

Disentangling stress and pitch accent: A typology of prominence at different prosodic levels¹

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1. Introduction

There are numerous studies devoted to the typological examination of stress (e.g. Hyman 1977, Liberman & Prince 1977, Hayes 1980, 1995, Prince 1983, Halle & Vergnaud 1987, Goedemans and van der Hulst 1996, Elenbaas & Kager 1999, Gordon 2002, Hyde 2002, Heinz 2009, van der Hulst & Goedemans 2009, van der Hulst et al 2010). This research program has produced many interesting observations and theoretical treatments of stress. Nevertheless, despite the advances it has made, stress typology is subject to limitations that make its findings difficult to situate within a broader theory of linguistic prominence encompassing intonation and prosodic constituency. In particular, even early stress typologists (e.g. Hyman 1977) observed that most typological and theoretical work on stress is based on descriptions gleaned from grammars, for which it is plausible, even likely, that the reported stress patterns are based on words uttered in isolation, where the word is equivalent to an utterance. In such cases, the reported stress patterns more accurately reflect phrase- or utterance-level prominence rather than true word-level stress.

This chapter represents a preliminary attempt to tease apart word-level stress from prominence associated with larger prosodic units with an eye toward creating a typological database of both types of prominence and their relationship to each other. In particular, we focus here on the ability of peripheral syllables to bear prominence at both the word and phrase level.

While this endeavor might seem premature due to the relative paucity of thorough descriptions that disambiguate prominence attributed to different constituents, there is a clear trend toward increasing awareness among linguists of the important distinction between word-level stress and higher-level prominence. Grammars are thus more likely nowadays to provide explicit, even if cursory, statements about whether their description of prominence refers to word-level stress or phrase-level prominence. Genetti's (2007) grammar of the Tibeto-Burman language Dolakha Newar provides an example of a recent grammar with a detailed prosodic description featuring a five-page description of stress, a 22-page chapter on prosody, including phrasal accent and intonation, as well as several representative pitch and intensity traces.

Closely intertwined with this movement toward greater clarity of prosodic descriptions is the now ubiquitous availability of free acoustic analysis software, in particular, Praat (Boersma & Weenink 2010), which allows for both rapid confirmation of impressionistic judgments about stress and phrasal prominence and the possibility of more systematic quantitative study of acoustic correlates of prominence of different types. Some grammars now include representative displays such as pitch traces, waveforms, intensity curves, that provide some sense of how prominence is acoustically manifested. The incorporation of phonetic data of this sort is

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invaluable in assessing the relationship between word-level stress and phrase-level prominence, which are often distinguished through different phonetic means.

Given the tendency toward greater explicitness of stress descriptions and the buttressing of these accounts with phonetic data, it seems worthwhile to foster this line of research by providing a typological framework into which languages can be categorized according to their prominence patterns associated with different prosodic units, much like languages are commonly classified as either being stress, tone, or pitch accent languages (see Hyman 2006, this volume, and van der Hulst 2011 for discussion). A further benefit of developing a typology of prominence at different levels is its potential for enriching the phonological literature on metrical stress theory. An enlarged typological database on both stress and phrasal prominence and the interaction between the two will enable linguistics to develop richer and empirically more explicit theories of prominence, thereby extending in new directions the research program of metrical stress theory that has been so productive since the 1970s.

2. Word-level stress vs. phrase-level pitch accent

A necessary precursor to discovering generalizations about prominence at different levels is an understanding of the various sources of prominence. Languages are characteristically bifurcated into two groups based on whether differences in prominence are based on lexical contrasts in pitch or not. Members of the former class of languages are traditionally termed “tone” languages, whereas members of the latter camp are regarded as “stress” languages. In reality, not all languages can be neatly classed into either the tone and stress categories (see Hyman 2006, this volume for discussion), prompting many researchers to introduce a new hybrid type of system based on “pitch accent” (see van der Hulst 2011 on pitch accent). We can abstract away from this complication for the time being, though, and instead confine our discussion largely to more prototypical stress systems, although section 4 will delve into some languages instantiating features of lexical tone.

The seminal research on the phonetic correlates of stress conducted by Fry (1955, 1958) identified several acoustic cues to stress, including increased duration and intensity and certain pitch properties such as higher or changing fundamental frequency (F0). Fry (1958) found that, of these features associated with stress, higher F0 was perceptually most important in determining perceived prominence. Acoustic studies of stress have been conducted for many languages since Fry’s study, e.g. Polish (Jassem et al. 1968), Mari (Baitschura 1976), Indonesian (Adisasmito-Smith & Cohn 1996), Tagalog (Gonzalez 1970), Thai (Potisuk et al. 1996), Pirahã (Everett 1998), Aleut (Taff et al. 2001), Chickasaw (Gordon 2004), Turkish (Levi 2005), Kabardian (Gordon & Applebaum 2010), with most languages showing a reliance on some combination of increased duration, greater intensity, and/or higher F0 as acoustic markers of stress.

A major limitation of Fry’s study (and many like it), however, is that it was based on words occurring in the focal position of an utterance, a position that subsequent work has shown conflates both word-level stress and phrase-level prominence. More recent work (e.g. Sluijter 1995, Sluijter and van Heuven 1996a,b) has attempted to tease apart these two types of prominence showing that each is realized through different phonetic means and is governed by different prosodic considerations. One of the most important findings emerging from this research is that salient F0 characteristics contributing to perceived prominence are primarily associated with syllables carrying phrasal prominence, often termed “pitch accented” syllables (where “pitch accent” is used in a different sense from its use to refer to hybrid prosodic systems sharing some features with tone languages and others with stress languages.) A pitch accent as it

pertains to stress languages like English may be broadly defined as a tonal prominence distinct from tones associated with the boundaries of intonational constituents. Pitch accents characteristically impart semantic information such as focus or other pragmatic content that the speaker wishes to convey. A syllable that carries stress at the word level thus may be promoted to pitch accent status by virtue of being in a certain position in a phrase or being associated with special semantic or pragmatic focus. For example, in the English sentence *Alligators terrify elephants* it is possible for the first syllable in either *alligators* or *elephants* to bear a prominent pitch accent depending on which noun is the object of focus. It is also possible for the verb *eat* to carry a pitch accent if the sentence is uttered in response to the question *What do alligators do to elephants?* In case of no special focus on either of the nouns, for example, if answering the question *What do alligators do?*, the first syllable of *elephants* is likely to carry a pitch accent. It is also possible for there to be multiple pitch accents in an utterance, as in the response to the question *Who terrifies whom?*, which is likely to have a pitch accent on both *alligators* and *elephants*.

A consistent feature of most stress languages is that the pitch accent is restricted to stressed syllables. Thus, only the first syllable of each of the English words *alligators*, *terrify*, and *elephants* is eligible to receive a pitch accent since the first syllable carries the main stress of each word. This property illustrates an important feature of pitch accents in most languages (with the exception of the “top-down” accentual systems discussed in section 4.1.2): they are assigned in bottom-up fashion by promoting one of the primary word-level stresses to pitch accent status.

Another key feature of pitch accents is that they are, as the name suggests, definitionally associated with certain pitch properties phonetically. This contrasts with stresses assigned at the word level which are not necessarily, in fact, often are not, cued by pitch features, but rather by other properties such as increased duration, greater intensity (particularly at higher frequencies), and/or hyperarticulation. Thus, Sluijter & van Heuven (1996a) show that pitch in English is a marker of phrase-level pitch accent rather than word-level stress, which is instead cued by other properties such as differences in spectral tilt and vowel reduction. Sluijter & van Heuven (1996b) show that spectral tilt is also a marker of stress in Dutch. Similarly, Gordon (2004) finds that, although raised F₀ is a useful cue to distinguishing primary word-level stress in Chickasaw, it is subordinate to duration and intensity in its robustness as a marker of word-level stress. At the phrase-level, on the other hand, F₀ is the most salient signal of pitch accents.

Pitch accents are not universally found in all stress languages. Wolof (Ka 1988, Rialland & Robert 2001) and Kuot (Lindström & Remijnsen 2005) both have word-level stress, lexically contrastive in Kuot and phonologically predictable in Wolof, but lack phrase-level pitch accents on stressed syllables. In both Wolof and Kuot, stress is cued by properties other than F₀, which is reserved for signaling semantic and pragmatic functions at phrase edges.

3. Pitch prominence beyond pitch accent

Pitch accents are not the only source of prominence. Pitch excursions associated with phrase edges, especially the right edge, provide another source of pitch movements that potentially contribute to perceived prominence. Most languages realize their unmarked declarative utterances with a terminal pitch fall (Ladd 1996, Gussenhoven 2004). Depending on the language, other semantic types of utterances may be associated with a pitch fall as well or may be realized with a pitch rise or a combination of the two. For example, yes/no questions in English characteristically are realized with a final rise in pitch, thereby distinguishing them intonationally from declaratives and wh-questions. The large prosodic units characterizing coherent semantic constituents such as declaratives and questions are typically termed ‘Intonational Phrases’ or ‘Intonation Units’.

Pitch excursions associated with a phrase edge may also be attributed to prosodic phrases smaller than the Intonational Phrase (or Unit). Thus, smaller phrases, termed ‘Accentual Phrases’ in French (Jun & Fougeron 1995, 2000) are associated with a tonal pattern that includes a final transition from a low pitch target to a high tone. Similarly, Accentual Phrases in Korean (Jun 1993) are realized with a beginning transition from low to high pitch.

It is significant for the typology of stress that the pitch excursions associated with both Intonational Phrases and smaller phrases may be interpreted as word-level stress for words uttered in isolation, where the word is equivalent to a phrase. Thus, the stress referred to in Fry’s work on English is actually attributed to the combination of pitch accent and terminal pitch excursion characteristic of words uttered in isolation, where the word is equivalent to an Intonational Phrase. Jun & Fougeron (1995, 2000) analyze the prominence on final syllables that is often referred to as stress in French as the pitch rise associated with the right edge of the Accentual Phrase, a smaller phrase than the Intonational Phrase. Similarly, Jun (1995) shows that the percept of stress in Korean is attributed to the pitch rise found at the left edge of an Accentual Phrase.

Perhaps the most striking case of a language that has frequently been analyzed as having word-level stress but has been experimentally shown to possess only boundary pitch excursions is Indonesian. Many accounts of Indonesian posit stress on the penultimate syllable of a word with, in some analyses, a provision that schwa in the penult relinquishes stress to the final syllable (see van Zanten & van Heuven 1998 for an overview). Van Zanten & van Heuven (1998) show, however, that Indonesian listeners fare no better in word recognition gating experiments when presented with a stressed syllable than when hearing an unstressed syllables. Based on this result, they conclude that stress plays no essential communicative function for Indonesian speakers. In another perception experiment, van Zanten et al (2003) found that there is no consistent syllable that is judged by listeners (except those who speak a substrate language such as Toba Batak with contrastive stress) to sound more felicitous when associated with prominence. They conclude (pg. 172): “In our view, the rule that drives prominence patterns in the influential Javanese variety of Indonesian is phrasal. Possibly the only phonological rule that is relevant for accent location in Indonesian states that it must occur somewhere at the right edge of the phrase.”

The upshot of this discussion is that it is important to distinguish word-level stress from pitch properties characteristic of units larger than a word. In practice, a study of word-level stress must thus look at words that are not pitch accented and not found in phrasal positions where boundary excursions might give the erroneous impression of stress.

4. The relationship between pitch accent and word-level stress

Although it is important to distinguish between word-level stress and phrasal pitch properties, there is a close relationship between stress and at least one phrasal pitch feature: pitch accents. As we have seen in section 2, pitch accents are characteristically assigned in bottom-up fashion based on word-level stress patterns. Thus, only syllables that are stressed at the word level may carry a pitch accent under normal circumstances in most languages. For example, only the first syllable of *rabbits* or the last syllable of *giraffes* may receive a pitch accent in the sentence *Rabbits like giraffes*, since they are the only stressed syllables in these words. Likewise, only the first and third syllables of *Tennessee* are eligible for pitch accents due to their stress. Most commonly, the third syllable of *Tennessee* would serve as the docking site for a pitch accent associated with the word since it is the primary stressed syllable. However, even a syllable carrying secondary stress could preferentially receive a pitch accent in certain phrasal contexts. For example, the rhythm rule of English (Hayes 1984) could trigger retraction of the pitch accent

in *Tennessee* to the secondary stressed initial syllable in the phrase *Tennessee governor* in order to avoid a clash with the primary stress on the initial syllable of *governor*.

Most languages typically only promote a subset of word stresses to pitch accent status. The dominant cross-linguistic pattern is for the primary stressed syllable in the rightmost content word to bear a pitch accent if there is only one in the phrase or to bear the most prominent pitch accent if there is more than one (Ladd 1996). Languages differ, however, in the density of their pitch accents. An extreme case of pitch accent density is found in Egyptian Arabic (Hellmuth 2006, 2007), in which every content word is associated with a pitch accent, which docks on the second mora of the foot containing the primary stress, i.e. on the second half of a stressed long vowel or the coda consonant of a stressed closed syllable, otherwise after a stressed short vowel in an open syllable.

Not all languages behave like English or Egyptian Arabic in having a default rule promoting the primary stressed syllable of a word to pitch accent status. There are other languages that have “top-down” pitch accent systems in which pitch accents are not necessarily projected from word-level stress but rather may be assigned based on at least partially orthogonal principles. Thus, several Northern Iroquoian languages (Chafe 1977, Michelson 1988) display an asymmetry between phrase-final words and phrase non-final words in their stress patterns. I mention some of these asymmetries here and refer the reader to Chafe (1970, 1977) and Michelson (1988) for discussion of the many interesting prosodic differences between utterance-final and utterance-medial forms observed in the family. Onondaga draws a distinction between what Chafe (1970) terms “sentence-final” words and non-sentence-final words in the location of their accent, which is most saliently associated with raised F₀. Onondaga words are accented on their final syllable when they are followed by one or more words within a sentence, which he describes as a phrasal prosodic constituent. Words in final position of a sentence, on the other hand, are characteristically accented on the penult, though certain morphemes can trigger either final or antepenult accent. Similar non-finality effects at the phrase-level are also observed in related Seneca (Chafe 1977, 1996) and Cayuga (Foster 1982, Chafe 1977, Michelson 1988, Dyck 2009), both of which display an alternating stress pattern originating at the beginning of the word from which the phrase-final accent is projected.

One issue that is less clear from published descriptions is the presence and relative prominence of non-final stresses in phrase-medial words. In her analysis of Cayuga, Dyck (2009) marks only the final stress in phrase-medial words. Michelson (1988:80), on the other hand, following Foster (1980) treats the stresses found in phrase-final forms as also being present phrase-medially in Cayuga. Chafe’s (1970) description of Onondaga suggests that only the final syllable is stressed in phrase-medial words. In Seneca, on the other hand, any accents found in phrase-final words are also present in phrase-medial words in addition to the word-final accent, although the relative prominence of the different accents is unclear (Chafe p.c.). Assuming that the non-final stresses are at least present (regardless of their prominence relative to the final stress) in phrase-medial forms, the pitch accent in phrase-final forms in Seneca and Cayuga selects a syllable that already has some degree of stress at the word-level. In Onondaga, on the other hand, the accent in phrase-final words appears to be docking on a syllable that is unstressed phrase-medially.

Another case of an accent falling on a syllable that is unstressed at the word-level is found in the Muskogean language, Chickasaw (Gordon 2003). Thus, words that have word-level stress on a final light (CV(C)) syllable position the pitch accent on a non-final syllable in questions. Thus, the word *tífo* ‘medicine man’ has final stress in non-final position of a phrase, e.g. *tífo pisa* ‘S/he looks at the medicine man’, but at the end of a question it has the pitch accent on the penult, e.g. *kata:t tífo?* ‘Who is a medicine man?’. The English equivalent to this type of pattern

would be exemplified by the highly unnatural sounding rendition of the question *What is a giraffe?* with a pitch accent on the first and unstressed syllable of *giraffe* rather than the second and stressed syllable.

Chickasaw and the Northern Iroquoian languages mentioned above share certain interesting properties. In both languages, the pitch accent is more resistant than stress to docking on final syllables. This non-finality effect observed in pitch accent placement is common in languages with top-down pitch accent systems and is examined further in section 4.

It is also interesting to note that the final stress in Chickasaw, Seneca, and Cayuga is also completely independent of the rhythmic stress that initiates at the opposite edge of the word, creating a stress clash at the right edge of words in which the penult is in a metrically strong position as calculated from the beginning of the word. Chickasaw, Seneca, and Cayuga thus represent a case of non-metrical primary stress (van der Hulst 1984, 1997, this volume), i.e. the primary stress being positioned independently of rhythmic stress.

There is another interesting feature of Chickasaw. There is phonetic evidence that the primary stress in a word bearing a pitch accent winds up on the same syllable as the pitch accent. Thus, pitch accented syllables not only are associated with higher F₀ than other unaccented syllables, but they also are realized with other phonetic correlates of primary stress including increased duration and intensity relative to both unstressed and secondary stressed syllables (Gordon 2003). Although one could argue that duration and intensity are parasitically increased due to the pitch accent rather than reflecting stress in its own right, it is empirically simpler to assume that both primary stress and the pitch accent congregate on the same syllable than to assume that they dock on different syllables. Furthermore, it is also not a logical necessity for pitch accented syllables to also be associated with increased duration and intensity as the separation of tone and stress in many languages, both those with lexical tone, e.g. Pirahã (Everett 1998) and Thai (Potisuk et al 1996), and those with intonational boundary tones, e.g. Wolof (Rialland & Robert 2001) and Kuot (Lindström & Remijsen 2005) demonstrates. The tendency for stress and pitch accent to end up on the same syllable regardless of the direction of attraction appears to be a shared characteristic of stress languages. Consistent with this view is the fact that normally unstressed syllables in English wind up with all the stress-related properties when they carry a pitch accent to mark contrastive syllable-level focus (van Heuven 1994), e.g. *I said sumMAry not sumMEry*.

There are, however, certain exceptional cases of intonational tones that are attributed neither to prosodic boundaries nor to pitch accents. Papiamentu (Remijsen & van Heuven 2005) and many varieties of Swedish and Norwegian (Riad 2006) possess a different type of tonal accent, termed a “prominence tone” by Riad, that may not be projected from word-level stress but is also not associated with a boundary. The distinction between the prominence tone and both boundaries and stress can be observed most clearly in polysyllabic words containing multiple stresses. According to Riad’s (2006) analysis, in certain Scandinavian dialects, e.g. Central Swedish, the prominence tone docks on the stressed syllable, typically the rightmost one, which is a secondary stress in words with multiple stresses. In other varieties, such as Southwestern Norwegian, the prominence tone associates with the posttonic syllable rather than the secondary stressed syllable. In both varieties, the left edge of the word is associated with a high tone and the right edge with a low tone, though these boundary tones are not found in all contexts (Bruce 2005). This contrast between dialects is illustrated by the word *sommarledigheten* ‘the summer vacation’, which is realized in Central Swedish as in (1a), and in Southwestern Norwegian as in (1b), where the prominence tone in both dialects (but not in all Scandinavian varieties) is LH (adapted from Riad 2006:44)

(1) Tonal association in two varieties of Scandinavian (based on Riad 2006)

a. Central Swedish

H LH L
| | |
'sɔmmar,ledigheten

b. Southwestern Norwegian

H LH L
| | |
'sɔmmar,ledigheten

Papiamentu (Remijsen & van Heuven 2005) also has a LH prominence tone that docks on an unstressed final syllable under focus in a certain class of words with stress on the penultimate syllable. In another class of words, the prominence tone aligns with a stressed syllable, either the penult or the ultima depending on a word's tonal category.

One complication concerning the Scandinavian and potentially the Papiamentu cases is the possibility of alternative analyses that attribute the prominence tone to a bitonal pitch accent containing a leading or trailing tone that phonetically either precedes or follows, respectively, the syllable with which it is phonologically associated (see, for example, Bruce 2005 on Swedish).

A clearer case of a prominence tone that is not projected from stress and is not amenable to reanalysis as a bitonal pitch accent is found in Nubi (Gussenhoven 2006). Every Nubi word contains one high tone, whose location is lexically marked with a statistical prevalence for falling on the penultimate syllable. As in Egyptian Arabic, there is a one-to-one relationship between tonally prominent syllables and words in Nubi, but unlike in Egyptian Arabic, there is no evidence for any stress independent of the prominence tone in Nubi.

In summary, there are many types of relationship between stress and tonal prominence. One dimension along which languages can be classified is whether pitch accents are projected bottom-up from word-level stress, as in English or Egyptian Arabic, or top-down under different principles from those governing word-level primary stress, as in Onondaga, Seneca, Cayuga, Chickasaw, Nubi, and possibly (depending on the analysis) Scandinavian and Papiamentu. Another cross-cutting parameter concerns the numerical mapping between phrasal accents and word-level stress. Thus, in many languages, e.g. English, Seneca, Chickasaw, and Papiamentu, only a subset of word-level stresses typically receive a pitch accent in a phrase, whereas in others, e.g. Egyptian Arabic, Scandinavian, and Nubi, the number of pitch accents is equal to, or nearly equal to, the number of word-level stresses.

In the rest of this chapter, we will focus on the relationship between word-level stress and tones that are unambiguously amenable to an analysis as pitch accents. This includes both bottom-up (English, Egyptian Arabic) and top-down (Seneca, Onondaga, Cayuga, Chickasaw) prominence systems, but excludes both languages like Scandinavian and Papiamentu in which stress and non-boundary tonal prominence may fall on different syllables, as well as languages like Nubi, which lack evidence for stress independent of tonal prominence. As we will see, the examination of both bottom-up and top-down pitch accent systems provides fertile ground for the examination of non-finality, and more generally non-peripherality, effects at both the word and phrase level.

4.1. The typology

A convenience survey of the literature on word-level stress and phrasal pitch accent was conducted in order to explore the range of variation observed in the types of relationship holding between stress and pitch accents. Although the results of this typology must be regarded with caution due to the paucity of available descriptions teasing apart the two types of prominence, it nevertheless reveals some interesting distributional asymmetries in the nature of interactions between stress and pitch accent.

4.1.1. Bottom-up pitch accent

The English and Egyptian Arabic type pattern in which phrasal pitch accents characteristically dock on a syllable carrying primary stress at the word level emerges as the dominant one cross-linguistically. It is typically the case that a phrasal pitch accent falls on the rightmost content word under default semantic and pragmatic conditions. Thus, in the English sentence *The president likes Tennessee*, a pitch accent is more likely to fall on the primary stressed (final) syllable of *Tennessee* than on *president* barring some type of special focus on president.

The English type system of bottom-up pitch accent projection is observed in many languages (see Jun 2005a for discussion of pitch accents in several languages), though it is worth noting that the sample is heavily skewed in favor of Indo-European languages. Crucially, languages of this type do not allow unstressed syllables to carry a pitch accent except under extremely limited syllable-level contrastive focus conditions (van Heuven 1994).

4.1.2. Top-down pitch accent

Another type of relationship between phrasal pitch accent and word-level stress is the Northern Iroquoian (i.e. Seneca, Onondaga, Cayuga) and Chickasaw type, according to which the pitch accent is delegated in “top-down” fashion. In most cases, this pattern can be inferred from descriptions that refer to differences in stress in phrase-final words vs. words in other positions in a phrase under the plausible assumption that phrase-final words are more likely to carry a pitch accent in the default case as appears to be the dominant (e.g. in English and Chickasaw) pattern cross-linguistically (Ladd 1996). All of the top-down pitch accent systems found in the survey display pitch accent repulsion from the right edge, since the pitch accent fails to dock on the final syllable and instead latches onto an earlier stressed syllable. With the exception of Chickasaw, another common feature of the top-down systems is that they select a syllable that carries some degree of stress, i.e. secondary stress, to promote to pitch accent status, a pattern reminiscent of the rhythm rule of English discussed in section 4. The selection of a secondary stressed (or unstressed syllable) as opposed to a primary stressed syllable as the docking site for the pitch accent differentiates the top-down systems from those found in languages like English, with a stricter (but not inviolable, cf. the rhythm rule) of bottom-up pitch projection situating pitch accents on phrase-final syllables carrying primary word-level stress.

Another language besides Chickasaw, Seneca, Onondaga, and Cayuga that instantiates top-down pitch accent placement is Central Alaskan Yup'ik (Miyooka 1985, 1996, Woodbury 1987), which displays an asymmetry in the stress patterns observed in phrase-final words and those found in phrase-non-final words that is amenable to interpretation in terms of an asymmetry between word-level stress, i.e. in phrase-non-final words, and phrasal pitch accent, i.e. in phrase-final words. Words in both contexts display an iambic stress pattern according to which stress falls on heavy (CVV everywhere and CVC word-initially) syllables and on the second in a sequence of adjacent light syllables. However, phrase-final syllables are unstressed,

whereas phrase-medial words have an additional stress on their final syllable, which, as in Seneca, Cayuga, and Chickasaw, is independent of the rhythmic stress initiating at the left edge of the word. It is difficult to discern from sources whether the additional stress on the final syllable of phrase-medial words in Central Alaskan Yup'ik is the primary stress or not.

Chickasaw presents a particularly complicated case of top-down pitch accent that offers insight into the reasons behind the observed asymmetries between stress and pitch accent placement. Word-level stress in Chickasaw (Gordon 2004) falls on word-final syllables, on heavy (CVV, CVC) syllables, and on the second syllable in a sequence of two light (CV) syllables (2). A stressed vowel in a non-final CV syllable is rhythmically lengthened and counts as a long vowel for purposes of primary stress and pitch accent (Munro and Ulrich 1984, Munro and Willmond 1994, Munro 2005, Gordon et al. 2000) (see the last two examples in 2). Primary word-level stress falls on the final syllable in words lacking either a long or rhythmically lengthened vowel. In words containing a long or rhythmically lengthened vowel (CVV), the primary stress docks on the long/lengthened vowel. Words with multiple CVV syllables display variation, both inter and intraspeaker, in whether the rightmost or leftmost CVV carries primary stress. Most typically, the rightmost CVV receives primary stress and the others receive secondary stress (as reflected in the stress markings in the last four examples in 2).

(2) Chickasaw stress and rhythmic lengthening

,isso'ba	'horse'
,baʃ'po	'knife'
a'bo:koʃiʔ	'river'
'ba:taɱbiʔ	Proper name
tʃa,lak'kiʔ	'Cherokee'
,ok,fokkol	'type of snail'
'na:ʔto,kaʔ	'policeman'
,a:jo'ka:tʃiʔ	'police station'
,a:ki'la:ʔ	'wick'
pi'sa:li,tok /pisalitok/	'I looked at him/her'
tʃi,pi:sali,tok /tʃipisalitok/	'I looked at you'

Stress is cued by a combination of increased duration and intensity and higher fundamental frequency (pitch) with duration being the most reliable cue to stress followed by intensity and then fundamental frequency. Unstressed syllables are also subject to various lenition processes, including vowel deletion, devoicing and qualitative reduction. There is interspeaker variation in the relative strength of the various correlates of stress.

Word-level stress patterns are observed in words that appear in non-final position of the prosodic domain Gordon (2003, 2005) terms the Intonational Phrase, following work on other languages within the ToBI framework (Pierrehumbert 1980, Silverman et al. 1992, Beckman and Hirschberg 1994, Pitrelli et al. 1994). The Intonational Phrase is characterized by, among other properties, a pitch accent, phonetically a high tone, falling within the final word. The location of the pitch accent differs depending on whether the Intonational Phrase is a question or a statement. In statements, the pitch accent falls on the final syllable, which already carries some degree of stress at the word level. In questions, the pitch accent is sensitive to a more complicated pattern governed by both phonological and morphological factors. I focus here on the phonological factors and refer the interested reader to the discussion of the morphological conditioning of the pitch accent in Gordon (2003). The pitch accent falls on the final syllable of

questions if this syllable contains a long or lengthened vowel (3a). Otherwise, it docks on the penultimate syllable provided it is heavy, where both CVV and CVC count as heavy (3b). If the final syllable is not CVV and the penult is neither CVV nor CVC, the pitch accent lands on the antepenult, which is necessarily either heavy due to the process of rhythmic lengthening or word-initial (3c).

(3) Pitch accent in Chickasaw questions

a. (ka:ti:mih'tā:) **sa,ha:'fá:** 'Why am I angry?'

(nan'ta:t) **ok'tá:k** 'What is a prairie?'

b. (nan'ta:t) **ha'tá:tʃim** 'What turned color?'

(nan'ta:t) **tʃilák,bi** 'What is dry and cracked?'

(ka:ti:jak,ta) **a'kán,kaʔ** 'Where's the chicken?'

c. **'málli,tam** 'Did s/he jump?'

(nan'ta:t) **a'bó:ko,ʃiʔ** 'What's a river?'

(nan,tah'tā:) **'písam** 'What did s/he see?'

In all of the cases discussed thus far for both statements and questions, the pitch accent falls on a CVV or CVC syllable, syllables which are already stressed at the word level. In some cases, however, the pitch-accented syllable would only carry secondary stress at the word level. This holds true of all pitch accented CVC penults and antepenults, of CVV penults and antepenults followed by a final CVV, and of statements ending in CV or CVC and preceded by a pre-final CVV syllable. To illustrate the case of pitch accents docking on syllables with secondary rather than primary word-level stress, consider the word /tala:nompaʔ/ 'telephone', which is realized as ta'la:nom,paʔ phrase-non-finally, as ta,la:nom'páʔ at the end of a statement Intonational Phrase, and as ta,la:nóm,paʔ at the end of an interrogative Intonational Phrase.

Even more interestingly, the overriding restriction against a pitch accent on a final syllable other than CVV in questions means that a disyllabic word of the form CVCV(C) carries a pitch accent on the CV first syllable, which is completely unstressed at the word level. For example, the word /fala/ 'crow' has final stress internal to a phrase, i.e. fa'la, and at the end of statements, where it also carries a pitch accent, i.e. fa'lá, but it has a pitch accent and initial stress at the end of questions, i.e. 'fála.

In summary, all of the pitch accent systems discussed in this section have in common that the pitch accent either avoids final stressed syllables completely, as in Cayuga, Central Alaskan Yup'ik, and Onondaga, or is subject to more stringent weight criteria than stress, as in Chickasaw. Interestingly, another logically possible system that appears to be far less widely attested, if at all, is the inverse of these patterns in which the pitch accent is attracted to rather than repulsed by the right edge. In this type of system, word-level stress would fall on a pre-final syllable but the phrasal pitch accent docks on a final syllable. We return to this gap in the typology in section 7.

The top-down prominence systems identified in the survey appear to vary in whether the pitch accent docks on a syllable that carries secondary stress or is unstressed at the word level. Thus, Yup'ik, Seneca, and Cayuga appear to promote a syllable carrying at least secondary stress to pitch accent status at the phrase-level. In Onondaga, on the other hand, it appears that the pitch-accented syllable is not stressed at the word level. Finally, Chickasaw displays both patterns, placing pre-final pitch accents on a secondary stressed syllable if one is available, but in

disyllabic stems of the form CVCV(C) assigning the pitch accent (in questions) to the initial syllable, which is completely unstressed. The diversity of patterns observed in the small sample of data examined here suggests the need for broader cross-linguistic investigation of the extent to which pitch accent is dependent on word-level stress even in top-down systems that assign pitch accents to syllables that do not carry primary stress at the word level.

4.2. Explaining the typology of stress/pitch accent relations

In accounting for the relationship between stress and pitch accent, it is instructive to consider the phonetic differences between the two types of prominence. Pitch accent, as the name suggests, is primarily cued through fundamental frequency, whereas stress may be signaled through a variety of properties, including duration, intensity, fundamental frequency, and various segmental processes. Because pitch accent is principally realized through the single phonetic dimension of fundamental frequency, it is potentially sensitive to other pitch events in the vicinity, including phrase level pitch properties. As discussed in section 3, one of the cross-linguistically most salient phrase-level tone features is the boundary tone associated with the right edge of large intonational constituents. Many intonation systems seek to avoid realizing multiple tonal targets on a single syllable just as many languages with lexical tone, e.g. Iraqw (Mous 1993), Runga (Nougayrol 1990), have restrictions against contour tones on a single syllable (see Maddieson 1978, Clark 1983, Hyman 1988, Zhang 2002 on the typology of contour tone restrictions). Tonal crowding is particularly problematic when the two tones have different target levels, e.g. if one is high and one is low, since it can be articulatorily and perceptually disadvantageous to temporally compress a fundamental frequency transition into a short time period.

There are differences strategies for ameliorating the effects of tonal crowding cross-linguistically. Certain languages eliminate one or more of the tones in crowding contexts, the intonational analog to tonal deletion rules simplifying contour tones (Hyman 2007). For example, in Hungarian (Ladd 1983), the question tune consists of a low tone (the nuclear pitch accent) on the primary stressed syllable of the focused word followed by a high plus low boundary tone at the right edge of the question, as in (4a). Because Hungarian imposes an upper limit of two tones per syllable (4b), the low component of the boundary tone is deleted if the final syllable would otherwise contain three tones (4c).

(4) Tonal crowding in Hungarian (Ladd 1983)

a. L* H L%
 | | |
 Beszél a miniszter? ‘Is the minister talking?’

b. L*HL%
 | |
 A tanár? ‘the teacher?’

c. L* H(L)%
 |
 sör? ‘beer?’

Other languages change the scaling of tones in crowding contexts so that the transition between tonal targets is less demanding, i.e. has a shallower slope. For example, in Greek (Arvaniti and Baltazani 2005), the second in a sequence of L* + H pitch accents often undergoes

undershoot of the L* component.

A third strategy for reducing tonal crowding is to lengthen the segments on which the tones are realized. For example, Japanese (Venditti 2005) and Korean (Jun 2005b) lengthen final syllables that are associated with boundary tones consisting of multiple tonal targets, e.g. LH% or HL%. Final lengthening in Swedish also allows for the realization of both lexical accents and boundary tones (Bruce 2005).

Still another possible response to tonal crowding is to shift the two tonal targets in the time domain such they are farther apart. For example, a prenuclear H* pitch accent in English occurs earlier in a syllable immediately preceding a nuclear accented syllable than in a syllable not followed by an accented syllable (Silverman and Pierrehumbert 1990). The LH prominence tone in Papiamentu is also shifted leftward in sentence-final position under pressure from a final boundary tone (Remijsen & van Heuven 2005).

This tonal shifting response offers an explanation for languages in which prominence in phrase-final words, inferred to be the pitch accent, is repelled from word-final syllables that carry stress internal to the phrase. An explanation of pitch accent placement in terms of tonal crowding avoidance is also supported by the Chickasaw sensitivity of pitch accent placement to both boundary tone type and syllable weight. Thus, questions have a low boundary tone that triggers retraction of the high pitch accent to a non-final syllable (unless the final syllable is CVV) whereas statements lack this low boundary tone and accordingly allow a pitch accent on any type of final syllable. Only questions thus require a transition from a high pitch accent to a low boundary tone. This transition is only possible if the final syllable contains a maximally sonorous long vowel, which is best equipped to handle the transition from high to low tonal targets. There is a parallel found in many tone languages, e.g. Tubu (Lukas 1953) and Somali (Berchem 1993), which allow contour tones only on syllables containing a long vowel (see Maddieson 1978, Clark 1983, Hyman 1988, Zhang 2002 for the typology of weight-sensitive tone restrictions).

Parallel to statements, there is also no tonal transition required in phrase-internal words in Chickasaw. For this reason, there is no compulsion to retract word-level stress from final syllables in words that are not in final position of a phrase; hence, the docking of word-level stress on final syllables.

A phonological analysis of pitch accent placement based on tonal crowding is further supported by phonetic timing patterns observed in Chickasaw. Gordon (2008) finds that the actual f₀ peak associated with the pitch accent in Chickasaw occurs progressively earlier in accented syllables as the distance between the accented syllable and the end of the phrase decreases. The peak is thus timed to fall at the beginning of final long vowels, during the second half of accented long vowels in the penult and near or after the end of accented long vowels in the antepenult. The pitch accent is also timed earlier in accented CVC syllables in the penult than in the antepenult.

An intonationally-driven account of stress and pitch accent finds additional support from certain phonetic details observed in Iroquoian languages. Pitch traces in Doherty's (1993) work on Cayuga show a terminal drop in F₀ utterance-finally as well as an F₀ peak associated with accented syllables, which together provide direct support for the potential for tonal crowding in Cayuga. Seneca (Chafe p.c.) utterances are likewise associated with a terminal F₀ fall in the default case of statements while accented syllables have an F₀ peak. In Onondaga, the pitch peak associated with stress characteristically precedes the stressed syllable utterance-finally (Michelson 1988). The early realization of the pitch peak may be regarded as a further repulsion of the pitch peak from the end of the utterance along the lines of the inverse correlation between the proximity of the accented syllable to the right edge of questions and the timing of the pitch peak within the accented syllable in Chickasaw. Historically, the ancestor of modern Northern Iroquoian languages is reconstructed as having penultimate accent (Chafe 1977, Michelson

1988), which the account advanced here would attribute to tonal crowding avoidance. The early timing of the pitch peak in Onondaga relative to the stress may thus be regarded as an extension of the tonal repulsion effect already present in the proto-language.

Following the discussion in Hyman (1977) and Gordon (2000b), the intonational analysis of pitch accent repulsion from final syllables can be extended to account for the preponderance of languages reported in grammars to have penultimate rather than final stress under the assumption that the reported stress patterns reflect those found in words uttered in isolation where, under the default pronunciation, there is likely to be a low boundary tone compelling the retraction of the stress, i.e. the pitch accent in this context, from the final syllable to the penult. The tonal account of final stress repulsion is particularly attractive given the contrast between the prevalence of reports of penultimate stress and the rarity of descriptions reporting the left edge counterpart to penultimate stress: peninitial stress. Thus, Hyman (1977), Gordon (2002), and van der Hulst and Goedemans (2009) all observe that penultimate stress is substantially more common than peninitial stress in their databases: 77 languages vs. 12 in Hyman (1977), 54 languages vs. 10 in Gordon (2002) and 77 languages vs. 13 in van der Hulst & Goedemans (2009). The asymmetry in the relative frequency of penultimate and peninitial stress also falls out naturally if one assumes that the majority of stress descriptions are referring to isolation forms where the stress is actually a pitch accent. Penultimate stress is common due to the pervasiveness of final boundary tones, in particular, final low boundary tones, whereas the striking rarity of peninitial stress is attributed to the paucity of left edge boundary tones. Antepenultimate stress is also amenable to an explanation in terms of tonal crowding avoidance under the assumption that some languages might deem it preferable to allow an entire syllable, the penult, to intervene between the pitch accent and the boundary tone. This account is supported by both the early timing of the pitch accent in the penult relative to the antepenult in Chickasaw questions as well as the early realization of the pitch accent even in Onondaga utterance-final words with stress on the penult.

Obviously the proposed link between tonal crowding and stress requires further evaluation, which will become increasingly feasible as the number of thorough descriptions of both word-level stress and phrase-level intonation expands. As a final note, it is worth mentioning that there are other potential contributing factors to final prominence avoidance, including the subglottal pressure trough characteristic of final position of the utterance and the opening of the vocal folds in anticipation of breathing. These properties are both antagonistic to prominence since they are often associated with devoicing (Gordon 1998, Barnes 2002, Myers 2011), which virtually precludes the possibility of realizing intonational information. Together with tonal crowding avoidance, final devoicing further militates against final pitch accents.

4.3. Left edge pitch accent repulsion

Although pitch accent repulsion is primarily observed at the right edge of phrases, there is some evidence that it also exists to a more limited extent at the beginning of phrases. Pitch contours characteristic of utterances generally display a declination from beginning to end. Prior to this declination pattern, there is typically a slight rise in fundamental frequency at the very beginning of the utterance as subglottal pressure rises. If the fundamental frequency peak at the beginning of the utterance is delayed sufficiently, it could fall in the second rather than the first syllable in the absence of any pitch accent at or near the right edge of the phrase. Under this approach, the relatively rare case of peninitial prominence can be analyzed as a pitch accent phenomenon parallel to the analysis of penultimate stress. Let us briefly consider two languages, Northwest Mari and Korean, that provide evidence that peninitial stress may be grounded in intonational factors.

Stress in Northwest Mari (Ivanov and Tuzharov 1970) falls on the rightmost non-final heavy

syllable, where heavy syllables contain a full vowel. In words lacking heavy syllables, stress is described as falling on the first or second syllable, depending on the quality of the first vowel. If the first vowel is a rounded central vowel, stress consistently falls on the second syllable, whereas, if the first vowel is an unrounded central vowel, stress variably docks on either the first or the second syllable. Interestingly, Ivanov and Tuzharov state that this pattern is characteristic of words in isolation. For words embedded in an utterance, stress is weight-sensitive and is oriented toward the right edge. We may thus infer that the default stress falling near the left edge of an isolated form is a feature of a phrasal domain rather than a word. This fact is consistent with an intonational analysis attributing prominence attributed to a fundamental frequency peak occurring early in the phrase. The placement of the pitch peak on the second rather than the first syllable would be consistent with the characteristic slight delay in the pitch peak associated with the utterance beginning. That this delay is quite short is supported by the fact that it occurs when the first vowel is central and thus likely to be phonetically short (see Gruzov 1960 for supporting phonetic data from the literary Mari dialect, which makes the same weight distinction as Northwest Mari).

The intonationally-driven account of Northwest Mari stress is consistent with De Jong's (2000) hypothesis that at least certain types of weight-sensitive stress may find their roots in intonation patterns. Focusing on Korean, which has alternately been described as either a stress or intonation language, De Jong suggests that the F₀ peak in the low-high tonal sequence at the beginning of the Accentual Phrase (Jun 1993) could easily be construed as stress. The fact that the F₀ peak characteristically falls after a short (CV) phrase-initial syllable but during a long (CVX) initial syllable offers an explanation for descriptions of stress that place stress on a heavy initial syllable, otherwise on the second syllable. Consistent with the account of intonationally-driven stress proposed in this chapter, De Jong hypothesizes that the Korean facts suggest a plausible historical mechanism for weight-sensitive stress to develop from intonation. The De Jong account of the potential intonational origins of weight-sensitive stress is discussed further in the next section.

4.4. Pitch accent and syllable weight

The relationship between syllable weight and the intonationally-driven account of prominence is a multifaceted one. On the one hand, as De Jong (2000) points out, there is a natural relationship between weight in peripheral syllables and phrasal tones. At the left edge of a phrase, the distance between an initial low tone and a following high tone may fall within the span of an initial heavy (CVX) syllable but exceed the characteristic duration of an initial light (CV) syllable. The result is a high tone on an initial heavy syllable but on the syllable following an initial light syllable. Reinterpretation of the high tone as stress would result in a weight-sensitive stress system with stress on an initial heavy syllable, otherwise on the second syllable. This stress pattern is attested in Hopi (Jeanne 1982). The same potential for weight to play a role in the reanalysis of a phrasal high tone as stress also exists at the right edge of a phrase. A final heavy syllable could provide sufficient time to realize the high component of a final high plus low tone sequence, whereas the high tone might fall to the left of a final light syllable. Given reanalysis of the high tone as stress, the result would be a stress system with stress on a final heavy syllable otherwise on the penult, a system found in several languages, including Tol (Fleming and Dennis 1979) and Bergüner Romansh (Kamprath 1987).

Another avenue for weight to interact with the intonational underpinnings of stress is instantiated by Chickasaw, which it may be recalled from section 4.1.2 places the pitch accent on a final syllable in questions only if it is CVV. The ability of CVV to support a sequence of H* pitch accent followed by L% boundary tone has an analog in tone languages that allow contour

tones only on CVV and is phonetically motivated in terms of the more salient backdrop for a contour tone provided by a long vowel relative to other rimes. Other languages that preferentially allow stress on final CVV but position stress to the left of a final syllable that is not CVV include Klamath (Barker 1964), Cuna (Holmer 1947), Aleut (Bergsland 1994, Rozelle 1997), Kadazan (Hurlbut 1981), Junin-Huanca Quechua (Cerrón-Palomino 1976), Huallaga Quechua (Weber 1989), and Aymara (Briggs 1976). The left edge counterpart to this weight distinction entailing stress on initial syllables only if they contain a long vowel, e.g. Konda (Krishnamurti and Benham 1998), is also amenable to an intonationally-driven account along the same lines as the one proposed for the right edge.

It is also possible for a heavy syllable to attract prominence away from a syllable that might otherwise be intonationally prominent. This phenomenon is plausibly observed in unbounded stress systems in which a heavy syllable attracts stress from a peripheral syllable that is reported to be stressed in the absence of heavy syllables elsewhere in the word. One such system, that of Northwest Mari, was discussed earlier in section 4.3. What is difficult to determine from most descriptions of unbounded stress systems is whether the default prominence on a peripheral syllable is completely absent or merely overshadowed in the face of a non-peripheral heavy syllable. Chuvash is exceptional in being explicitly described by Dobrovolsky (1999; see section 6.2), as preserving the initial tonal peak even in words with a heavy syllable to the right of the first one. If the default prominence is preserved, as in Chuvash, even in the face of a heavy syllable removed from the default site, this suggests that the default prominence is due to a boundary tone.

It is interesting to note that 9 of the 11 languages with default-to-opposite stress in Gordon (2000a) are default-to-left. A further 7 of 10 languages with default-to-same side stress in Hayes (1995) have the default as the left side,² yielding a total of 16 of 21 (76%) unbounded systems with a default prominence on the initial syllable. It is possible that these stress systems may represent a hybrid type of prosodic system entailing, as in Chuvash, a combination of either pitch accentual or stress prominence on non-initial heavy syllables plus an initial boundary high tone contributed by the intonational system. Of the 5 languages with default-to-right stress, 4 position the default stress on the final syllable, which may be an intonational effect (see section 6.1). One of the 5 languages with default stress at the right edge, Western Mari (Itkonen 1955), positions the default stress on the penultimate rather than the final syllable, possibly suggesting an intonationally-driven pitch accent repulsion effect. It is also interesting that four of the languages with default-to-left stress also display restrictions on final stress pertaining to heavy syllables. Final heavy syllables in Northwest Mari fail to attract stress, only superheavy final syllables carry stress in Classical Arabic, and stress falls on a final heavy syllable in Khalkha and Buriat only if there is no other heavy syllable in the word. Avoidance of stress on final heavy syllables where there is a pre-final heavy syllable is not confined to unbounded stress systems but also is found in languages with stress windows at the right edge. For example, the stress pattern reported for Hindi by Kelkar (1968) entails stress on the rightmost non-final syllable which is heaviest along the tripartite scale $CVXX > CVX > CV$. Awadhi (Saksena 1971) and Sarangani Manobo (DuBois 1976) display essentially the same pattern except that they employ a two-syllable window rather than a three-syllable window and only have two degrees of weight, $CVX > CV$ in Awadhi and full vowels $>$ schwa in Sarangani Manobo.

² An additional case of default-to-same side stress (not included in the 10 default-to-same patterns included in the text) that Hayes (1995) discusses, that of Khalkha Mongolian, is treated as a default-to-opposite system by Gordon (2000a), following Bosson (1964), Poppe (1970), and Walker (1996).

5. Synchrony vs. diachrony: the place of word-level stress in the typology

The tone-driven analysis of peripheral stress avoidance raises questions about the place of true word-level stress in the typology of prominence from both a distributional and an explanatory perspective. In this section, we explore this issue focusing for expository purposes on the typologically common pattern of penultimate prominence, though the same questions pertain to the considerably rarer cases of peninitial prominence as well.

Because tonal crowding is primarily an issue at the end of phrases, it is not clear why a language might also retract stress from the final to the penultimate syllable of a *word*, where tonal crowding is not likely to be an issue. Although many languages classified as having penultimate stress might in fact have penultimate pitch accent, there are some languages in which penultimate prominence truly reflects word-level stress. This includes some well-studied languages with consistent or dominant penultimate stress, e.g. Polish, Spanish, and Italian.

The hypothesis I advance here (following Hyman 1977) is that true cases of penultimate stress ultimately have their roots in penultimate pitch accent, which became generalized from a phrasal domain to the word level through a process of grammaticalization. This hypothesis assumes that prosodic patterns associated either with words uttered in isolation or words appearing in final position of an utterance, where there is likely to be a pitch accent, are weighted more heavily than other instantiations by speakers seeking to construct a general rule of stress assignment pertaining to all contexts in which a word appears. Generalizing a pattern across different instantiations of a word has the advantage of minimizing variation just as analogical leveling in morphological paradigms has the virtue of reducing allomorphy. The bias in favor of isolation and/or phrase-final tokens over phrase-medial tokens may be rooted in either a statistical predominance in the frequency of occurrence of isolation and/or phrase-final tokens relative to phrase-medial tokens or in a perceptual bias that renders isolation and/or phrase-final instantiations more salient. Either of these scenarios seems feasible and both are consistent with other phenomena that are also likely to have originated as phonetically motivated patterns at the phrasal level that have been generalized to the word level. For example, obstruent devoicing finds a clear motivation in utterance final position where aerodynamic factors conspire against sustained voicing of obstruents (Westbury and Keating 1986). Many languages nevertheless generalize devoicing to smaller domains, where the phonetic conditioning factors behind devoicing are not as compelling.³

Although this explanation for true penultimate stress appears plausible, it is admittedly speculative. Given our limited typological knowledge about the interaction between stress and pitch accent, it is unclear how many languages have penultimate stress as opposed to penultimate pitch accent. It is conceivable that languages like Chickasaw displaying different stress and pitch accent patterns are not mere outliers but rather that they constitute the statistical majority of languages. Without more detailed case studies of individual languages it will be impossible to tackle this issue on a broad typological scale. In lieu of such data, however, there might be certain diagnostics that could provide some insight into whether a particular language has penultimate pitch accent or penultimate stress. One potential criterion is the presence of lexically marked exceptions, either in root or affixes, to the general location of prominence. If prominence were truly a phrasal pitch accent one would not expect lexical exceptions to exist. Thus, all of the languages mentioned above as displaying dominant penultimate word stress, Polish, Italian,

³ Evidence from loanword phonology further hints at the importance of isolation forms in conditioning the transfer of prominence from one language to another. Rice (this volume) discusses the case of Navajo, a tone language that has reanalyzed stress from Spanish loan words as high tone. This reinterpretation of stress as high tone makes sense if isolation forms, where the stress carries a high pitch accent, serve as the basis for the borrowing.

and Spanish, have lexical items with stress on a syllable other than the penult. It is also interesting to note that Onondaga (section 4.1.2), which asymmetrically has final stress at the word-level but dominant penultimate pitch accent at the phrase-level, possesses morphemes that exceptionally attract prominence to final syllables both at the word and phrase-level as well as morphemes that trigger retraction of prominence to the antepenult (Chafe 1970). This indicates that stress has become lexicalized at the word-level and that the lexical stress also attracts the pitch accent in phrase-final position, an instance of bottom-up pitch accent placement existing alongside the top-down accent placement otherwise characteristic of Onondaga.

Another enticing diagnostic for determining whether a description of stress truly reflects word-level stress as opposed to phrasal pitch accent could be the occurrence of binary stress propagating from the prominence reported to be the primary one. Under the assumption that pitch accents are not assigned rhythmically, the existence of an alternating stress pattern presumably would not be attributed to mere pitch accent. Placing stress on the penultimate syllable and on alternating syllables preceding the penult conforms to the trochaic template, which is independently preferred over its iambic counterpart both typologically in quantity-insensitive stress systems (Hayes 1995, Gordon 2002) and in language acquisition (Allen & Hawkins 1978, Adam & Bat-El 2009).⁴ It is possible that placement of a pitch accent on the penult sets up the trochaic template that is prone due to its eurhythmy to be extended leftward when the pitch accent becomes phonologized as stress at the word level. It is also conceivable that the naturalness of the trochaic prominence pattern, working in conjunction with tonal crowding avoidance, reinforces the adoption of penultimate pitch accent itself. Bolinger (1980:44) alludes to this possibility when he suggests that “an intonational prominence is set off best when there are non-prominences to either side” and “penultimate position is the best compromise between climax and clarity”.

Regardless of what future research reveals to be the relative frequency of penultimate pitch accent vs. penultimate stress, the existence of documented cases of each in the relatively small data sample presented here indicates that mechanisms for accounting for both are necessary for an adequate theory of prominence.

6. The basis for initial and final prominence

Thus far, we have offered an account of peripheral stress avoidance grounded in tonal crowding effects, which operate either synchronically to produce penultimate, antepenultimate, or peninitial pitch accent or diachronically via a process of phonologization of phrasal pitch accent to word stress. This raises the question of how initial and final stress should be accounted for. Both locations for stress are quite common cross-linguistically, as shown in table 1, which shows the number of languages with initial, peninitial antepenultimate, penultimate and final stress in surveys conducted by Hyman (1977), Gordon (2002), and van der Hulst & Goedemans (2009).

⁴ Thanks to Harry van der Hulst for reminding me of the potential contribution of rhythmic euphony in accounting for penultimate prominence.

Table 1. Number of languages displaying different stress patterns in three surveys

Location	Hyman (1977)		Gordon (2002) ⁵		Van der Hulst & Goedemans (2009) ⁶	
	No.	%	No.	%	No.	%
Initial	114	37.3	57	30.6	77	36.5
Penultimate	77	25.2	53	28.5	77	36.5
Final	97	31.7	59	31.7	38	18
Antepenultimate	6	2.0	7	3.8	6	2.8
Peninitial	12	3.9	10	5.4	13	6.2
Total	306		186		211	

In sections 6.1 and 6.2 we examine these two docking sites for stress, arguing that, unlike non-peripheral stress, they find a natural explanation in terms of *both* phrasal and word level considerations. Initial and final stress are amenable to an intonational account, parallel to penultimate and peninitial stress, not in terms of tonal crowding avoidance but rather in terms of phrase level or boundary tones. In addition, initial and final stress are natural docking sites for stress even at the word level due to their demarcative function in signaling the beginning and end points, respectively, of words.

6.1. Final stress

If one assumes that many, if not the majority of, cases of penultimate stress in the literature actually reflect phrase-level pitch accent, it is logical to adopt the same assumption about descriptions of final stress. If so, then one wonders why so many languages would permit a pitch accent on a final syllable that also is associated with a low final boundary tone in the default case. Pursuing an intonational account of final stress, there are at least two tacks to take in response to this query.

One possibility is that many languages simply allow crowding of a pitch accent and a boundary tone onto the same syllable, much as English permits multiple tones on a single syllable. A pitch-accented word with final stress such as *Tennessee* is thus associated with both a H* pitch accent and L% boundary tone in neutral declaratives. English, in fact, is quite tolerant of substantially more tonal crowding than found in this example. The characteristic lengthening of final syllables (Wightman et al 1992) facilitates the crowding of intonational tones onto final syllables much as many tone languages allow more complex tones in final position relative to other contexts (Maddieson 1978, Clark 1983, Zhang 2002, Hyman 2007).

Another possibility is that some languages have different tonal inventories than the canonical H* pitch accent and L% boundary tone that seem to predominate cross-linguistically. For example, in some languages, a L* pitch accent or either a H% boundary tone or no boundary tone might be prevalent, in which case the issue of tonal crowding would not be so acute. This situation, in fact, holds of Chickasaw statements, where there is characteristically no boundary tone that would necessitate a rapid transition from the high pitch accent to a low target. In some languages, it might not be a large phrasal boundary tone but rather a high tone characteristic of a small phrase that is responsible for the final prominence. For example, the Accentual Phrase final

⁵ Languages in the Gordon (2002) survey have a single stress per word.

⁶ The number of languages reflects percentage of languages returned by entering the query for each stress location (without any additional filters) using the online version of the StressTyp database (<http://www.unileiden.net/stresstyp/index.htm>).

high tone in French (Fougeron and Jun 1995) accounts for the final prominence that is often interpreted as stress.

A final possibility is that many cases of final prominence reflect true word level stress. Final stress has a clear functional benefit in signaling the ends of words, which aids the listener in the parsing of an utterance. I would thus hypothesize that, relative to penultimate stress, a larger percentage of the reported cases of final prominence in the literature reflect true word level stress.

6.2. Initial stress

Initial stress has the same advantage as final stress in serving the role of demarcating word boundaries. There are also, however, intonational factors that could be relevant in conditioning initial prominence. Cross-linguistically, pitch typically declines throughout an utterance with the highest pitch occurring at or near the beginning of an utterance. It is plausible that this initial pitch peak could be interpreted as stress.

The prosodic system of Chuvash offers support for an intonational account of initial stress along these lines. According to Krueger (1961), stress in Chuvash falls on the rightmost heavy syllable (a syllable containing a vowel other than schwa) otherwise on the initial syllable. A more recent phonetic study by Dobrovolsky (1999), however, suggests that the initial stress is actually attributed to intonational prominence rather than true word-level stress. In his study, Dobrovolsky measured the peak intensity, the average intensity, the duration, the fundamental frequency, and the intensity integral (intensity integrated over time; see Beckman 1986 for discussion of this measure) for a corpus of disyllabic words in which the weight of both syllables was varied such that all combinations of heavy and light syllables were attested. Dobrovolsky found that, while at least certain intensity measures differentiated stressed from unstressed syllables in most word shapes, he found that light syllables were not typically characterized by greater peak, average, and total intensity, nor by increased duration, even when occurring in positions predicted to carry stress, i.e. in the initial syllable in words with no heavy syllables that would attract stress away from the left periphery. Rather the first syllable characteristically had the highest fundamental frequency, which subsequently fell throughout the rest of the word. This initial peak in fundamental frequency peak was a consistent property of the initial syllable, even when it was not predicted to be stressed. As Dobrovolsky suggests, the picture which thus emerges is one in which certain prominence correlates do not pattern together. At least one of the intensity and/or durational correlates of stress are associated with stressed heavy syllables, whereas a fundamental frequency peak is consistently associated with the initial syllable independent of syllable weight. Dobrovolsky interprets this mismatch as a divergence between intonational and stress prominence. Heavy syllables have the potential to be stressed as indicated by increased duration and/or intensity, whereas the initial syllable is prominent by virtue of its intonational properties.

There is an important issue which Dobrovolsky's study leaves unresolved. It is unclear whether the fundamental frequency peak and subsequent fall found in Dobrovolsky's study is a word property or is a feature of a larger intonational unit. If the latter scenario is true, then we would not expect generally to find a fundamental frequency peak in words in non-initial position of this larger intonational unit. Unfortunately, we are not in a position to address the nature of intonation domains in Chuvash. However, given the fact that intonational properties cross-linguistically tend to be associated with prosodic units larger than the word, it is quite plausible that the fundamental frequency peak in Dobrovolsky's data is not a feature of all words but is a feature of a domain larger than the word.

7. Toward a typology of stress/pitch accent interactions: some predictions

Thus far we have focused on showing how a number of observations attributed to the typology of word-level stress may be better explained if one assumes that the stress reported in many language descriptions is actually either a phrasal pitch accent or a phrasal tone. The general schema is for pitch accents and phrasal tones to be attracted to phrasal edges, presumably as a boundary signal to aid the listener in parsing an utterance. Competing with edge attraction is a tendency for pitch accents to be repulsed from peripheral syllables due to constraints against tonal crowding. Final pitch accents are particularly vulnerable to edge repulsion since the right edge of phrases is often associated with a terminal pitch fall. Initial pitch accents are also potentially subject to a shift away from the periphery due to the tendency for subglottal pitch and pitch to rise slightly at the left edge of an utterance. Because the factors conditioning edge repulsion of the pitch peak are relatively weak at the left edge, it is not surprising that peninitial prominence is rare cross-linguistically. It also follows that the left edge counterpart to antepenultimate stress, postpeninitial stress, appears to be unattested.

In summary, all five reported docking sites for prominence, initial, peninitial, antepenultimate, penultimate, and final syllables, find an explanation in terms of pitch properties characteristic of phrases rather than individual words. If, however, pitch factors are responsible for the typological distribution of pitch-driven prominence, the typology of true word-level stress is predicted to be relatively impoverished to that of pitch accents. Assuming that word-level stress also serves the purpose of facilitating the morphosyntactic parse, both initial and final stress are natural occurrences. It is more difficult, however, to account for apparent edge repulsion effects at the word level since there are less likely to be any pitch properties bounded by the word that would repel stress from an edge. The question is then how we can account for peninitial, penultimate, and antepenultimate prominence that truly reflects word level stress as opposed to pitch accent. The first approach to this problem is to ascertain how many true instances of these stress locations are actually word phenomena as opposed to phrasally bound. Unfortunately, we are not in a position to assess the typological frequency of these non-peripheral stress sites. It is likely, however, as argued earlier, that many of the reported cases of stress in general, including both peripheral and non-peripheral stress sites, actually reflect phrasal pitch characteristics rather than word-level stress. Since there are so few cases of peninitial and antepenultimate stress in the literature, these patterns are particularly vulnerable to complete reanalysis as pitch-driven phrasal prominence. The strongest possible prediction made by the intonation-driven account of prominence is thus that there are only two docking sites for true word-level stress: the initial syllable and the final syllable. This contrasts with the richer inventory of five docking sites for pitch prominence at the phrase level: initial, peninitial, antepenultimate, penultimate, and final syllable.

As discussed in section 5.2, we know, however, that it is not possible, at least in the case of penultimate prominence, to attribute all cases to phrasal pitch phenomena at least synchronically, even if non-peripheral word-level stress may diachronically originate as a pitch accent that has been generalized to the word. Although the existence of penultimate word-level stress vitiates the predictive power of the intonation-driven approach to stress typology, there are nevertheless some predictions that can be made about the relationship between word-level stress and phrasal pitch accent. There are two possible scenarios that are expected to emerge cross-linguistically. First, some languages will be like English in assigning pitch accents to the same syllable that carries word-level stress. Others will be like Chickasaw in employing orthogonal principles from word-level stress in situating pitch accents. Crucially, in languages of this latter type, only phrasal prominence and not word-level stress is predicted to display edge repulsion effects since the motivating factors behind edge repulsion are only in play at the phrasal level. This effectively

excludes systems in which word-level stress is peninitial, penultimate, or antepenultimate while phrasal prominence is initial or final. For example, we would not expect the inverse of Chickasaw, where the pitch accent is consistently final but word-level stress often retracts to the penultimate or antepenultimate syllable.

If the only mechanism for word-level stress falling on a non-peripheral syllable is historical reanalysis of phrase-level prominence as word-level stress, non-peripheral stress should only occur in languages in which a pitch accent may fall on the same non-peripheral syllable as the stress. This situation occurs in English, which has many words with non-final stress and places the pitch accent on the same non-final syllables carrying word-level stress.

The predictions of the intonationally-driven approach to prominence typology are summarized schematically in table 2 according to two dimensions: whether prominence is repelled from a peripheral syllable and whether the location of prominence is the same at the word and phrase levels.

Table 2. The typology of prominence systems

	Edge repulsion		Languages
	Word	Phrase	
Symmetrical	Yes	Yes	English, Egyptian Arabic
	No	No	Hebrew, Farsi
Asymmetrical	No	Yes	Chickasaw, Cayuga, Seneca, Central Alaskan Yup'ik, Onondaga
	No	No PA	Wolof
	Yes	No	Unattested?
	Yes	No PA	Unattested?

There are six possible relationships between word-level stress and phrasal prominence shown in the table if we add the possibility of a language lacking a phrasal pitch accent (indicated by ‘No PA’ in the table).⁷ Two are symmetrical in that prominence docks on the same syllable both at the phrase and word level and four are asymmetrical in positioning prominence on different syllables at the two prosodic levels. The symmetrical prosodic types can be divided according to whether prominence falls on a peripheral syllable at both the word and phrase level or whether it is repelled from the periphery at both levels. English instantiates the latter type of symmetrical system since lexical items with non-final stress position phrasal pitch accent on the same syllables with non-final stress. Hebrew exemplifies a symmetrical system with peripheral prominence, on the final syllable, at both the word and phrase-level (Becker 2003). Farsi (Mahjani 2003) also stresses word-final syllables (with morphological effects producing non-final stress in certain forms) and assigns them pitch accents.

The asymmetrical systems can be subdivided based on whether prominence repulsion occurs at the word or phrase level. In one type of asymmetrical system, instantiated by Cayuga, Central Alaskan Yup'ik, Onondaga and Chickasaw, edge repulsion is observed at the phrase-

⁷ Another a priori possibility, a language with phrasal pitch accent (either on a peripheral syllable or not) but an absence of word stress is omitted from the table since the tonally-driven account of prominence makes no predictions about its existence. It is also in practice difficult to know whether phrase-level tones are attributed to pitch accents or boundary tones in the absence of word-level stress with which to compare the realization and location of the phrase-level tones. This issue, for example, is evident in the debates about the prosodic analysis of French, Korean, and Indonesian (see section 3).

level but not the word-level. In another type of asymmetrical system, word-level stress falls on a peripheral syllable but there is no phrase-level pitch accent. A language that appears to fit this profile is Wolof, which has word-level stress on either the initial or second syllable depending on weight (Ka 1988) but which has phrase level intonation contours which are projected independently of stress (Rialland & Robert 2001).

In the other two subtypes of asymmetrical systems, edge repulsion applies only at the word level and there are either no pitch accents, i.e. Wolof but with non-peripheral word-level stress, or pitch accents that fall on a peripheral syllable, i.e. the inverse of Onondaga with stress on the penultimate syllable and pitch accent on the final syllable. It is these types of systems that are hypothesized to be unattested since they would involve edge repulsion at only the word level, precisely where the intonational factors claimed here to motivate peripheral prominence avoidance are absent.

Whether the predictions of this six-way typology turn out to be corroborated must await further detailed investigation of the relationship between word-level stress and phrase-level prominence for a broader sampling of languages. The proposed taxonomy may nevertheless be regarded as a useful hypothesis guiding future studies of prominence in different prosodic constituents.

8. Conclusions

This chapter has suggested that a large portion, if not the majority, of the prosodic typology that is currently understood to refer to stress may actually reflect phrasal prominence associated with tonal events occurring at or near phrase edges. Several features of the cross-linguistic distribution of the “stress” typology support this view. First, the asymmetry in the relative frequency of penultimate and peninitial stress finds an explanation in the fact that tonal crowding factors are primarily, though not exclusively, found at the right edge of phrases, where a transition from high pitch accent to low boundary tone occurs. Second, the existence of several languages in which final stress avoidance is observed only in phrase-final words is consistent with an analysis appealing to tonal crowding avoidance. Third, the Chickasaw asymmetry between questions which have a L% boundary tone and display final H* pitch accent avoidance on all but the most sonorous syllables and statements which lack a L% boundary tone and permit H* on all final syllables supports the intonational view of prominence. Finally, descriptions of initial prominence in languages like Chuvash and Northwest Mari suggest a subtler and cross-linguistically less pervasive effect of initial prominence avoidance that accords with the predictions of an intonation-driven account. While an intonational account has the potential to dramatically impact the stress typology landscape by reassigning many “stress” patterns to the class of “pitch accent” patterns, this redistribution offers an exciting opportunity for constructing new typologies of both stress and pitch accent and the relationship between the two. Furthermore, it potentially opens up fertile new ground in the formal analysis of both phenomena.

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