages (with stress):
predictable stress
phonemic vowel length possible
no vowel reduction in unstressed syllables
no vowel lengthening in stressed syllables
no consonant changes conditioned by stress.

Recently it has been suggested that rhythmic typologies relate also to the position of stress. Donegan and Stampe (1983) (see also Gil 1986) relate timing to initial vs. final stress: initial stress goes with syllable-timed languages and final stress goes with stress-timed. Our data do not support this hypothesis. Taking initial and second-syllable stress together we have five cases of vowel reduction out of thirteen languages; among final and penultimately-stressed languages we have three cases of vowel reduction out of thirteen languages (see Appendix B). If anything, initial stress seems to lead to stress-timed rhythm. The two languages among those with predictable stress that also have vowel lengthening in stressed syllables and consonant changes conditioned by stress have initial stress (Tohono O'odham and Norwegian).

12. Vowel harmony

Vowel harmony is a type of vowel reduction that maintains the temporal integrity of the vowel and is usually not influenced by the position of stress. It thus seems plausible that it would occur primarily in languages where the difference between stressed and unstressed syllables is minimal, i.e. in level tone languages and in languages with predictable stress. This generalization tends to hold for our data, but it is difficult to demonstrate significance for this tendency due to the strong genetic and areal factors involved in the distribution of vowel harmony systems. The Niger-Kordofanian languages of

Africa, which are primarily level tone languages, have vowel harmony involving the feature Advanced Tongue Root. The Ural-Altaic languages, which tend to have predictable initial or final stress, have vowel harmony systems involving the feature [back] and sometimes also the feature [round]. Regular vowel harmony was not found in any other languages of the Gramcats sample.

13. Representation

This paper primarily concerns paths of diachronic change and the relation between the correlates of stress and segmental processes, but any finding on linguistic change has implications for the modeling of the cognitive representation of language. Here we will consider the likelihood that stress, pitch and the rhythmic properties of words and phrases are represented in lexical storage.

We begin with the clearest case — that of stress in English. Cutler (1984) reviews the literature and concludes that English "word stress patterns are an integral part of the phonological representation of words in the mental lexicon; they are not generated by rule" (Cutler 1984:78). Among the phenomena she cites are: in tip-of-the-tongue phenomenon the position of stress can sometimes be accessed for a word that is itself not accessible; word substitution errors maintain the position of stress; comprehension errors show that stressed syllables are more important to the reconstruction of a misheard message than unstressed syllables; a variety of studies show that stress is important in word recognition and lexical access. Thus both production and comprehension studies demonstrate that English word stress is part of the lexical representation of words.

This conclusion is not so surprising for English, since attempts to formulate rules of stress assignment lead to highly complex statements full of morphological and specific lexical information. Moreover, as we have seen, the asymmetry of stressed and unstressed syllables is so great in English that the stress pattern affects the overall shape of the word to such an extent that its removal and the removal of its affects would leave something totally unrecognizable as an English word.

For a language such as Spanish, where the stress pattern is more predictable and produces less distortion of the segmental organization of the word, the role of stress in the lexicon is not so obvious. However, the studies

reported in Aske (1990), which we have described above, show that stress is also lexicalized in Spanish, where speakers use local generalizations about stress in actual words, which refer to specific vowels and consonants rather than to the general CV structure, in assigning stress to novel words.

Even where the position of stress appears to be predictable on the surface there is evidence for lexicalization. We have documented a strong tendency for demarcative stress to develop exceptions and to become less predictable. Such developments would not be possible if stress were assigned by an independent rule; such developments occur because even predictable stress is regarded as an integral organizational feature of words, and as such, is part of the lexical representation of words. If stress were assigned by rule and no lexical entries had any indication of the position of stress, then there would be no mechanism by which exceptions could be developed, since no words could have any stress other than that assigned by the rule.

Perhaps in cases where stress is completely predictable from a word boundary, and even loan words are adapted to the native stress (as in reports on Polish, Comrie and Corbett 1993), stress is not indicated in the lexicon. After all, it is precisely in such cases that stress has the least segmental effect, and thus is less important to the temporal organization of the word. Of course, this is an empirical question that can be researched experimentally, as questions about stress in Spanish have been. But even in what appear to be the clearest of cases of stress that is not lexical, we have reason to believe that stress might still form an inherent part of a word's representation.

Consider again Hyman's suggestion concerning the genesis of demarcative word stress: Hyman argues on typological evidence that demarcative word stress derives from intonation patterns that are transferred from the level of the phrase to the level of the word. We have already mentioned that this implies the lexicalization of intonation patterns. In order for the pitch changes of intonation to become associated with words and word boundaries, these pitch patterns must be taken to be an inherent part of the word. As we said in Section 2, the stored memory representation is a cluster of tokens, with the most frequent ones dominating the cluster. If the pitch and rhythmic patterns of the tokens are not abstracted away, a frequent prosodic pattern could become characteristic of the word. This scenario for the origins of demarcative stress, then, presupposes that pitch patterns can be lexicalized with the other features of words.

These facts and their interpretations are all consistent with the notion that lexical storage is maximally redundant and generalizations over stored

items can be formulated with different degrees of generality (Bybee 1985, Langacker 1987, 1998). In the models proposed by Bybee and Langacker, generalizations are not separate from representations, but rather are emergent from them, and expressed in the form of schemas. Langacker observes that local or low-level schemas take precedence over higher level ones in the sense that they are more readily accessible and therefore used more easily in the creation of new formations. This principle explains why Aske's subjects referred to the particular vowels and consonants in the novel words he gave them, rather than applying the general stress rule of Spanish. It also explains the lack of adaptation in loan words and in general the development and tolerance for exceptions.

The tendency to develop local generalizations for stress patterns also explains the high degree of morphologization of stress patterns: eleven out of the sixteen languages we classified as having unpredictable stress had some morphological conditioning of stress, that is, local generalizations based on morphological categories (see the discussion of Spanish in Section 3). Even among languages that we classified as 3 — fairly predictable stress — there were seven in which stress patterns are associated with morphological categories. This also suggests a strong tendency for speakers to take stress patterns to be part of the meaning-bearing apparatus of the language.

Thus we are claiming that even predictable stress is an inherent part of the word, and being such an important part of the organization of the word, it becomes gradually more entrenched as a part of the word. It is originally a pitch contour, but it seems that it commonly takes on temporal importance as well: as part of the temporal organization of the word it begins to gradually affect the segmental structure of the word. This is an incremental process by which changes in segmental features slowly accumulate in the lexical representation. The changes, once begun, are unidirectional: reduction of unstressed syllables and augmentation of stressed ones is cumulative and not reversible. The structure of words is permanently altered (Bybee 1998).

The basic rhythmic structure of a language, then, is contained in the structure of its words and their shapes. We are not denying of course that there are interesting questions concerning the way the intonation and rhythm of phrases interact with the given shape of words, nor that rhythm and intonation of actual utterances affect further changes in the shape of words; we are, however, asserting that basic patterns of rhythm for a language are stored and maintained in the representation of words. Our view, than, echoes that expressed by Firth in 1948:

> I am inclined to the classical view that the correct rendering of the syllabic accent or the syllabic prosodies of the word is the *anima vocis*, the soul, the breath, the life of the word. (p. 177)

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APPENDICES

Appendix A: Languages used in study

Languages used in the study were taken from the Gramcats sample, a stratified probability sample of seventy-six languages that controls for genetic bias. For several languages of that sample, adequate information on phonology was not available. If information on a closely related language was not also available, the language group was not represented. The table below shows the sixty-eight languages that were used. The table gives the language number assigned (Bybee *et al.* 1994) in the Gramcats sample, which can be used to locate the bibliographic information on the language in the references, the language name, its affiliation, and in the final column our classification of the language as using stress (S), tone (T) or both (S/T).

Lang. #	Language Name	Language Affiliation	Prosodic type
1	Inuit	Unaffiliated	S*
2	Basque	Unaffiliated	S
3	Margi	Afroasiatic (Chadic, E. Chadic)	T
4	Kanakuru	Afroasiatic (Chadic, W. Chadic)	T
5	Afar	Afroasiatic (E. Cushitic)	S
6	Tamazight	Afroasiatic (Berber)	S*
8	Tigre	Afroasiatic (Semitic)	S
9	Cheyenne	Macro-Algonquian	T
10	Island Carib	Andean-Equatorial (Equatorial, Arawakan)	S
11	Cocama	Andean-Equatorial (Equatorial, Tupi)	S
12	Chacobo	Andean-Equatorial	S
13	Jivaro	Andean-Equatorial (Jivaroan)	S/T
14	Tucano	Andean-Equatorial (Tucanoan)	S/T
15	Gugada	Australian (Pama-Nyugan, Southwest)	S
16	Gugu-Yalanji	Australian (Pama-Nyugan, Pama-Maric)	S
17	Alyawarra	Australian (Pama-Nyugan)	S
18	Maung	Australian (Iwaidjan)	S
20	Alawa	Australian (Maran)	S
22	Koho	Austroasiatic (Mon-Khmer, Bahnaric)	S
24	Nicobarese (Car)	Austroasiatic	S
26	Motu	Austronesian (Oceanic, Papua Austronesian)	S
27	Atchin	Austronesian (Oceanic, NW New Hebrides)	S
30	Tanga	Austronesian (Oceanic, Bismarck Archipelago)	S
32	Nakanai	Austronesian (Oceanic, NE New Guinea)	S
34	Pangasinan	Austronesian (Malayo-Polynesian, Hesperonesian)	S
35	Rukai	Austronesian (Malayo-Polynesian, Formosan AN)	S
37	Buli	Austronesian (S Halmahera — W New Guinea)	S
38	Tohono O'odham	Aztec-Tanoan	S
39	Abkhaz	Caucasian	S
40	Guaymi	Macro-Chibchan (Chibchan)	S
42	Kui	Dravidian	S
43	Capanahua	Ge-Pano-Carib (Pano-Tocano)	S/T

Lang. #	Language Name	Language Affiliation	Prosodic type
46	Karok	Hokan	S/T
47	Latin	Indo-European (Italic)	S
48	Maithili	Indo-European (Indo-Iranian, Indic)	S
49	Baluchi	Indo-European (Indo-Iranian, Iranian)	S
50	Modern Greek	Indo-European (Hellenic)	S
51	Norwegian	Indo-European (Germanic)	S
52	Yagaria	Indo-Pacific (C New Guinea, E NG Highlands)	S/T
56	Ono	Indo-Pacific (C New Guinea, Huon-Finisterre)	S
58	Nimboran	Indo-Pacific (N New Guinea, N Papuan)	S
60	Yimas	Indo-Pacific (N New Guinea, Lower Sepik)	S
67	!Xóõ	Khoisan	T
68	Slave	Na-dene	T
69	Krongo	Niger-Kordofanian (Kordofanian)	T
71	Temne	Niger-Kordofanian (Niger Congo, W Atlantic)	T
72	Mwera	Niger-Kordofanian (Niger Congo, Benue-Congo)	S/T
73	Tem	Niger-Kordofanian (Niger Congo, Gur)	T
74	Engenni	Niger-Kordofanian (Niger Congo, Kwa)	T
75	Mano	Niger-Kordofanian (Niger Congo, Mande)	T
76	Bari	Nilo-Saharan (Chari-Nile, E Sudanic)	T
77	Ngambay	Nilo-Saharan (Chari-Nile, C Sudanic)	T
78	Kanuri	Nilo-Saharan	T
79	Palantla Chinantec	Oto-Manguean	S/T
80	Tojolabal	Penutian (Mayan)	S
81	Zuni	Penutian (isolate)	S
82	Maidu	Penutian	S
83	Shuswap	Salish	S
84	Lao	Sino-Tibetan (Kam-Tai)	T
85	Chepang	Sino-Tibetan (Tibeto-Burman, Gyarung-Mishmi)	S
86	Bawm	Sino-Tibetan (Tibeto-Burman, Naga-Kuki-Chin)	S/T
87	Lahu	Sino-Tibetan (Tibeto-Burman, Burmese-Lolo)	T
89	Cantonese	Sino-Tibetan	T

Lang. #	Language Name	Language Affiliation	Prosodic type
90	Dakota	Macro-Siouan	S
91	Udmurt	Ural-Altaic (Uralic)	S
92	Uigur	Ural-Altaic (Altaic, Turkic)	S
93	Buriat	Ural-Altaic (Altaic)	S
94	Tok Pisin	Creoles	S

* Phrasal stress only.

Appendix B: Segmental processes of stress languages in the sample

The table below shows the forty-two languages (out of the sixty-eight languages in the original sample), which have word stress and do not have tone. The table is sorted first in terms of "degree of predictability of stress" in the descending order from most predictable (4) to least predicable (1). Within predictability, languages are then listed by the "position of the primary stressed syllable" (for stress types 3 and 4) in the order of initial syllable through final syllable. These are further followed by "language number" in the ascending order, "language name", "morphological conditioning", "vowel-reduction", "vowel-lengthening" and finally "consonantal-change".

Degree of predictability of stress	Position of the primary stressed syllable	Language Number	Language Name	Morphological conditioning	Vowel-reduction	Vowel-lengthening	Consonantal-change
2		5	Afar	Yes	Yes	No	?
2		24	Nicobarese	Yes	Yes	No	Yes
2		48	Maithili	Yes	Yes	Yes	Yes
2		50	Modern Greek	Yes	Yes	Yes	No
2		60	Yimas	Yes	Yes	Yes	No
2		82	Maidu	No	Yes	Yes	No
2		83	Shuswap	Yes	Yes	No	Yes
1		2	Basque	Yes	No	No	No
1		8	Tigre	?	Yes	Yes	Yes
1		10	Island Carib	No	Yes	No	Yes
1		12	Chacobo	Yes	No	No	No
1		34	Pangasinan	Yes	Yes	No	No
1		39	Abkhaz	Yes	Yes	No	No
1		40	Guaymi	No	Yes	Yes	?
1		58	Nimboran	No	Yes	No	No
1		80	Tojolabal	Yes	No	No	No

NOTES

1. The major class of exceptions to this proposal are cases in which lexical stress has developed directly from a tone or pitch accent system, with high tone reinterpreted as main word stress (Clements and Goldsmith 1984; Salmon 1990; see also the discussion of Slavic languages in Section 9).
2. Hyman seems to assume that demarcative stress exists because it can serve the function of helping the listener identify word boundaries. If this were the case, we wouldn't expect it to evolve so easily into lexical or morphological stress (see below). Our own view is much more mechanistic: we view demarcative stress as just one stage along an evolutionary path; the explanation for its existence is precisely in its origins.

Degree of predictability of stress	Position of the primary stressed syllable	Language Number	Language Name	Morphological conditioning	Vowel-reduction	Vowel-lengthening	Consonantal-change
4	Initial	16	Gugu-Yalanji	No	No	No	No
4	Initial	56	Ono	No	No	No	No
4	Initial	81	Zuni	No	No	No	No
4	Initial	85	Chepang	No	No	No	No
4	Penultimate	32	Nakanai	No	Yes	No	No
4	Final	22	Koho (Sre)	No	No	No	No
4	Final	35	Rukai	No	Yes	No	No
3	Initial	15	Gugada	No	Yes	No	No
3	Initial	30	Tanga	?	No	No	No
3	Initial	38	Tohono O'odham	No	Yes	Yes	Yes
3	Initial	42	Kui	No	No	No	No
3	Initial	51	Norwegian	Yes	Yes	Yes	Yes
3	Initial	93	Buriat	No	Yes	No	No
3	Initial	94	Tok Pisin	No	No	No	No
3	Second	17	Alyawarra	Yes	Yes	No	No
3	Second	90	Dakota	Yes	No	No	No
3	Penultimate	11	Cocama	No	No	No	No
3	Penultimate	18	Maung	No	No	No	No
3	Penultimate	20	Alawa	No	No	No	No
3	Penultimate	26	Motu	Yes	No	No	No
3	Penultimate	27	Atchin	No	No	No	No
3	Penultimate	37	Buli	No	No	No	No
3	Penultimate	47	Latin	Yes	No	No	No
3	Penultimate	49	Baluchi	Yes	No	No	No
3	Final	91	Udmurt	Yes	?	?	?
3	Final	92	Uigur	No	Yes	No	No

1. For instance, Mapuche (Araucanian) has alternating stress starting on the second syllable of a "phonological word". Thus two-syllable words ending in vowels may be stressed on either syllable, and one syllable words are stressed only if an unstressed syllable follows. Only in a few cases are stress patterns determined by lexical words (Echeverría and Contreras 1965).
4. Second syllable stress may arise from the lexicalization of an alternating iambic stress pattern that originally had the utterance as its domain.
5. Only Indicative forms are given in the example, but an analogous change occurred in the Imperfect Subjunctive.
6. The deletion or elision of a vowel next to another vowel was not counted as deletion.
7. The numbers in Table 5 do not equal the number languages with vowel reduction, since some languages have more than one reduction process.
8. Both languages also have word-initial stress.
9. We requested help over the Internet and several people sent us examples of consonantal changes conditioned by stress in the languages they were familiar with. We are very grateful for all the help we received in this way.
10. Gabas (1989) formulates the synchronic stress-placement rule as stressing the penultimate if the last syllable begins with /b, r, g/. Since historically /p, t, k/ became /b, r, g/ at the beginning of unstressed syllables, their presence indicates that the syllable is unstressed!
11. Once vowel lengthening and gemination in stressed syllables has occurred, then it will often be possible to predict stress from the presence of these segmental indicators, especially if vowel deletion has also created exceptions to predictability from word boundaries. Thus predictability in terms of syllable weight may indicate that the language has already gone through a period in which stress has conditioned segmental effects.
12. Some studies have shown that the deletion of Spanish /d/ between vowels is favored after a stressed vowel. However, D'Introno and Sosa (1986) have shown that there is considerable lexical effect on this process. The favoring of deletion in the highly frequent Past Participle morpheme *-ádo* may account for this apparent tendency. It is probably not a deletion conditioned by the position of stress.

REFERENCES

Aske, Jon. 1990. "Disembodied rules vs. patterns in the lexicon: Testing the psychological reality of Spanish stress rules". In: *Proceedings of the 16th annual meeting of the Berkeley linguistic society* 30–45. Berkeley: Berkeley Linguistics Society.

Auer, Peter; and Uhmann, Suzanne. 1988. "Silben- und akzentzählende Sprachen". *Zeitschrift für Sprachwissenschaft* 7: 214–259.

Beckman, Mary; and Pierrehumbert, Janet. 1986. "Intonational structure in Japanese and English". *Phonology Yearbook* 3: 255–309.
Bolinger, Dwight. 1978. "Intonation across languages". In: Greenberg, Joseph H.; Ferguson, Charles A.; and Moravczik, Edith A. (eds), *Universals of human language, Vol. 2: Phonology* 471–524. Stanford: Stanford University Press.
Braine, Jean Critchfield. 1970. Nicobarese grammar (Car dialect). Berkeley: University of California Doctoral Dissertation.
Bright, William. 1957. *The Karok language*. Berkeley: University of California [*University of California Publications in Linguistics* 13].
Browman, Catherine P.; and Goldstein, Louis M. 1992. "Articulatory phonology: An overview". *Phonetica* 49: 155–180.
Bybee, Joan L. 1985. *Morphology: A study of the relation between meaning and form.* Philadelphia: Benjamins.
Bybee, Joan L. 1988. "Morphology as lexical organization". In: Hammond, Michael; and Noonan, Mickey (eds), *Theoretical Morphology* 119–144. San Diego: Academic Press.
Bybee, Joan L. 1998. "The phonology of the lexicon". In: Barlow, Michael; and Kemmer, Suzanne (eds.), *Usage-based models of language.* Stanford, CSLI.
Bybee, Joan; Perkins, Revere; and Pagliuca, William. 1994. *The evolution of grammar: Tense, aspect and modality in the languages of the world.* Chicago: University of Chicago Press.
Carlton, Terence R. 1991. *Introduction to the phonological history of the Slavic languages.* Columbus, Ohio: Slavic Publishers, Inc.
Clements, N. G.; and Goldsmith, John. 1984. "Autosegmental studies in Bantu tone: Introduction". In: Clements, G. N.; and Goldsmith, John (eds), *Autosegmental studies in Bantu tone* 1–17. Dordrecht: Foris Publications.
Comrie, Bernard. 1976. "Irregular stress in Polish and Macedonian". *International Review of Slavic Linguistics* 1: 227–240.
Comrie, Bernard; and Corbett, Greville G. (eds). 1993. *The Slavonic languages.* London and New York: Routledge.
Contini-Morava, Ellen. 1996. "Swahili phonology". In: Kaye, Alan (ed.), *Asian and African phonologies.* Wiesbaden: Harrassowitz Verlag.
Cutler, Ann. 1984. "Stress and accent in language production and understanding". In: Gibbon, Dfydd; and Richter, Helmut (eds), *Intonation, accent and rhythm: Studies in discourse phonology* 77–90. Berlin: De Gruyter.
Delattre, Pierre. 1966. "A comparison of syllable length conditioning among languages". *International Review of Applied Linguistics* 4: 183–198.

D'Introno, Francisco; and Sosa, Juan Manuel. 1986. "Elisión de la /d/ en el español de Caracas: Aspectos sociolinguisticos e implicaciones teóricas". In: Rafael A. Núñez Cedeño; Iraset Páez Urdaneta; y Jorge Guitart (eds), *Estudios sobre la fonología del español del Caribe.* Ediciones La Casa de Bello.
Donegan, Patricia; and Stampe, David. 1983. "Rhythm and the holistic organization of language structure". In: Richardson, John G.; Marks, Mitchell; and Chukerman, Amy (eds), *Papers from the parasession on the interplay of phonology, morphology and syntax* 337–353. Chicago: The Chicago Linguistic Society.
Durie, Mark. 1985. *A grammar of Acehnese on the basis of a dialect of North Aceh.* Dordrecht: Foris Publications.
Echeverría, Max S.; and Contreras, Heles. 1965. "Araucanian phonemics". *International Journal of American Linguistics* 31: 132–135.
Falcone, Giuseppe. 1976. *Calabria.* Pisa: Paini (Profilo dei dialetti d'Italia).
Firth, J. R. 1948. "Sounds and prosodies". *Transactions of the Philological Society,* 127– 152.
Gabas Junior, Nilson. 1989. Estudo fonológico da língua Karo (Arara de Rondônia). Campinas: State University of Campinas M. A. Thesis.
Gil, David. 1986. "A prosodic typology of language". *Folia Linguistica* 20: 165–231.
Hale, Kenneth L. 1959. A Papago grammar. Bloomington: Indiana University dissertation.
Harries, Lyndon. 1950. *A grammar of Mwera.* Johannesburg: Witwatersrand University.
Hoard, James. 1971. "Aspiration, tenseness and syllabication in English". *Language* 47: 133–140.
Hooper, Joan B. 1976. *Introduction to natural generative phonology.* New York: Academic Press.
Hyman, Larry M. 1977. "On the nature of linguistic stress". In: Hyman, L. M. (ed.), *Studies in stress and accent* 37–82. Los Angeles: Department of Linguistics, University of Southern California [*SCOPIL* 4].
Jhā, Subhadra. 1958. *The formation of the Maithili language.* London: Luzac.
Jakobson, Roman; and Halle, Morris. 1956. "Phonology and phonetics". In: *Roman Jakobson, Selected Writings,* 464–504.
Kahn, Daniel. 1976. Syllable-based generalizations in English phonology. Cambridge, Mass: MIT Doctoral Dissertation.
Kent, Roland. 1940. *The sounds of Latin.* Baltimore: Linguistic Society of America at the Waverly Press.

Keyser, S. J.; and Kiparsky, Paul. 1984. "Syllable structure in Finnish phonology". In: Aronoff, Mark; and Oehrle, Richard T. (eds), *Language sound structure* 7–31. Cambridge, Mass: The MIT Press.

Langacker, Ronald. 1987. *Foundations of cognitive grammar, Vol. 1. Theoretical prerequisites.* Stanford: Stanford University Press.

Langacker, Ronald. 1998. A dynamic usage-based model. In: Barlow, Michael; and Kemmer, Suzanne (eds.), *Usage-based models of language.* Stanford, CSLI.

Lewis, G. L. 1967. *Turkish grammar.* Oxford: The Clarendon Press.

Miller, Joanne. 1994. "On the internal structure of phonetic categories: A progress report". *Cognition* 50: 271–285.

Nadzhip, E.N. 1971. *Modern Uigur.* Translated by D.M. Segal. Moscow: Nauka.

Pike, Kenneth. 1945. *The intonation of American English.* Ann Arbor: University of Michigan Press.

Priestly, T. M. S. 1993. "Slovene". In: Comrie, Bernard; and Corbett, Greville G. (eds), *The Slavonic languages* 388–451. London and New York: Routledge.

Salmon, Joe. 1990. "From tone to stress: Mechanisms and motivations". In: *Proceedings of the 16th annual meeting of the Berkeley linguistic society* 282–291. Berkeley: Berkeley Linguistics Society.

Shevelov, George Y. 1993. "Ukrainian". In: Comrie, Bernard; and Corbett, Greville G. (eds), *The Slavonic languages* 947–998. London and New York: Routledge.

Sorensen, Arthur P. Jr. 1969. The morphology of Tucano. Columbia University dissertation.

Stone, Gerald. 1993. "Sorbian". In: Comrie, Bernard; and Corbett, Greville G. (eds), *The Slavonic languages* 593–685. London and New York: Routledge.

Thurgood, Graham. 1993. "Geminates: A cross-linguistic examination". In: Nevis, Joel Ashmore; McMenamin, Gerald; and Thurgood, Graham (eds), *Papers in honor of Frederick H. Brengelman on the occasion of the twenty-fifth anniversary of the department of linguistics, CSU Fresno* 129–139. Fresno, Ca: Department of Linguistics, CSU Fresno.

Turner, Glen D. 1958. Jivaro: Phonology and morphology. Indiana University dissertation.

Trubetzkoy, Nicholai. 1939. *Principles of phonology.* Trans. by Christiane A. M. Baltaxe. Berkeley and Los Angeles: University of California Press.

Vennemann, Theo. 1988. *Preference laws for syllable structure.* Berlin: Mouton De Gruyter.

Voegelin, Carl. R.; and Voegelin, Florence M. 1978. *Classification and index of the world's languages.* New York: Elsevier.

REFERENCES FOR GRAMCATS SAMPLE

01 Fortescue, Michael. 1984. *West Greenlandic.* London: Croom Helm.

02 Saltarelli, Mario, *et al.* 1988. *Basque.* New York: Croom Helm.

03 Hoffmann, Carl. 1963. *A grammar of the Margi language.* London: Oxford University Press.

04 Newman, Paul. 1974. *The Kanakuru language.* Leeds: Institute of Modern English Language Studies University of Leeds in association with The West African Linguistic Society.

05 Bliese, Loren F. 1981. *A generative grammar of Afar.* University of Texas at Arlington: Summer Institute of Linguistics.

06 Penchaen, Thomas G. 1973. "Tamazight of Ayt Ndhir". *Afroasiatic Dialects* 1: 1–124.

08 Leslau, Wolf. 1945. *Short grammar of Tigré.* New Haven: American Oriental Society [*Publications of the American Oriental Society, Offprint Series* 18].

08 Palmer, F. R. 1962. *The morphology of the Tigre noun.* London: Oxford University Press.

08 Raz, Shlomo. 1983. *Tigre grammar and texts.* Malibu: Undena [*Afroasiatic Dialects* 4].

09 Leman, Wayne. 1981. "Cheyenne pitch rules". *International Journal of American Linguistics* 47(4): 283–309.

10 Taylor, Douglas. 1955. "Phonemes of the Hopkins (British Honduras) dialect of Island Carib (= Island Carib I)". *International Journal of American Linguistics* 21: 233–41.

11 Faust, Norma. 1978. *Gramática Cocama: Lecciones para el aprendizaje del idioma Cocama.* Lima: Ministerio de Educación, Instituto Lingüístico de Verano [*Serie Lingüística Peruana* 6].

12 Prost, Gilbert R. 1967. "Phonemes of the Chacobo language". *Linguistics* 35:61–5.

13 Turner, Glen D. 1958. Jivaro: Phonology and morphology. Indiana University dissertation.

14 Sorensen, Arthur P. Jr. 1969. The morphology of Tucano. Columbia University dissertation.

14 West, Birdie. 1980. *Gramática popular del Tucano.* Bogotá: Ministerio de Gobierno, Instituto Lingüístico de Verano.

15 Platt, J.T. 1972. *An outline grammar of the Gugada dialect, South Australia.* Canberra: Australian Institute of Aboriginal Studies.

16 Patz, Elizabeth. 1982. A grammar of the Kuku Yalanji language of North Queensland. Canberra: Australian National University dissertation.

17 Yallop, Colin. 1977. *Alyawarra: An Aboriginal language of central Australia.* Canberra: Australian Institute of Aboriginal Studies.

18 Capell, A. and H.E. Hinch. 1970. *Maung grammar: Texts and vocabulary.* The Hague: Mouton.
20 Sharpe, Margaret C. 1972. *Alawa phonology and grammar.* Canberra: Australian Institute of Aboriginal Studies [*Australian Aboriginal Studies* 37].
22 Manley, Timothy M. 1972. *Outline of Sre structure.* Honolulu: University of Hawaii.
24 Braine, Jean Critchfield. 1970. Nicobarese grammar (Car dialect). Berkeley: University of California dissertation.
26 Lister-Turner, R.; and Clark, J.B. n.d. *A grammar of the Motu language of Papua.* 2nd edition, ed. by Percy Chatterton. Sydney, NSW: A.H. Pettifer, Government Printer.
27 Capell, A.; and Layard, J. 1980. *Materials in Atchin, Malekula: Grammar, vocabulary and texts.* Canberra: The Australian National University [*Pacific Linguistics Series D* 20].
30 Bell, F.L.S. 1977. *Tanga-English, English-Tanga dictionary.* Sydney: University of Sydney [*Oceania Linguistic Monographs* 21].
32 Johnston, Raymond Leslie. 1980. *Nakanai of New Britain.* Canberra: Australian National University [*Pacific Linguistics Series B* 70].
34 Benton, Richard A. 1971. *Pangasinan reference grammar.* Honolulu: University of Hawaii.
35 Li, Paul Jen-Kuei. 1973. Rukai structure. University of Hawaii dissertation.
37 Maan, G. 1951. *Proeve van een bulische spraakkunst.* S'Gravenhage: Martinus Nijhoff [*Verhandelingen van het Koninklijk Instituut voor Taal-, Land-en Volkenkunde* 10].
38 Hale, Kenneth L. 1959. A Papago grammar. Bloomington: Indiana University dissertation.
38 Mason, J. Alden. 1950. *The language of the Papago of Arizona.* Philadelphia: The University Museum, University of Pennsylvania.
39 Hewitt, B.G. 1979. *Abkhaz.* Amsterdam: North-Holland [*Lingua Descriptive Studies* Vol. 2].
40 Lininger, Ross Barbara. 1981. "Estudios sobre el Guaymí Ngabere: Fonología alfabeto y diccionario provisional". *Revista de Filología y Lingüística de la Universidad de Costa Rica* 7(1 y 2): 101–115.
42 Winfield, W.W. 1928. *A grammar of the Kui language.* Calcutta: The Asiatic Society of Bengal [*Biblioteca Indica Work* 245].
43 Loos, Eugene E. 1969. *The phonology of Capanahua and its grammatical basis.* Norman, OK: Summer Institute of Linguistics.
46 Bright, William. 1957. *The Karok language.* Berkeley: University of California [*University of California Publications in Linguistics* 13].
47 Kent, Roland G. 1940. *The sounds of Latin: A descriptive and historical phonology.* Linguistic Society of America.

47 Zirin, Ronald Andrew. 1970. *The phonological basis of Latin prosody.* The Hague: Mouton.
48 Grierson, George A. 1909. *An introduction to the Maithili dialect of the Bihari language as spoken in North Bihar, part I: Grammar.* Calcutta: The Asiatic Society.
48 Jha, Subhadra. 1958. *The formation of the Maithili language.* London: Luzac & Company.
49 Barker, Muhammad Abd-al-Rahman; and Aqil Khan Mengal. 1969. *A course in Baluchi.* Volumes 1 & 2. Montreal: Institute of Islamic Studies, McGill University.
50 Thumb, Albert. 1964. *A handbook of the Modern Greek language.* Chicago: Argonaut, Inc., Publishers.
51 Berulfsen, Bjarne. 1963. *Norwegian grammar.* Oslo: H. Aschehoug & Co.
52 Renck, G.L. 1975. *A grammar of Yagaria.* Canberra: Australian National University.
56 Wacke, Von Missionar K. n.d. "Formenlehre der Ono-sprache (Neuguinea)".
Zeitschrift für Eingeborenen Sprachen 21: 161–208.
58 Anceaux, J.C. 1965. *The Nimboran language: Phonology and morphology.* 'S-Gravenhage: Martinus Nijhoff [*Verhandelingen van het Koninklijk Instituut voor Taal-, Land- en Volkenkunde* 44].
60 Foley, William A. 1991. *The Yimas language of New Guinea.* Stanford, California: Stanford University Press.
67 Traill, Anthony. 1981. Phonetic and phonological studies of !Xóõ Bushman. Johannesberg: University of the Witwatersrand dissertation.
68 Rice, Keren 1989. *A Grammar of Slave.* New York: Mouton de Gruyter.
69 Reh, Mechthild. 1985. *Die Krongo-Sprache.* Berlin: Dietrich Reimer Verlag.
71 Wilson, W.A.A. 1961. *An outline of the Temne language.* London: School of Oriental and African Studies, University of London.
72 Harries, Lyndon. 1950. *A grammar of Mwera.* Johannesburg: Witwatersrand University.
73 Der-Houssikian, Haig. 1980. *Tem grammar handbook.* Brattleboro, Vermont: The Experiment in International Living [*Peace Corps Language Handbook Series*].
74 Thomas, Elaine. 1978. *A grammatical description of the Engenni language.* University of Texas at Arlington: Summer Institute of Linguistics.
75 Becker-Donner, Etta. 1965. *Die Sprache der Mano.* Wien: Hermann Böhlaus [*Osterreichische Akademie der Wissenschaften, Philosophisch-Historisch Klasse, Sitzungsberichte* 245, Band 5].
76 Spagnolo, L.M. 1933. *Bari grammar.* Verona: Missioni Africane.

77 Vandame, R.P. Charles. 1963. *Le Ngambay-Moundou: Phonolo grammaire et textes.* Dakar: Ifan [*Mémoires de l'Institut Français d'A que Noire* 69].
78 Lukas, Johannes. 1967. *A study of the Kanuri language: Grammar vocabulary.* London: Dawsons of Pall Mall.
79 Merrifield, William R. 1963. "Palantla Chinantec syllable types". *Anth pological Linguistics* 5(5): 1–16.
79 Merrifield, William R. 1968. *Palantla Chinantec grammar.* Mexico C Instituto Nacional de Anthropología e Historia de México.
80 Furbee-Losee, Louanna. 1976. *The correct language: Tojolabal: A gra mar with ethnographic notes.* New York: Garland.
81 Newman, Stanley. 1965. *Zuni grammar.* Albuquerque: University of Ne Mexico Press [*University of New Mexico Publication in Anthropology* 1
82 Shipley, William F. 1964. *Maidu grammar.* Berkeley: University California Press [*University of California Publications in Linguistics* 41
83 Kuipers, Aert H. 1974. *The Shuswap language: Grammar, texts, dicti nary.* The Hague: Mouton.
84 Morev, L.N. *et al.* 1979. *The Lao language.* Moscow: Nauka.
85 Caughley, Ross Charles. 1982. *The syntax and morphology of the verb Chepang.* Canberra: The Australian National University [*Pacific Linguis tics Series B* 84].
86 Reichle, Verena. 1981. *Bawm language and lore.* Bern: Peter Lang.
87 Matisoff, James A. 1973. *The grammar of Lahu.* Berkeley: University California Press [*University of California Publications in Linguistics* 75]
89 Bruce, R. 1970. *Cantonese.* London: St. Pauls House [*Teach Yoursel Language Books*].
90 Boas, Franz and Ella Deloria. 1941. *Dakota grammar.* Memoirs of the National Academy of Sciences 23. Washington, DC: U.S. Governmen Printing Office. 2:1–183.
91 Perevoshikov, P.N. 1962. *Grammatika sovremennogo udmurtskogo jazyka: Fonetika i morfologija.* Izhevsk: Udmurtskoe Knizhnoe Izdatelstvo.
92 Nadzhip, E.N. 1971. *Modern Uigur.* Translated by D.M. Segal. Moscow: Nauka.
93 Poppe, Nicholas N. 1960. *Buriat grammar.* Bloomington and The Hague: Indiana University and Mouton [*Indiana University Publications Uralic and Altaic Series* 2].
94 Wurm, S. A.; and Mühlhäusler, P. 1985. *Handbook of Tok Pisin (New Guinea Pidgin).* Canberra: Research School of Pacific Studies [*Pacific Linguistics Series C* 70].