The study of word accent and stress: past, present and future

Harry van der Hulst

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1 Introduction

This volume contains 10 chapters that all originated from presentations at the First or Second Word Accent Conference held at the University of Connecticut on April 30th, 2010 and December 3, 2011, respectively. The first conference brought together phonologists who share an interest in the study of word stress, based on broad typological surveys.[1] In several cases, such surveys have taken the form of digital databases which contain information about stress properties in large numbers of languages. In particular, two such databases (*StressTyp* and *Stress Pattern Database*) are publicly available on the WWW.[2] While the chapters in this volume are based on public talks, the ('hidden') goal of the first conference was to develop a grant proposal which would allow the architects of these databases to merge the two resources into one system, to be named *StressTyp2*.[3] Beyond merger, the goal was to enrich the information, both in terms of depth (detail of encoding) and breadth (number of languages) and to improve quality and accessibility of the data. Like the first conference, the second conference (which occurred after the grant had been obtained) had a part with public lectures and a 'closed door session' which aimed at discussing the design of a new relational database structure and desiderata for a user friendly front end for StressTyp2. The chapters in the present volume are *not* concerned with the technical details of the StressTyp2 project, but are based on some of the public talks in which more general issues were addressed, relating to typologically-based theoretical work.[4] In general terms, these chapters, taken as a whole, reflect on issues concerning the nature of word stress, the methodology of studying the relevant phenomena, as well as the actual and potential applications of typological data collections in any form, either with reference to theoretical issues or to language contact situations.

In this introductory chapter[5], my goal is to situate the chapters within the broader context of the study of word stress. I survey relevant areas of research, raise questions and point to topics that require closer attention. To this end, section 2 first discusses some terminological matters. This section is followed by several sections (3-7) which go over more theoretical issues regarding the distinction between the lexical specification and phonetic exponents of stress, distinctions between levels or kinds of stress the role of morphology and of intonation. Section 8 reviews some special themes in past and current theoretical work on stress, including the area of learnability and acquisition. Section 9 provides factual information about the above-mentioned database projects, while section 10 reviews various recurrent problems that we encounter in the study of word stress, both generally and with specific reference to building databases. In section 11, I summarize the chapters in this volume, point out their relevance to the issues that are addressed in this introduction, and highlight some of

[1] This conference was made possible by a Large Faculty Grant of the University of Connecticut awarded to H. van der Hulst.
[2] See section 9 of this introduction for a discussion of these projects.
[3] This effort lead to NSF grants NSF#1123661 (PI H. van der Hulst), NSF# 1123692 (PI J. Heinz), which allowed us to plan and execute the merger and currently supports ongoing work on StressTyp2, which is accessible at [URL to be added in proof stage].
[4] All chapters are the result of a blind double peer-review process and have last been updated in September 2012.
[5] I would like to thank all contributors to this volume for their comments on earlier versions of this chapter. In addition, I'm grateful for comments from Anthi Revithiadou and Beata Moskal.

the ways in which these studies are interconnected. In section 12, I conclude with perspectives for future research in this area.

2 Terminological issues

In this section I discuss a number of terminological points. While these cannot always be separated from theoretical issues or substantive issues, i.e. distinctions that are 'sensible' to make, even independent of any specific theory, I will try to not get into theoretical issues until section 3, realizing that the separation between terminology, substance and theory is intrinsically unclear, if not unprincipled. Where relevant, I will make references to the chapters in this volume, with a more complete assessment of these being the subject of section 10.

This section focuses on the well-known issue that the use of the terms 'stress' and 'accent' is somewhat problematic. This may easily lead to confusion when comparing different traditions or theories. In one respect, the two terms can be understood as being *translations* of each other (as in *stress* being an English term and *accent* as a French term for the same thing, whatever that thing is). However, given the widespread use of Romance vocabulary in many Germanic languages and the widespread use of English terms in many more languages, we often end up with *both* terms, either as synonyms or as having acquired their own specialized meanings. Putting aside the translation and synonym instances, let us focus on how both terms, when used within the same language (or theory of language), have come to differ. As Fox (2000: 114), in his highly informative book on prosody, notes: "The term *accent* is used in a number of legitimate ways by different scholars, and many of these uses are mutually incompatible." The same can be said for the term *stress*. If used in contrast with the term 'stress', perhaps the biggest confusion is that 'accent' can be something that lies 'below' stress (being 'more abstract' than stress) as well as something that occurs 'above' or 'later than' stress (being associated to the realization of stress, in particular in relation to intonational properties):

(1)

Accent (Intonation, i.e. 'pitch accent')
↑
Stress
↑
Accent (lexicon)

In (1) I indicate that the 'abstract use' of the term accent (as *underlying* stress) refers to a lexical property of lexemes (morphemes or words) which marks the *location* of certain types of observable stress properties that occur in words; often, then, the term 'stress' is simply used as a cover term for these observable phonetic properties (such as greater duration, greater intensity etc.). The following quote from Abercrombie (1976 [1991: 82-3]) is a good description of this use of the term accent:

> When I say that such-and-such syllable of a word has an (or the) accent, or is accented (other syllables therefore being unaccented), I am not saying anything about the phonetic characteristics of that syllable. All that is being said is that in certain conditions (which must be specified) in utterances, an accented syllable will show certain characteristics which can be predicted. The

> various possible realisations of accent may have nothing phonetic in common. An accented syllable *may* be realised as stress, with various features of pitch, of syllable length and segment length, of loudness, and of articulatory characteristics in various combinations. But none of these are included in the definition of accent. In other words, accent is ineffable. It plays no part in the phonological analysis of utterances; its place is in the lexicon. Accent, in fact, is what is indicated by the 'stress marks' in the English Pronouncing Dictionary.

Here, clearly, Abercrombie understands *stress* to be a (possible) phonetic *realization* of *accent*, which itself is said to have no phonetic content. Note that for Abercrombie stress does not refer to *one* specific phonetic realization. Rather, various realizations can occur in various combinations. In fact, as we will see below, if we use *stress* as a cover term for *correlates* of accent (rather than just realizations of accent), we must also include *phonological correlates* (such as for example the possibility of a broader range of phonemic distinctions in the accented syllable). Adopting this view, several further questions arise, both with reference to the notion accent and with reference to the notion stress:

(2) Questions about accent and stress

a. How do morphemes and complex words come to have their accents?
b. For both of these domains, are accent locations unpredictable or can there be rules that predict where they occur?
c. What are accents properties of (candidates include vowels, moras, rhymes, syllables), i.e. what is the accent-bearing unit?"
d. What is the domain of accent (candidates include morphemes, syntactic words, prosodic words, larger units…)?
e. How do accents interact with the morphological structure of the word?
f. Can lexemes be unaccented or have more than one accent?
g. What are possible phonetic (i.e. non-contrastive, allophonic) correlates of accent?
h. What are possible phonological correlates of accent?
i. Is stress always based on accent or can languages have stress *without* having accent (an option which might be likely for languages in which the placement of stress is fully regular and this requires no lexical marking)?
j. Are stress properties locally realized on the accent-bearing unit or globally throughout the whole domain, e.g. in terms of rhythm?
k. Are there good reasons for separating out systems as somehow different if they specifically exploit one phonetic property such as e.g. pitch?

Obviously, we need a *theory* of accent which gives or entails answers to all these (and likely more) questions, as well as a theory of accent correlates. The former theory will involve a *formal notation* involving local 'marks' (often represented with an asterisk, as in Goldsmith 1985, or with a partial or full metrical structure, as in Liberman and Prince (1977); see section 3.1.

Whatever the answers to all these questions are (and many of them have received serious attention, elsewhere as well as in this volume), once we adopt the Abercrombian perspective, there is no problem in appreciating how the terms accent and stress *can* be used distinctively, accent being the term for 'substance-free' lexical marks and stress for phonetic and phonological correlates of accent. Van der Hulst (2011, this volume) follows this

Abercrombian tradition, as does Fox (2000). This leaves us with the second use of accent, namely as a pitch or tonal unit of intonation. I will return to this usage in section 6.

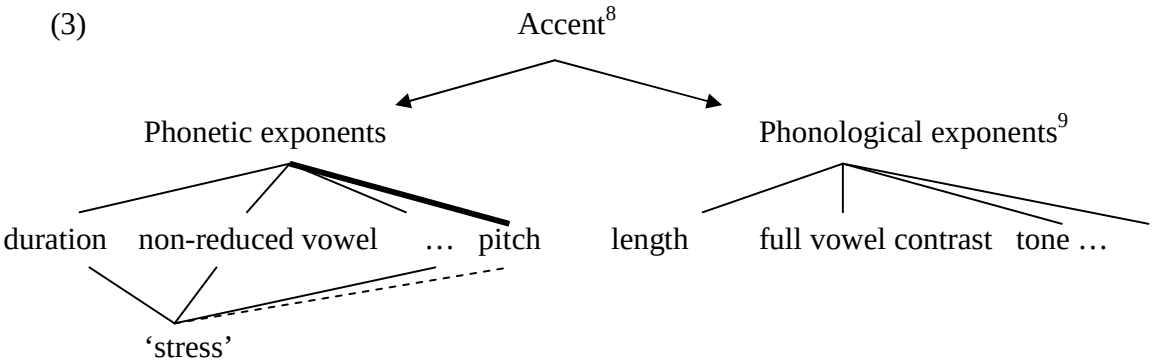
The Abercrombian tradition comes with the use of compound terms like *stress-accent* and *pitch-accent*, corresponding to more traditional terms like *dynamic accent* and *musical accent*. This distinction is based on the idea that among the various possible phonetic correlates of accent, an important distinction exists between 'stress exponents' and non-stress exponents (cf. Beckman 1986), the latter characteristically involving the exclusive use of pitch levels or pitch transitions. While it was originally thought that pitch properties were an important part of the set of stress exponents (see for example Mol and Uhlenbeck 1956; Fry 1955), it has been argued that this was often an illusion, arising from the fact that stressed syllables of words 'in focus' position function as anchors for intonational pitch movements (see section 6). Since descriptions of stress would often be based on the pronunciation of words in isolation, the stressed syllable would be in focus and thus be associated to an intonational pitch movement. This, then, accounts for the pitch properties that are often (wrongly) argued to be an intrinsic part of the stress package.[6] But investigation of stressed syllables in and outside of focus has shown that these pitch properties are in fact very often *not* part of the set of word-level stress properties. When stressed syllables are measured in out-of-focus position they do often not include pitch as a significant factor, but rather comprise primarily the various consequences of *articulatory force* or *hyperarticulation* which typically enhance intensity ('loudness'), duration, fullness of articulation (with consequences for vowel quality and phonation) and more technical notions such as spectral tilt (or spectral balance), *not* excluding somewhat elevated pitch, but *not* the kinds of pitch movements which are introduced by the intonational system as markers of focus (and domain edges) (see Beckman 1986 and Gordon 2011 for relevant discussion and references). This being so, stress-accent and pitch-accent are almost complementary in their use of phonetic exponents of accent, the former showing various effects of articulatory force, while the latter merely or mainly shows a pitch property.

In (3), I display the dichotomy between phonetic and phonological cues of accent with some typical exponents:[7]

[6] Hellmuth (2006) discusses the case of Egyptian Arabic in which *every (prosodic) word* bears a "pitch-accent", despite the fact that this language is usually taken to be a stress(-accent) language. Since it cannot be the case that every word is 'in focus', pitch, in this case, must be an exponent of word-level accent. See Hellmuth (2006) for extensive discussion of what she argues is a specific typological category.

[7] In van der Hulst (to appear), I argue that the term 'stress' still covers too many different uses even if the distinction proposed here between accent and stress is observed, proposing to adopt a set of terms such as *accent* (as suggested here), *phonotactic correlates of accent*, *edge prominence* and *rhythm*, leaving the denotation of *stress* to be the various phonetic effects that results from *articulatory force* which essentially involves 'stretching' or 'exaggerating' the inherent properties of stressed syllables. In this introduction I will not push for this 'extreme' position, however.

(3)



Here we see that, under this perspective, stress is not a very well-defined property but rather a broad cover term for a set of properties that tend to cluster together. In fact, as mentioned and indicated in (3), we must also include the *phonological exponents* under this umbrella. Van der Hulst (2010) elaborates this point and mentions still other correlates of accent such as those occurring when the accent location plays a role in the anchoring of intonational units (see section 6), or in morphological processes that are sensitive to it.[10] Given the wide variety of accent cues (beyond the phonetic exponents called stress), Goedemans and van der Hulst (2009) suggest that many more languages may be accentual than the ones that have thus far been recognized as such. They speculate that accent might be a universal trait of words, but that claim might be difficult to prove wrong if accent can in principle exist without any cue at all (see Hyman, this volume).[11]

The dichotomy between stress-accent and pitch-accent languages raises a further question, namely whether perhaps an even finer array of accent types should be recognized, including 'duration-accent' if there are clear cases in which specifically duration (and little else) signals the accent location. If there are no clear cases of this sort, the next question is why pitch would be special? The answer that is given by several scholars (Poser 1984,

[8] Among the exponents, I did not include *rhythm* which is usually also be seen as a 'global' aspect of stress. I will return to this point in section 7.

[9] In addition to greater phonological contrast, we can also find greater syllabic complexity. In Dutch, syllables containing a schwa cannot be stressed and they also (with minor exceptions) cannot have a complex onset (see Zonneveld 1993).

[10] When considering such 'extra-phonological' correlates, the question arises whether the correlates in question are correlates of the accent or of its stress manifestation. If stress is a phonetic matter, one would not expect morphology to be sensitive to it, but intonational phenomena could presumably be sensitive to phonetic properties of utterances.

[11] The idea that accent may be a universal property of words comes from a potential identification of the notion accent with the notion *head*. Following principles of Dependency Phonology (Anderson and Ewen 1987; Anderson 2011), the idea might be pursued that all domains *must* have a head, making heads and thus accent obligatory in all words (save minor category words) in all languages. However, a different understanding of accent, also discussed in this chapter, is that accent is a mark of *diacritic weight*, meaning that the accent marks the syllable as *behaving as* a heavy syllable. In that view, there is no issue with words having no accent, or indeed having more than one accent. I refer to van der Hulst (2012) for a reconciliation of these two assessments of the notion accent. In short, diacritic accent, like syllable weight, functions as input to an accent algorithm which can select one accent as the head accent, or can assign a default head accent if no diacritic accent or weight is present. In van der Hulst (2012) I suggest that accentual systems in which accent is both obligatory and culminative are most likely to give rise to stress exponents. In all other cases, accentual systems are more likely to give rise to pitch-accent (or tone accent) systems.

Pulleyblank 1986, Hyman 2007, this volume) is that the alleged pitch-accent systems are *tonal systems*, pitch being the core correlate of tone. If, then, one syllable per word has a high pitch (like in Kinga, Schadeberg 1973), rather than saying that one syllable has an accent which has a pitch exponent, it is claimed that one syllable bears a H tone, making such a system a so-called *restricted tone* system (in which, in this specific case, there is no paradigmatic tonal contrast at all). In this view there are only two *prosodic* properties relevant to the discussion here, namely stress (which then becomes a term both for the lexical mark and for its various correlates) and tone. I refer to Hyman (2006, to appear) and van der Hulst (2011) for various arguments pro and con the idea that 'pitch-accent systems' can (and therefore should) be analyzed as restricted tone systems, which implies that the notion 'pitch-accent' is not a third prosodic property that needs to be distinguished alongside stress and tone.

An in-between position would be to analyze a language like Kinga using *both* accent and tone, marking the specific syllable with an accent and then assigning a H tone to that syllable; this is the approach taken in Goldsmith (1975). This view captures that languages like Kinga are similar to stress-accent languages like English in marking exactly one syllable per word as 'special' as well as the fact that languages like Kinga sound like tonal languages and may even have rules that spread the 'H tone' to neighboring syllables. The approach taken by Poser (1984) and Pulleyblank (1986) denies the similarity between English and Kinga.

A slightly less restricted tone system would allow a tonal *contrast* on one specific syllable. Suárez (1983) mentions Nothern Pame and Yaitepec Chatino, as languages that have a tonal contrast only in the syllable that is said to be 'stressed' (which is the last syllable in both cases). In the Abercrombian way we would call this syllable accented, although it is possible that there are also stress correlates. Indeed, Hyman (1978) calls this type (with reference to other, similar cases) *tonal accent*. Tonal accent is a *phonological correlate* of accent since it involves contrastive differences in the accented syllable that are not available in other syllables. As mentioned, it is possible that the designated syllable also shows properties that we associate with stress, in which case we have a language with both stress (or stress-accent) and tone (dependent on accent, i.e. tonal accent). This shows that a language can have combinations of different kinds of accent correlates, a fact that we already established (see 3).[12]

There are two kinds of arguments in favor of the use of accents for 'pitch-accent languages'. One argument (alluded to above) regards the fact that, in the approach of Poser, Pulleyblank and Hyman there are unexplained similarities between the distribution of stress and the distribution of 'tones' (in restricted 'tone' systems such as Kinga, i.e. the former pitch-accent cases) which involve the specific *edge oriented* (demarcative) locations, as well as the observance of *culminativity* (both stress and 'tone' being restricted to one designated syllable) and *obligatoriness* (each word must have a H tone). These similarities motivate the use of a common element, accent, for both types of cases. To be sure, there appear to be distributional differences between stress and tone (again in restricted systems) in that stress seems to always be obligatory (all, at least major category, words are stressed), while in certain restricted tone systems, words can be toneless (i.e. unaccented in the Abercrombian

[12] In this connection, Hyman (2007) argues that it is not correct to classify languages as exclusively belonging to one type of system, Rather, in typological studies, we should rather refer to *properties* of languages.

view), 'violating' obligatoriness.[13] A second type of argument against the tonal analysis of pitch-accent systems could be that the use of the notion 'tone' should be limited to cases of a tone *contrast*. If a language marks one syllable per word with high pitch, it is not obvious that this warrants the postulation of a *phonological* entity 'H' (since the pitch quality of the alleged tone is predicable). Analogously, we would not assign a lexical specification '[+long]' to vowels that are predictably lengthened in a certain position (such as finally or before voiced obstruents). Van der Hulst (2011, 2012) exploits such arguments to support the pitch-accent analysis of languages such as Kinga, as well as the notorious case of Tokyo Japanese.

However, there are also arguments against the use of accent for restricted 'tone' systems. As suggested above, the pitch-accent approach does not account for the apparent fact that pitch is special among the potential accentual correlates. The special nature of pitch is explained if we acknowledge that the pitch is really a phonological tone, since we know that among the phonological properties 'tone is different' (Hyman 2011). Another problem with the pitch accent analysis is that there are several examples of phonetic or phonological properties (not involving pitch) that reflect some sort of culminativity in that they can occur only once per word. Hyman (2007) mentions various examples:

(4) Culminative properties

a. Aspiration and glottalization in Cuzco Quechua
b. Length in Mam
c. Mid vowels in the Bantu language Punu
d. Nasalized vowels in Karo

Although such properties reflect culminativity, it is not obvious that we should see them as correlates of an accent because they do not, as Hyman notes display *obligatoriness*. Against this objection, we should recall the fact that in languages that have traditionally been analyzed as having pitch-accent, words can certainly be *unaccented* (Tokyo Japanese has unaccented words). [14] Hyman (1981) discusses the case of Somali in which accent correlates with high pitch (in a pitch-accent analysis), but unaccented words simply lack high pitch.[15] On the other hand, in a stress-accent language, if accents are only used to mark unpredictable locations of stress, words without accent would still always have stress, in a predictable location. This suggests that 'stress' is more than an exponent of accent. Rather, one might argue that it is an independent prosodic system that interacts with accent. If conceived as a post-lexical system, all words would be subjected to it, i.e. words could not be marked as not undergoing it (see van der Hulst 2012). A different kind of problem with an accentual analysis of *all* apparently culminative properties (such as those in 4) is that in particular cases, independently from these properties, there could be another property such as stress,

[13] Van der Hulst (2011, 2012) argues that whereas accent may not be an obligatory property, it can be, and that this specific case triggers stress exponents as a mark of 'wordhood' (following the Prague School).

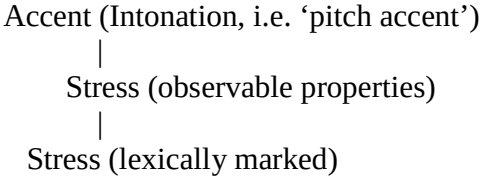
[14] Tokyo Japanese unaccented words have a high pitch plateau extending to the end of the domain, similar to accented words with final accent. However, there are problems with assuming that lexically unaccented words get a final accent *by default*; see van der Hulst (2012) for discussion.

[15] Another alleged problem with an accentual analysis of cases like Tokyo Japanese and Somali is that accents appear to be properties of subsyllabic units like the mora, whereas in stress-accent languages, accents are part of whole syllables (or their rhymes). See van der Hulst (2012) for a dismissal of this problem.

which may itself require accentual marking in a different location. Hyman (2007) remarks, for example, that in Mam the location of length does not coincide with the location of stress. Can languages have two independent accentual systems, leading to *accentual incoherence*?[16] Eamples in which we find conflicting indications for accent locations occur in several Bantu languages in which the initial syllable of the root licenses greater phonotactic complexity than other syllables (suggesting root initial accent), while at the same time there is a process of penultimate lengthening or penultimate tone attraction (suggesting penultimate accent; see Hyman 2009, Downing 2010).[17] In some Bantu languages, the penultimate effect may belong to the phrasal level and thus only hit on phrase final words, in which case there is no accentual incoherence since different domains may have different locations for accent. In other cases it would seem that we have to reckon with the possibility of the cue for one of the alleged accent locations being a reflection of a historically earlier stage of the language, the second accent location being an innovation. This is what Hyman (2009) suggests for the Bantu case for which he sees the penultimate effects as an innovation which, although phrasal, in some languages has 'narrowed' down to a word domain process in others.

So, in conclusion, if one would follow the authors who reject the notion accent as useful, we would replace it by either stress (for a language like English) or by tone (for Kinga, Tokyo Japanese or Somali). In the case of English, we could of course not deny the need for lexical marks in specific cases (notably where the location of stress is not predictable), but these scholars would presumably refer to the lexical mark simply as *stress*, using this term to refer to both lexical marks and the phonetic properties that are said to signal stress:

(5)



Hyman (this volume) represents the view that we only need the notions stress and tone. Both can co-occur within the same language, either independently or in dependencies that seem to go in both directions (stress-dependent tone or tone-dependent stress).[18]

My goal in this section has been to clarify the differences between (1) and (5) and the various considerations that lie behind going with one terminological scheme or the other. The 'debate' continues and the important controversy does not so much lie in the domain of stress systems (not much depends on whether we refer to lexical marking of the stress location as accent or stress), but rather in the analysis of the alleged 'pitch-accent' systems (or, more generally restricted tone systems[19]). Here the difference is theoretical since (ignoring the intermediate option that uses accent and tone) we *either* use a theoretical entity accent (with a

[16] The problem at hand is reminiscent of what Dresher and Lahiri (1991) call *metrical (in)coherence*.

[17] This problem also arises in languages that have vowel harmony, which has also been claimed to be accentual in nature (e.g. in Garde 1968). In Turkish, for example, the first syllable could be claimed to be accented for purposes of harmony (assuming that Turkish vowel harmony is triggered by a vowel contrast in the initial syllable), which contradicts the usual analysis of Turkish stress as falling on the final syllable.

[18] Hyman (2007) has reservations about the occurrence of tone-dependent stress; also see de Lacy (this volume).

[19] Van der Hulst (2011) suggests ways in which systems that are not traditionally seen as pitch-accent systems, and that seem truly tonal (in the sense of having a tonal contrast) can be analyzed accentually, as long as the 'tonal' contrast is binary (i.e. 'H' vs. 'L').

phonetic pitch exponent) or we appeal to tone even where it is not used contrastively.[20] The key issue is whether there is a *linguistically significant resemblance* between the locations for stress properties and the locations for (non-contrastive) pitch properties, and if so, whether that resemblance should be captured in terms of the notion accent[21], or rather should be captured by a general theory of prominent positions or culminative phenomena (see Beckman 1999). In favor of the latter view is the fact that languages do display apparently culminative distributions of phonological or phonetic properties for which an accentual analysis would that lead to 'accentual incoherence'.

Given the issues considered here, it might be argued that one must keep an open mind and not limit one's study to so-called stress systems (ignoring for the moment that here too it might not always be obvious how that terms applies to a given language), but rather include consideration of *all* culminative phenomena so that deeper analysis can reveal which ones truly reflect the role of a potentially unifying notion of accent.

3 Stress typology, areal distributions and acquisition

3.1 Stress systems and their formal analysis

In this subsection, before we continue with the various factors that enter into the study of stress, I provide a brief review of the various types of stress that are widely recognized to exist, leaving finer distinctions and problematic issues to following sections.

Word stress patterns are broadly categorized according the two criteria: boundedness and weight-sensitivity:

(6)

	Weight-sensitive	*Weight-insensitive*
Bounded	English	Finnish
Unbounded	Amele	Turkish

Hayes (1995), van der Hulst (1999) and Kager (1995, 2007) provide thorough overviews of the different kinds of patterns.[22]

Bounded quantity-insensitive (QI) stress patterns, extensively reviewed in Gordon (2002a), are those in which the statement of the stress rule need not refer to the quantity, or weight, of the syllables, thereby leaving only domain *edges* as reference points. These patterns can be divided into four kinds: single, polar (or dual) and rhythmic binary or ternary systems (Gordon 2002a). *Single stress systems* have a single stressed syllable in each word and thus no further rhythmic alternation. Polar stress systems have at most two stressed

[20] Van der Hulst and Smith (1988), a volume on 'pitch–accent systems', contains chapters on systems that mix stress and pitch or tone, which, as pointed out in Hyman (to appear), are not all equally likely to fall within the pitch-accent category if this category is to be considered at all.

[21] In this connection it is interesting to note that Kubozono (2011) demonstrates that certain regularities in the location of accents in Tokyo Japanese suggest a rule that is very similar to the English stress rule.

[22] Many of these systems have what is called both primary and non-primary (or rhythmic) stress. For the moment we focus on *primary stress*.

syllables in each word, at opposite ends of the domain, one primary and the other secondary, with no rhythmic alternation in between. Binary and ternary systems have no fixed upper bound on the number of stressed syllables in a word and place stress on every second or third syllable respectively, one stress typically being 'primary'. Additionally, systems lacking rhythm, may nonetheless have multiple stresses when they place secondary stress on all heavy syllables. [23] They are similar to binary and ternary patterns in that there is no clear principled upper limit on how many syllables in a word can receive stress, but they differ from binary and ternary patterns in that any number of unstressed syllables can occur between stresses.[24]

Quantity-sensitive (QS) stress systems are unlike QI stress systems in that stress placement is predictable only if reference is made to syllable types, in addition to edges. Because syllable distinctions are usually describable in terms of the quantity, or weight, of a syllable (measured in terms of vowel length, syllable closure or other prominence-lending properties), such patterns are called quantity-sensitive. The basic property of QS systems is that certain syllables with certain intrinsic properties (long vowel, syllable closure, high sonority vowels, high tone, including combinations of these; de Lacy 2007) 'demand' to be stressed, although it may also happen that syllables with certain properties (e.g., containing a schwa) *refuse* to be stressed. Like the QI patterns, QS bounded patterns can be subdivided into single and dual systems. In polar systems, the location of the secondary 'polar' accent is typically not weight sensitive. When QS systems have stressed syllables throughout the word, these can display a rhythmic (either binary or ternary) alternation that is insensitive to weight or sensitive to weight, or can be weight-sensitive but non-rhythmic. Because of the various possible weight distinctions, each of these subtypes shows extensive variation.

Finally, QS *unbounded* stress systems place no limits on the distances between primary stress and word edges, as primary stress usually falls on the leftmost (or rightmost) heavy syllable. Within the class of unbounded systems it is hard to identify a QI type because with stress invariably lying on the left or right edge such cases will be hard to distinguish from QI bounded systems.[25]

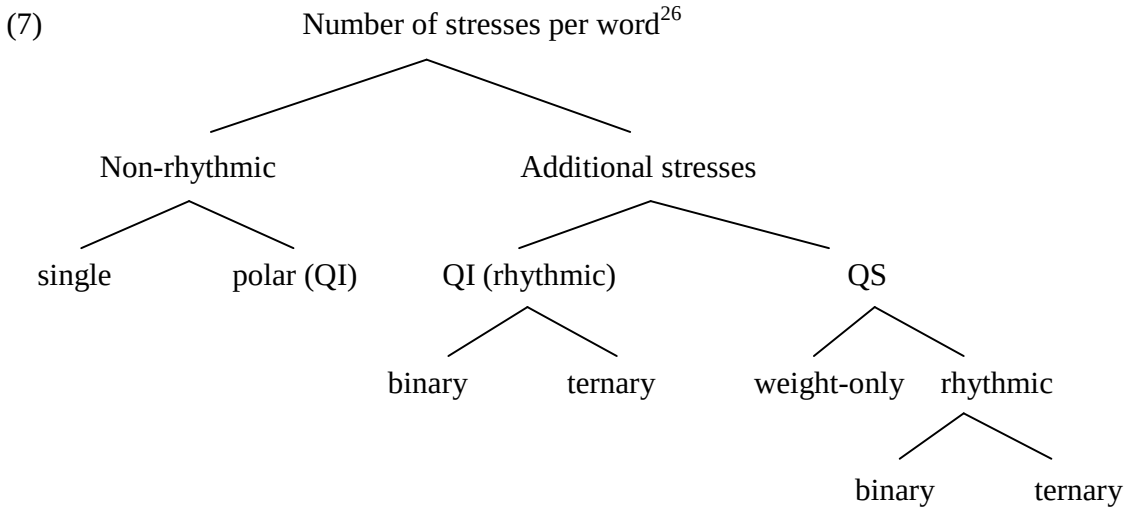
The four-way classification in (6) can thus be augmented by the following array of possibilities regarding the number of stresses per word:

[23] See Goedemans and van der Hulst (this volume) for the fact that the presence or type of weight-sensitive can differ for primary stress and non-primary stress(es).

[24] The location of non-primary stresses in these languages has been called unbounded.

[25] A possible criterion for discrimination is the patterns of exceptions in QI systems. Van der Hulst (1999, 2012) argues that Turkish, which has exceptional stress locations that can be on any syllable in the word, is for that reason unbounded.

(7)



Stress systems can be still further classified in terms of the precise rules for the location of primary stress. For bounded systems, both QI and QS we can focus on the *exact location* of stress with reference to the left or right edge of the word. In bounded systems stress can only fall on a syllable near the edge of the word (initial, second syllable, third, final, penultimate, antepenultimate):[27]

(8) Possible accent locations in bounded systems

Left				Right		
Initial	Second	Third		Antepenultimate	Penultimate	Ultimate
Finnish	Dakota	Winnebago		Macedonian	Polish	French
(σ	σ	σ	…….	σ	σ	σ)$_{word}$

In QS systems the location of stress depends on syllable weight.

In unbounded systems we also find a variety, depending on whether the leftmost or the rightmost heavy syllable is selected for primary stress and depending on the location of stress in words that do not contain a heavy syllable. For example, in Classical Arabic stress falls on the rightmost (or last) heavy syllable, but if no heavy syllable is present in the word, stress is on the first syllable. This is a 'Last/First' system. Given the independence of the heavy syllable rule and what we might call the default rule, we expect four types of unbounded systems to occur:

[26] In foot-based theories, different types of rhythm can be distinguished in terms of the location of the rhythmic beat. If the location is left we get trochaic (binary) or dactylic (ternary) rhythm. If the location is right we get iambic (binary) or anapest (ternary) rhythm. See section 7.1 and Hyde (this volume) and van der Hulst (this volume).

[27] These characterizations of stress/accent locations are based on StressTyp, a database for word stress/accent systems of the languages of the world; cf. Goedemans and van der Hulst (2009). Except for some cases that are discussed in more detail, I did not include references for the languages mentioned here and below all of which can be found in the database that is available online: http://www.unileiden.net/stresstyp/.

(9) Unbounded systems

a. Accent the first heavy, or else the first light syllable; e.g. Amele

b. Accent the first heavy, or else the last light syllable; e.g. Tahitian

c. Accent the last heavy, or else the last light syllable; e.g. Puluwatese

d. Accent the last heavy, or else the first light syllable; e.g. Sikaritai

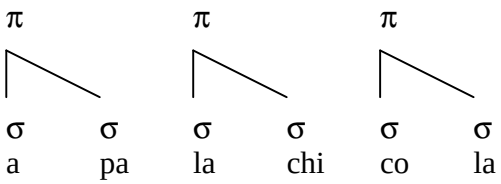
As shown, all four patterns are attested in the languages of the world (also see Hayes 1995).[28]

The variety of stress system is further compounded by the possibility of regarding a final or initial syllable as invisible for the purposes of stress assignment.

In formal terms, the advent of metrical theory (Liberman and Prince 1977) led to an analysis of this variety of stress systems in terms of a recipe for building a constituent structure consisting of two layers, a foot layer and a layer combining feet into a structure that comprises the entire stress domain (in most cases 'the word').[29] The central idea then is that primary stress is derived by organizing the syllables of a word into *headed feet* and, subsequently, feet into a *word structure* in which one foot is the head. The head of the head foot, being a head at both levels, represents the primary stress location. In this view, rhythm is assigned first, while primary stress is regarded as the 'promotion' of one of these rhythmic beats:

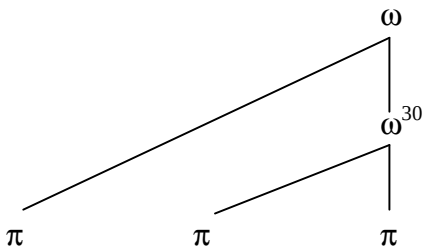
(10) Metrical Theory

STEP 1



Group from R-to-L into bounded left-headed foot

STEP 2

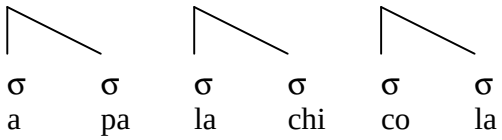


Group feet into an unbounded right-headed word tree[30]

[28] I refer to Goedemans and van der Hulst (this volume) for an overview of the possibilities for bounded QS systems which shows that such systems display the exact same four possibilities that unbounded systems show, albeit within a two-syllable domain either on the left or the right side of the word.

[29] While Liberman and Prince (1977) only deals with English, Vergnaud and Halle (1978) develop their approach into a parametric system for dealing with all stress languages. Their work was further developed in Hayes (1981).

[30] In early versions of metrical theory the constituent corresponding to the word was thought to be recursive, even though intermediate 'word' labels were not specified. In later versions (e.g. Halle and Vergnaud 1987a), the word was taken to be a flat constituent.



Metrical theory thus integrates the full rhythmic organization, including primary word stress and non-primary stresses into one arboreal structure, even though in this structure there are two levels which directly correspond to the distinction between rhythm (non-primary stresses) and primary stress. With this elegant theory, word stress rules can be formulated as a set of parameters with specific settings for forming a binary branching organization within the word.

(11) Word stress parameters[31]
Foot formation
Feet are left-headed/right-headed
Feet are assigned from right-to-left/left-to-right
Feet are bounded/unbounded
Word formation
Feet are grouped into a left-headed/right-headed word tree
Extrametricality
The final syllable is ignored (yes/no)
Weight-sensitivity
A syllable with internal weight must be a head (yes/no)

Extrametricality allows bounded system to have their stress 'on the third syllable in' (i.e. third syllable or antepenultimate syllable). The distinction between bounded and unbounded systems relies on the option for feet to be bounded (comprising at most two syllables) or unbounded.[32]

An initial success of metrical theory was that examples could be found for the majority of logically possible types (Vergnaud and Halle 1978, Hayes 1981), although not all types turned out to be equally common and some were not attested at all. This led to changes in the inventory of feet (see Hayes 1995) which allowed a better match between the theoretical possibilities and the empirically attested cases (see van der Hulst 1999, 2000 for detailed overviews of these changes). It is not my intention here to discuss these various theoretical issues in any further detail. What our field needs is a thorough review of approaches to word stress/accent that not only deals with the generative traditions, but also with other approaches, both earlier and contemporary. Fox's (2000) excellent book contains one chapter on accent which is highly informative, but it is only one chapter in a much broader study of prosodic phenomena.

[31] This set of parameters does not reckon with the distinctions between single and dual systems, nor with the fact that weight-sensitivity can differ for primary and non-primary stresses; see van der Hulst and Goedemans (this volume) for discussion.

[32] Liberman and Prince (1977) propose two planes for the formal representations that underlie stress, the metrical tree and the metrical grid. Prince (1983) abandoned the tree notation, whereas Kiparsky (1979) and Giegerich (1985) abandoned the grid. See van der Hulst (1999) for further discussion of these issues.

3.2 The areal distribution of stress types

In addition to the question of which types of stress systems occur in the world, it is also worthwhile to investigate how these systems are distributed in language families and over areas. Van der Hulst, Hendriks and van de Weijer (1999) provide some maps with the distribution of stress types across Europe, while Goedemans and van der Hulst (2005a-d), using the StressTyp database, have provided more detailed maps which show such distributions world wide (also see Goedemans and van der Hulst, this volume). Clearly, with increasing numbers of languages represented in StressTyp2, it will be possible to set up more case studies in which areal properties of stress types can be investigated. Rice (this volume) investigates the areal dimension of stress typology with specific reference to the languages of North America. Hayes (1995) notices some recurrent types in North America which are concentrated in certain areas, cutting across language families. Rice takes a closer look at these cases and discusses in detail the problems that arise in deciding whether an apparent areal distribution is in fact due to language contact or perhaps other factors. Van der Hulst, Goedemans and Rice (to appear) focus on the areal distribution of stress types on a global level.

3.3 Learnability (and acquisition)

While early studies on the acquisition of phonology mostly focus on segmental inventories and the order of development of phonemic contrasts, there is now a significant body of work that deals with the acquisition of stress in three ways (sometimes combined in one study). The first consists of *developmental studies* which chart the different stages toward the full representation of words, including their stress properties (Hochberg 1986; Nouveau 1994; Daelemans, Gillis, and Durieux 1994; Fikkert 1995 and many others). A second strand of work deals with the *logical problem* of stress acquisition. In the context of parameter theory, Dresher and Kaye (1990) make specific proposals about the kinds of cues that are available to the child to set the values of metrical parameters (also see Fikkert 1994, Gillis Durieux, and Daelemans 1995). An extension of this kind of work is to detect cues for foot structure that is not signaled in actual phonetic stress patterns, but rather depends on even subtler cue that regard phonotactic pattern, allomorphic variation and the like (see Boersma and Pater. to appear). Thirdly, formal computational accounts of learnability, adopting different models (such as finite state grammars, or Optimality Theoretic grammars), have also flourished. I refer to Heinz (2009, this volume) for references.

4 Summing up: Marks and exponents

It is clear that, despite the terminological differences reviewed in section 2, the distinction between content-free formal *marks* on syllables (whether called stress or accent) and *exponents or correlates of these marks* (both stress and non-stress) captures a real distinction which underlies virtually all work in this domain of research. In fact, in practice we can see research being focused on either one or the other pole.

Over the last few decades, starting with Chomsky and Halle (1968) and continuing into the present day, detailed proposals for assigning 'marks' to vowels or syllables have been developed, all of which assume that it is possible to deal with these marks, irrespective of and ignoring, their phonetic correlates. Formalisms for assigning stress or accent range from linear to non-linear approaches, each in various varieties, using determinative recipes for assigning marks (as in SPE) or structural configurations which embody these marks as 'designated terminal elements' of arboreal structures (as in metrical phonology, where the recipes take the form of sets of valued parameters, as demonstrated in the previous section). Alternatively, we find evaluative constraint-based theories (such as *Optimality Theory*) that, while having no bearing on the technical manner in which accent/stress is represented, substitute rules or parameters by *constraints* and theories of constraint-interaction (most notably allowing parochial, i.e. language-specific, ranking); see Prince and Smolensky 1993; Kager (2007).

In general it can be said that the study of accent or stress *as marks* has lead to a significant understanding of the typological diversity in terms of the possible locations for such marks, leading to such distinctions as bounded and unbounded systems and various subtypes within these (see section 3.1). Much research here focuses on understanding the factors that determine the location of marks which include:

(12) Factors determining primary stress
   a. Rhythm
   b. Syllable weight
   c. Word edges
   d. Lexical marking (to be discussed in the next section)

The role of rhythm is possibly (although not necessarily) manifested in bounded systems in which the stress does not lie on the first or last syllable but one syllable removed from it. In Metrical Theory, this location is derived by appealing to a rhythmic unit called the *foot*. Syllable weight by itself can also determine a location away from the edge. For example, a penultimate heavy syllable may pull stress onto it and thus away from the final syllable. We also see that both factors (feet and weight) can occur simultaneously (in so-called bounded weight-sensitive systems). The overall relevance of word edges is evident from *all* rule-based systems, either in determining the edge at which the relevant foot is located or, in unbounded systems, in choosing the heavy syllable closest to the left or right side of the word.[33] Theories differ in how they incorporate these various factors in their formalisms and these formalisms can also differ (trees, grids, neither). The factors in (12) are all *bottom-up* factors in the sense that stress is built on syllables that have rhythmic or weight properties or occur at an edge. Gordon (this volume) discusses *top-down effects* involving the occurrence of intonational pitch movements which may determine or influence the location of stress. For example, a HL intonational unit occurring at the right-edge of a phrase may prefer to see its H tone be associated to the *penultimate* syllable to avoid *tonal crowding* on the final syllable. This intonational H tone may then cause a stress which would otherwise be final to 'retract' to the penultimate syllable.

[33] Revithiadou (1999) argues that even in systems with unpredictable, lexical accent marking, edge locations influence possible locations of unpredictable accents.

On the side of the exponents, we also see an impressive amount of work being carried out which focuses on the phonetic details of the exponents. The question of the correlates of 'stress' have led to a significant amount of phonetic research (Lehiste 1970, Fox 2000 for overviews) and more recently many novel contributions have been made (Sluijter and van Heuven 1996, Dogil and Williams 1999, Gordon 2011). An important ingredient of this research is the above mentioned realization that it is crucial to separate the contributions of word-level exponents and higher-level effects that result from intonational properties. Another issue regards differences in cues for primary and non-primary stresses. Notoriously, especially the latter are hard to measure in objective terms (see de Lacy, this volume). Hualde and Nadeu (this volume) report on the result of experiments regarding the phonetic properties of primary (lexical) and secondary (postlexical) stress, showing that these differ in their phonetic cues.

These two poles of research into this domain (marks and exponents) fall, traditionally, perhaps in two distinct subdisciplines, namely phonology (marks) and phonetics (exponents). However, many researchers deal with both aspects in studying specific languages, often under the umbrella of what has come to be known as 'laboratory phonology'; see Gordon (this volume) and Hualde and Nadeu (this volume) for some specific examples.

5 The role of the lexicon and morphology

5.1 Lexical marking

To establish the basic pattern of a culminative property such as stress (or other properties) it is often advisable to first examine words with no or minimal morphological structure. A regularity thus established may be almost 'automatic' (have no exceptions) or hold for a majority of cases, while, at the same time, a subset (small, sometimes sizeable) displays a different pattern. For example, while stress on the penultimate syllable may be the majority rule, certain words may have to be lexically marked as having final or penultimate stress (as in Polish; see Franks 1985). A question of some interest is whether exceptions need to be 'close to' the regular rule. Could a language with regular penultimate stress have a subclass of words that have initial stress, or some form of unbounded stress? It has been argued (for example in Idsardi 1992 and van der Hulst 1999) that lexical marking of exceptions has to be visible to the regular algorithm to have effect, which would imply that a right-edge algorithm could not be 'distracted' by marks on the left edge (except in very short words). What is implied here is that the lexical marks are *not* marks of primary stress, but rather marks that indicate that the marked syllable behaves as if it is a 'heavy syllable'.[34] In this sense, lexical marking could be called *diacritic weight* (van der Hulst 1999, 2010). Just like heavy syllables can only interfere with stress[35] placement if they are within the scope of the stress rule, the same would apply to marked syllables. A theory of this kind is developed in, for example, Idsardi (1992, 2009) and van der Hulst (1999, 2009, 2012), but has been implicit in many approaches to the treatment of exceptions (e.g., Franks 1991).

[34] In addition to bearing diacritic accent, affixes can also be associated with rules that place, delete or relocate accents on other morphemes.

[35] Some would say 'accent placement' (see section 2), but to simplify the discussion I will henceforth use the term *stress* unless I specifically wish to focus on the different terminological usages.

However, in some languages certain classes of words appear to be marked for a rather different stress rule. In Turkish, for example, regular stress is final, but there is a class of words in which stress placement is weight-sensitive (see Sezer 1983). Van der Hulst (1999), however, shows how both aspects can be unified if Turkish is analyzed as an unbounded system with final stress being the default option when no stress further to the left is present in the word due to a special rule or, additionally, the behavior of certain (often bisyllabic) suffixes (see Inkelas and Orgun 2003). More research is needed to assess whether languages can have radically different stress systems, competing as 'co-phonologies' (cf. Shaw 1985) or occurring at different strata.

Gussenhoven (this volume) discusses the treatment of exceptions in the stress system of Dutch within an OT framework, making the significant claim, also pointed at above, that exception mechanisms should not have the power of characterizing exceptions of any sort in a given language since such mechanisms interact with the rules or constraints that are relevant to (the) regular cases. On the other hand, it is known that languages can have a stratified lexicon, part of which is fully tonal, the other part more like a H vs. Ø system, with at least underspecification of L (see Good 2004 on Saramaccan). If stratification can be this different, one might wonder if we won't find a system with two radically different stress-assignments. The evidence available in StressTyp (see section 5) suggests that cases in which exceptional locations deviate quite a bit from the regular pattern may not be so rare. Of the 70 languages (out of 511) 70 are marked as having significant numbers of exceptions. In 7 cases these exceptional locations are on the side opposite to the side with regular stress.

In other languages, lexical marking of stress (or rather diacritic weight) is the norm rather than the exception. Such languages have been referred to as having *free stress*, as opposed to *fixed stress* (when stress is rule governed and thus predictable).[36] We find the term *lexical stress* or *lexical accent language* for this type as well. In this case, morphemes may or may not have a lexical mark. What languages of this kind require, then, is a rule which decides which mark prevails in case more than one mark is present, as well as a rule which locates stress in case there is no mark at all.[37] As in the case of the unbounded systems discussed above, in principle, we can expect to find four types of cases here. If the domain of stress is the whole word, stress can be located on the rightmost (or leftmost) mark, or, if there is no mark on the rightmost (or leftmost) syllable. Both choices appear to be independent, which leads to four types of systems, all of which, then, can also be properly called unbounded, because the stress can end up anywhere in the word. An example of a lexical accent First/First system (stress is on the first lexical mark and on the first syllable if there is no mark) is Russian (Dogil 1995). As just remarked, Turkish is an example of a Last/Last system. However, other strategies occur as well. Garde (1965) was a pioneer in pointing out that lexical accent systems are only unpredictable in the lexical marking of the accent properties of morphemes. He showed with numerous examples that once morphemes are combined in complex word, the selection of which marks qualifies as the primary stress is

[36] If fixed is taken to mean rule governed, it allows cases in which stress is always on the same syllable (when stress placement is weight-insensitive) and cases in which the location of stress is dependent on syllable weight. For the latter case, sometimes the term 'variable stress' is used.

[37] Garde (1965) was a pioneer in pointing out that lexical accent systems are only unpredictable in the lexical marking of the accent properties of morphemes. He showed with numerous examples that once morphemes are combined in complex words, the selection of which mark qualifies as the primary stress is governed by rules. He showed that there is a small set of *resolution strategies* that languages employ for this purpose.

governed by rules. He showed that there is a small set of strategies that languages employ for this purpose. Modern studies in this area are Revithiadou (1999) and Alderete (1999, 2004).

It is also possible that marks are only 'seen' by the stress rule when they occur in a smaller domain (2 or 3 syllables) which, effectively, gives us a bounded system in which stress placement is claimed to be unpredictable within a two- or three-syllable window on the right- or left-edge, except for there being a *default clause* which applies if there are no lexical marks within the window. An example of this type is Modern Greek (Revithiadou 1999). General studies of lexical accent systems, both bounded and unbounded, are van Coetsem (1996), Revithiadou (1999) and Alderete (1999. The latter two also draw attention to the fact that in lexical accent system, specific morphemes (both stems and affixes) can come with rules that affect the location of accent. Affixes can insert, delete or move accents. See Poser (1984, chapter 2) for a detailed study of such phenomena in Tokyo Japanese.

5.2 Affix classes

Leaving aside compounds (see Visch 1999), the morphological complexity of words can be relevant to stress placement in several ways. Since the chapters in this volume do not specifically deal with stress~morphology interaction, I will only make a few general remarks here. As is well-known, English has two classes of affixes which differ notably in terms of the way that they interact with word stress placement. A distinction can be made between words with affixes (often called stress-sensitive or Class I affixes) that are subject to the same stress rule that also applies to simplex words and cases in which the affixes seem to fall outside the scope of the word stress rule (stress-neutral or Class II affixes). Siegel (1984) proposed to order the word stress rule after Class I affixation and before Class II affixation, a proposal that was incorporated into the framework of lexical phonology which extended this idea of level ordering to other phonological processes (Kiparsky 1982, 1985).[38]

When, for example, stress is located on the right edge, adding a Class I suffix may lead to an apparent 'shift' of stress as in:

(13) [condénse] ⟶ [[condens]átion]

However, there is no stress *shift*. Rather, the stress on the base, *condénse*, is 'silenced' and a new stress, assigned by the same rule, is placed the penultimate syllable of the larger word. If silencing of the stress on the syllable /dens/ it surfaces as a non-primary so-called 'cyclic' stress:

(14) [condénse] ⟶ [[condèns]átion]

The idea is that the stress that is assigned in last *cycle* prevails over previously assigned stresses, which Chomsky and Halle (1968) implement with a *stress lowering convention*. If, as in SPE, we assume that stress is indeed assigned cyclically (see also Kiparsky 1979),

[38] Halle and Vergnaud (1987) contest the claim that affixes can be grouped in blocks like that and suggest that the stress behavior of affixes is more like an idiosyncratic property of the affix. See also Fabb (1988).

complete stress silencing could be regarded as the result of 'forgetting' that there is an embedded base: [39]

(15) [condénse] ⟶ [[condèns]átion] ⟶ [condensátion]

Now, preservation of stress on an embedded cycle is more obviously the case when a class I affix is added because addition of such an affix does not trigger an application of the stress rule on the newly formed word. Compare in this respect addition of class I suffix *–al* and class II suffix *–hood*:

(16) a. [párent] ⟶ [[parént]al] (Class I)

b. [párent] ⟶ [[párent]hood] (Class II)

In the former case (Class I), the stress on /en/ results from applying the stress rule to the whole word. In this case, the stress in the embedded word on /pa/ does not survive because it occurs in clash with the new primary stress, especially since it occurs on a light syllable, which is not the case in *condensation* where the syllable is closed.[40] These brief remarks are not meant to suggest an analysis of English stress which is a highly complex system (see Fudge 1984; Kager 1989; Hammond 1999; Burzio 1994; Pater 2000). This is true, firstly, of the rule that governs the location of primary stress (which makes English a prime candidate for a stress-*accent* language), but also with regard to non-primary stresses which, in addition to displaying cyclic effects, are sensitive on syllable weight. Also, initial syllables tend to have a secondary stress which qualifies English as a language with polar secondary stress and weight-sensitive rhythm.

To make a connection with lexical marking, it could be that cyclic non-primary stresses only occur in languages in which the location of stress is heavily dependent on lexical marking[41], which makes stress a lexical rule, as opposed to a post-cyclic or post-lexical rule, perhaps even implying that words are lexically stored *with* their stress pattern in place (see Brame 1974).[42] In this view, cyclic stresses 'shine through' because they are an intrinsic part of the embedded unit as it is stored in the lexicon. Related to this is the approach which, rather than seeing the embedded unit as containing a lexical mark that underlies their stress, accounts for cyclic stresses by assuming that the words in question have lexicalized the segmental *effect* of stress, which in English would be 'full vowel quality' (Bolinger 1981; Kager ms.). In this view, which assumes that many alleged full vowels are really schwas, cyclic stresses would effectively occur on syllables that do not have schwa vowels and are thus phonologically heavy. A problem is, however, that even when vowels are full, they do

[39] I here ignore the effect of a predictable initial secondary stress; see below.

[40] Many have argued that the extent to which Class I affixes respect the stress pattern of their base is highly variable (Fudge 1984, Pater 2000). We would be inclined to call Class I affixes, cyclic affixes. However, in some approaches (e.g. Halle and Vergnaud 1987ab; Halle and Kenstowicz 1991), Class II affixes are called cyclic because these affixes, as a rule, respect their base as a fully spelled-out 'cycle'.

[41] Chung (1983), however, analyzes stress in Chamorro showing cyclic effect in a language with highly predictable stress.

[42] This might be related to Bybee et al's (1998) observations about unpredictable stress having more exponent effects.

not necessarily bear stress, as shown by the pair *prodúce* vs *pròtráct*, both of which have a full vowel in the first syllable, while on the second word has a secondary stress on the first syllable. It would seem, then, that an account of such differences must make use of lexical marks for secondary stress (see section 7.1).

Much of the preceding discussion assumes that stress in English is assigned by rule (at least to each newly formed word). One could also argue that in languages such as English where stress placement is irregular (depending on lexical marking and morphology), *all* stresses are based on lexical marks in morphemes and that the stress system is one in which the rightmost or leftmost lexical mark is interpreted as primary stress, with marks to the left or right being potentially interpreted as secondary stresses. On this account, even English could count as a lexical accent language (analogous to the analysis that Revithiadou 1999 gives for Greek) and would belong in the family of cases discussed in the previous section.

Finally, we must reckon with the effect of highly complex morphological systems that occur in so-called *polysynthetic* languages. It is to be expected that languages with very 'long words' will show certain effects (such as the division of long words into several prosodic domains) that are absent in languages with shorter words. It is striking that many of the cases in which Hayes (1995) reports that words have 'no primary stress', or 'multiple equal stresses', occur in languages with very long words (cf. van der Hulst 1997).

In conclusion, despite many insightful cases studies and general studies, a comprehensive typology of the interaction between stress or accent and lexical or morphological factors appears to be absent at the present time.

6 Intonational pitch accents

Returning to the topic of section 2, let us now turn to the use of the term accent that lies on the other side of (i.e. 'above') stress, as in (1). Here, we are dealing with a rather different notion of accent which is far from abstract or devoid of phonetic content. Rather this use of accent refers typically to a perceptible intonational unit, which hooks up with the stressed syllable, which Bolinger (1972, 1985) calls a 'pitch accent', a term that has also been adopted in autosegmental approaches to intonation following the lead of Pierrehumbert (1980).

The correlation between stress and (intonational) pitch accent is not a necessary one. Stressed syllables are usually linked to an intonational pitch accent under specific circumstances, typically when the word that contains the stressed syllable is part of a *focus domain*.[43] One can imagine that proponents of the scheme in (1), which involves the use of pitch-accent for cases in which accents are correlated with pitch at the word level, would prefer to avoid the term pitch accent for intonational events and instead use 'tonic accent' or 'intoneme' in this case. Once again we realize that students of stress and intonation must be careful in their use or understanding of terminology.[44]

The relationship between word stress and intonation raises various further issues. Firstly, as implied above, not all word stresses correlate with intonational pitch accents in language

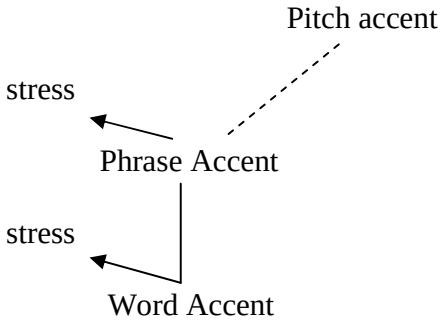
[43] But see Hellmuth (2006) for other possibilities for pitch accent distribution. Also see Gussenhoven (2004) for a general overview and several cases studies.

[44] I am not excluding that some scholars (e.g. Jassem and Gibbon 1980) take *accent* to refer to *all* phonetic correlates of stress (both at the word level and intonational level), in which case 'stress' has become the abstract mark, possibly lexically marked, and accent the phonetic correlates. This view is radically opposite to the one we discussed earlier and these two views can therefore not be reconciled.

where focus is the driving force. Rather, when several words together make up a phrase which as a whole form a focus domain, only certain words, often just one, can function as an anchor for the pitch accents that serve to mark that the phrase is in focus. This entails that there must be rules which determine which words within a phrase have this privileged status. Such rules are often called *phrasal stress rules* (or, again, phrasal accent rules) such as the *nuclear stress rule* in SPE which picks out the last (major category) word in the phrase, although there is an extensive literature on the correctness of this rule (for English) with many alternatives being now available as well as a better perspective on typological differences in this area (see Ladd 2008, chapter 5). Here too, the linear approach of SPE has been replaced by metrical approaches (either arboreal or grid-based or both). The distribution of pitch accents forms an important topic of research and we now know that more is needed to explain their occurrence than phrasal stresses, especially if various kinds of pitch accents are distinguished, such as the 'nuclear' pitch accent and pre- or post-nuclear pitch accents; see Gussenhoven (2004) and Ladd (2008) for general introductions.

Recognizing phrasal stress as a separate category from word stress raises the following question. Do such phrasal stresses have their own set of exponents which are present and detectable even when no intonational pitch accent is present? Another question for those who distinguish accent from stress at the word level is whether it also makes sense to separate these two notions at the phrasal level, and, if so, whether phrasal accent is built on word accent or on word stress:

(17)



I refer to van der Hulst (in prep.) for the point that the culminative properties of words and phrases are indeed parallel and that in languages such as English and Dutch phrasal prominence involves the notion of accentuation (phrasal accents being build on word accents), while in other types of languages (such as the Romance language or Bengali; Ladd 2008), intonational units are anchored to phrasal edges.[45]

[45] This view actually unifies the two uses of the term 'pitch accent' as 'pitch correlate of accent'. This seems straightforwardly correct for the word level notion of pitch accent, while it could be correct for intonational pitch properties if we say that intonation pitch properties are not anchored in word stress, but rather in phrasal accent, where a phrasal accent corresponds to stress of words in a certain phrasal position:

Word	Phrase
Pitch	Pitch (intonational unit)
|	|
Accent	Accent

Another aspect of the relationship between word stress and pitch accents that I have already commented on is that the dependency between them is not always as implied thus far (stress-based pitch accent). As Gordon (this volume) shows, we must also reckon with pitch accent based stress, i.e. cases in which the location of intonational pitch accent seems to synchronically determine the location of word stress such as Chickasaw (Gordon 2003). (Here I added 'synchronically' because, as Gordon shows, this particular dependency also has a diachronic importance in the study of the historical emergence of word stress). Top-down effects can even be more dramatic when the claim is made that an alleged word stress is not present at all and that the impression of words stress is caused by the fact that final syllables of words (typically when occurring in phrasal final position) carry an intonation pitch accent, not because they have stress, but simply because they are phrase final. This is one way of analyzing the 'final stress' in French; see Gussenhoven (2004). I also refer to van Goedemans and van Zanten (2007) who show that in Indonesian has no word stress, which suggest that what researchers have heard as stress my be the result of intonational effects involving boundary tones.

7 Non-primary stress

There is one additional dimension to the terminological web that we need to reckon with. As we already recognized in section 3.1 and 5.2, at the word level, many researchers make reference to *levels of stress*, recognizing that words can have a *rhythmic profile* in which various syllables 'stand out' to different degrees. Usually, one "culminative" stress will prevail over all others (called the primary stress), but other syllables might bear a lesser degree of stress.

7.1 Sources of non-primary stress

Non-primary stresses can have several sources:[46]

(18) Sources of non-primary stress
- a. Rhythm
- b. Syllable weight
- c. Word edges
- d. Lexical marking
- e. Cyclic effects

(In both cases there could be additional correlates.) The only terminological issue is that in the case of a word pitch accent system, it is not customary to refer to the pitch properties themselves as pitch-accents, but it would be quite appropriate to do just that. To push this even further, a real phrasal analogue to a word level pitch accent system would be a system in which, at the phrasal level, all focused phrases receive a *predictable* pitch event. A language like English in which there are various contrastive phrasal pitch movements would be the proper analogy to a tonal accent language (in which we find a tonal contrast on the accented syllable). That would make Bolinger's term 'pitch accent' the wrong one for English and instead the term '(phrasal) tonal accent' should be used.

[46] A problem here is whether these sources are present in the speech signal or only in the mind of listener; see de Lacy (this volume).

We saw that all these factors play a role in the placement of primary stress as well. As in the case of primary stress, these factors occur in a variety of forms and they can be co-present. In fact, in the stress system of English all have a role to play. I mention cyclic effects as a fifth source non-primary stress. However, if, as argued in section 5.1, cyclic stress would be analyzed as a form of syllable weight, (18e) reduces to (18b). However, if that view is rejected, cyclic stress would remain a fifth factor.

Rhythm results from a binary or sometimes ternary alternation of strong and weak syllables, usually throughout the word, but rarely perhaps in a non-iterative fashion, causing only one non-primary beat. Another dimension of variation results from the fact that rhythm can be *trochaic* (peak first) or *iambic* (trough first) and perhaps additional types can be recognized, especially in combination with the binary/ternary distinction (see van der Hulst 1999, 2000, this volume for detailed discussions). Of specific interest is the interplay between rhythmic stress and the primary stress. Here a case could be made for dependencies going in either direction (rhythm-based primary stress and stress-based rhythm). Hayes (1995) provides a broad overview of stress systems in which, on his analysis, stress is rhythm-based, although he does also acknowledge cases in which the location of primary stress seems to be independent of rhythm. These options are discussed in Goedemans and van der Hulst (this volume) and van der Hulst (this volume). Both Hyde (this volume) and van der Hulst (this volume) discuss the properties of rhythmic patterns in some detail, proposing accounts of the array of attested patterns from different theoretical perspectives.

Having added rhythm to the picture, another terminological issue again comes up. One could argue that the notion of stress be limited to the most prominent syllable, providing another term such as 'rhythmic beats' to refer to other prominent syllables. More commonly, however, although such a terminological distinction might be used informally, stress is taken to comprise the overall rhythmic profile of words, making reference to primary and non-primary stress (sometimes, as in SPE, following Trager and Smith 1951, even differentiating between secondary and lower levels of stress).

It is important, however, to bear in mind that rhythm and (primary) stress are distinct phenomena, the former either feeding into the latter (the standard metrical, bottom up view) or following the latter (the top-down view proposed in van der Hulst 2009; see van der Hulst and Goedemans, this volume). In the stress-first, top-down mode, rhythm can either be seen as 'rippling away' from the stress (which is called echo accent in Garde 1968), or moving toward it (which gives rise to what has been called either *dual* or *bidirectional* or *polar* systems); see van der Hulst (this volume) for discussion and exemplification. As remarked earlier, while rhythm interacts with primary stress, rhythm is *not* an exponent of stress (like hyperarticulation is). If rhythm would always simply ripple away from the primary stress, it could be seen as an exponent, but that is not the case since rhythm can come in from the other side, possibly rippling away from the initial secondary stress (see below) or simply be absent.

The matter of syllable weight has triggered a significant amount of attention. It is intuitively easy to understand that the intrinsic properties of syllables can interfere with the distribution of rhythm.[47] There are two strands of research that elucidate this correlation. Seeing that the location of stress (both primary and rhythmic) can be dependent on properties

[47] As they do with the location of primary stress, either independently from rhythm or via their influence on rhythm (this choice being dependent on the issue mentioned earlier regarding the possible separation of primary stress and rhythm).

of syllables, with certain syllables (called heavy) attracting stress, several questions arise such as:

(19)
a. What kinds of weight distinctions are attested?
b. Which properties of syllables can attribute to weight?
c. Are all weight distinctions binary?
d. What is the formal representation of weight?

I refer to Davis (2011), Zec (2011) and Gordon (2004) for recent overviews of these and other issues, which are not the primary target of the studies in this volume. See Goedemans (1993, 1996) for the phonetics of weight and the (ir)relevance of onset differences to weight distinctions. There are also accounts which suggest a role for onset properties in stress assignment (Gordon 2004, 2006, Topintzi 2011). An important distinction in categories of weight is that between weight by quantity (CV vs. CVV or CVC) and weight by quality. When stress is sensitive to vowel quality (full vs. reduced vowels, or low vs. high vowels) one often speaks of *prominence- or quality-driven* systems (see Kenstowicz 1997).

A very important aspect of the relationship between syllable weight and stress concerns the question whether there are systematic correlations between specific kinds of weight and specific kinds of stress types. But perhaps the first question that needs to be addressed is whether the fact that syllable weight plays any role at all can be predicted from the inventories of syllable types in any given language. It seems obvious that languages which do not permit either closed syllables or long vowels are very unlikely to have weight-sensitive stress, simply because weight distinctions are lacking. Kager (1992) refers to such languages as being trivially weight-insensitive. However, since one form of weight may lie in the difference between open and closed vowels (open or high sonority vowels attracting stress), or reduced versus non-reduced vowels no language is strictly speaking trivially weight-insensitive and it is therefore reasonable to look for weight effects, even in strict CV languages (see Kenstowicz 1997).

Turning to languages that do have different types of syllables (CVC, CVV in addition to CV), it could have been the case that such languages *must* be weight-sensitive, i.e. that stress placement cannot ignore such differences. This does not seem to be the case and the general assumption is that languages with long vowels and/or closed syllables can be either weight-insensitive or weight-sensitive. Kager (1992) asks whether there are 'truly quantity-insensitive languages' implying that weight differences, if present, will always have some influence. A factor that we must reckon with here is that primary stress and rhythmic stress might respond differently to weight (see Goedemans and van der Hulst, this volume). If rhythmic stress is more likely to be a 'low-level' automatic effect, it is perhaps also more likely to be sensitive to intrinsic differences between syllables and it is thus worth investigating whether non-primary, rhythmic stress will always be sensitive to weight differences, whereas primary stress (perhaps especially if it shows effects of being sensitive to lexical marks ands thus lexical as opposed to post-lexical or at least post-cyclic) might be neglectful of weight because it is a more categorial and phonologized process (assuming that phonologization may entail suppressing natural effects that are below a certain threshold). In short, it is worth investigating whether the influence of weight on stress as a natural low level effect can be more easily ignored by a phonological rule for primary stress than by a phonetic process for rhythm.

Gordon (2002b, 2006) investigates whether there are phonetic differences between phonologically identical syllables that act as heavy in one language, but not in another, thus comparing the behavior of identical syllables in different languages. He shows that such differences exist and this raises the question whether these differences 'existed first' and thus caused certain syllables in certain languages to attract stress or whether the differences are the result of these syllables being selected for stress.

As we have seen, a major division in stress systems is that between bounded and unbounded systems. Ahn (2000) investigates a number of weight-sensitive unbounded systems and concludes that syllables that are heavy due to having long vowels, CVV (and thus not closed CVC syllables) constitute the kind of weight that attracts stress in these systems. This is an interesting result that clearly shows a typological correlation between certain kinds of weight and certain kinds of stress placement, but it needs to be tested against a larger sample of languages.

Another line of research that investigates the relationship between syllable structure and stress refers to the typological distinction between stress-timed, syllable-timed and mora-timed languages. An overview of this work can be found in Nespor, Shukla and Mehler (2011) where we find the interesting claim that such distinctions (which have often been called into question because it was unclear what they were based on; see Roach 1982, den Os 1983) relate to the complexity of syllable structure and more specifically to the time interval between vowels as syllable peaks. The three-way distinction can be correlated, Nespor, Shukla and Mehler show, with the relative complexity of the consonant units that intervene between vowels. If clusters can be complex and thus vary in duration (as in English) a stress-timed rhythm results, whereas syllable-timed and especially mora-timed systems correlate with more regular intervals caused by simpler or no consonant clusters.

Turning to a third factor that impinges on the rhythmic profile (i.e. 18c), let us recall the fact that in English (and Dutch), which have right-edge primary stress, the left edge (first) syllable is typically prominent. This is sometimes called the 'àbracadábra' effect. I have referred in section 3.1 to such secondary stresses as polar stresses.[48] The initial strong syllable and the right-edge stress create a 'hammock' pattern (Zonneveld 1982) with possible additional rhythmic beats in-between, provided that the string of syllables is long enough. If there are intermediate beats, the initial beat is stronger than those intermediate stresses which is why the initial beat being called the secondary stress and the other beats tertiary stresses.

This initial beat *can* be derived rhythmically if it is assumed that rhythm is assigned from left-to-right in English and Dutch, while in other cases it is often assigned from the edge where the primary stress is located. These differences (between 'polar' and 'echo' rhythm) are discussed in van der Hulst (this volume) where it is also suggested that the polar beat is not a rhythmic beat at all, but rather an effect of what Moskal (to appear) calls *edge prominence*, a strengthening effect that is not atypical of edge syllables.[49] An indication of the independence of the initial beat is that in some languages it can be involved in cases in which it clashes either with the primary stress or with a genuine rhythmic beat. For such

[48] Di Cristo (1998) also draws attention to such polar patterns.

[49] The rule in question is more complex than stated here. If the primary stress is on the second syllable, the non-primary stress is unlikely to show up. Syllable weight is important here as well. If the first syllable is light and the second heavy, the second syllable may claim the secondary accent. It is open to question whether this rule is sensitive to phrasal context. Chapter 8 of Hammond's (1999) book provides a nice list of the various permutations of stressed and unstressed syllables as a function of weight, and distance from the primary stress in English.

cases, I refer to the chapters by Hyde and van der Hulst in this volume, as well as Moskal (to appear).

Turning to factor (18d), it is relevant to ask whether non-primary stresses can be *un*predictable and thus lexically specified? Claims have indeed been made that non-primary stresses sometimes need to be lexically specified. Such claims come in different forms. Firstly, there are cases where *real* non-primary stresses are claimed to be lexical. In fact, English provides a case in point with pairs such as *prodúce* vs *pròtráct*.

Secondly, there are cases in which allomorphic variation is due to a syllable-counting regularity which suggests foot structure beyond or independent of the feet needed for stress (see Gonzalez 2003, Vaysman 2009). In these cases the feet needed for the allomorphy do not necessarily account for rhythmic beats and thus are purely motivated to account for the allomorphic variation. This suggests that rhythm can be lexicalized in terms of abstract foot structure, as such conditioning allomorphy, while the language has meanwhile developed a different surface rhythm.

Factor (18e) brings us back to the issue of cyclic stresses, which, as discussed in the previous section, are non-primary stresses that are not due to the other four factors in (18). As suggested in section 7.1 various approaches to such cases are possible, including one which reduces cyclic stress to a matter of syllable weight.

Finally, relating to the question of stress levels, we also need to consider the matter of compound stress. Compounds often require a stress rule that is distinct from the word stress rule and the phrasal stress rule. Typically, compound-internal words whose primary stress is not reinforced as compound stress shine through as cyclic secondary stresses. The question arises as to whether the primary and non-primary stresses of compounds should contribute to the number of stress levels that needs to be distinguished. Specifically, is the secondary stress in a compound stronger than the secondary stress in a simplex or derived word, as was suggested in Trager and Smith (1951)? Fox (2000: 127-134) offers a detailed discussion of these issues.

7.2 Non-primary stress and intonation

We need to revisit the claim that pitch accents dock on primary stressed syllables. It has been frequently observed that this is not always the case, i.e. in specific cases the pitch accent docks on what appears to be the secondary stress of a word:[50]

(20) a. That chair is made of bàmbóo
:
H*L

b. A bámbòo cháir
: :
H*L H*L

Note that it seems as if the relationship between the primary and secondary stress is reversed in (20b).[51] The reason for alleged stress reversal has been identified as a *stress clash*

[50] The so-called 'starred tone' is the one that associates to the stressed syllable; cf. Pierrehumbert (1980).

(between the stress on /boo/ and the stress on /chair/. The stress on *chair* is phrasal and thus stronger which makes the word stress on *bamboo* 'move over'. The role of stress clash avoidance is widely recognized, so an account along these lines is well-founded (see Nespor and Vogel 1989; Hayes 1984). However, on a different account (Gussenhoven 2004), what happens here is not a reversal of stress, but rather an anchoring of the first pitch accent on the syllable with secondary stress, the reason for which lies in the preferred separation of the two 'clashing' pitch accents.[52] If one would maintain that there is, additionally, a stress reversal this would be an instance of the top-down effect of intonation on stress location (see Gordon, this volume). Cases like this are open to different analyses (stress-based or intonation-based).

8 Problems in the study of word stress

Despite the central role of stress research in phonology, there are certain problems that continue to command our interest, especially in the context of the above discussed database project. Some of these problems are briefly mentioned in van der Hulst (this volume) with specific reference to rhythm, while the contributions of de Lacy (this volume) and Gordon (this volume) take these general problems to be their main concern.

As indicated in section 2 of this chapter, the student of stress faces serious problems relating to terminology. One implication is that in building a database for 'stress systems' or constructing a theory of 'stress systems', we do not know whether the languages being lumped together truly form a natural class, given that different scholars may be describing different phenomena while using the same term and vice versa. Of course, this is only partly a terminological problem. It is also a methodological matter, as well as one that depends on one's control of phonetics and one's underlying phonological theory. This calls for extreme caution which, however, is not (or cannot be) always observed in broad typological studies.

Early on in word stress research a big concern was that there did not seem to be a homogeneous or invariant phonetic characterization of 'stress'. One problem, regarding the role of pitch as a property of stress, was resolved when it was realized that in many cases significant pitch properties associated with stressed syllables are actually properties of only those stressed syllables that end up being linked to an intonational pitch accent. Additionally, it came to be agreed upon that stress or accent can have different phonetic and phonological properties in different languages which would not have to stand in the way of generalizations about the rule that determines the location of stress or accent which, after all, could abstract away from the various phonetic properties. Thus, many typological and theoretical generalizations about 'stress or accent locations' are really about the locations and not so much, or at all, about the realizational phonetic details. Of course, the identification of the location, based on human perception or instrumental measurement is not always straightforward; different scholars may hear different things, or indeed nothing at all. As Hualde and Nadeu (this volume) point out, such problems often are very different for locating primary stress as opposed to non-primary stress, the former often being easily

[51] This would also be a case in which we have two pitch accents in one focus domain, a pre-nuclear and a nuclear pitch accent.

[52] Shattuck-Hufnagel, Ostendorf and Ross (1995) is a phonetic study of clash avoidance as an intonationally-driven phenomenon.

identifiable, especially in languages in which this location is not entirely predictable. Goedemans and van Zanten (2007) show that in languages with fully predictable (alleged) primary stress, it may in fact not be easy at all to tell what the location is.

But there are other problems which involve the domain of the alleged 'word' stress or accent. There are at least three classes of problems:

(21) a. Is the domain of stress the whole word of a subpart?
b. Is the domain the morphological word or the prosodic word?
c. Is the domain the 'word' (in whatever sense) or a larger phrasal unit?

Each of these problems can be parceled out into various further problems or questions.

In section 5, we addressed the issue of morphologically complex words and here we saw that sometimes stress can be a property of a subpart of morphologically complex words (in the case of Class II affixation) or of designated units such as roots or affixes. In still other cases, where words can be very long, it is conceivable that the morphological word is broken up in various prosodic subparts (prosodic words, perhaps) for the purpose of stress assignment, leading to the apparent fact that a word can have multiple equal stresses.

(21b) concerns another aspect of the domain issue. When stress displays cyclic effects it seems clear that the stress rules must make reference to the morphological structure. Reference to lexical information (such as exception marking or reference to word classes) also suggests application to a grammatical or morphological domain. However, when a stress rule applies blindly to 'words' with no reference to morphological structure or lexical information, it is possible that the domain of this rule is post-lexical or prosodic, which calls for a specification of the nature of this prosodic domain. A problem here is that the relevant prosodic domain (such as the prosodic word) might in fact be smaller than morphological (or syntactic) words, as is clearly the case in compounds but also, as suggested, in words that result from polysynthetic morphology. In other cases, in languages involving 'clitics' the relevant domain may be larger than the morphological word.

Gordon (this volume) addresses the question in (21c). He points out, as others have occasionally remarked, that when one studies the prominence pattern of words, it often happens that words are taken in isolation, which makes it difficult to separate what might be word-level properties and phrasal-level properties. We already encountered this point in relation to the realization that in many cases, pitch movements are not intrinsic cues of word stress, but are instead the realization of an intonational pitch accent which is associated to a specific word within an utterance. There will thus be potential ambiguity if a word is taken in isolation. Gordon pushes this issue one step further by asking whether the stress of words in isolation is a word stress at all, pointing to the possibility that we are really dealing with a phrasal stress and its intonational correlates. He pursues this point along two lines. Firstly, he suggests that the popular penultimate location of word stress suggests that, in a historical sense, word stresses may be lexicalizations of intonational pitch accents (see next section for details). Secondly, he suggests it might also be the case that alleged word stresses are, synchronically, phrasal effects.

As shown, there are many issues surrounding the notion of domain for word stress, which are easier to raise than to answer and this volume will only shed light on some of these, specifically those in (21c).

9 Database applications

The typological diversity of stress systems and, to some extent, the ease with which one can make 'quick' statements about the location of stress (statements which often need to be relativized upon closer investigation) invites 'Greenberg' style surveys in which hundreds of languages are assigned to types. One of the first surveys of this type can be found in Hyman (1977), another such survey (focusing on types and less on 'numbers') being Greenberg and Kaschube (1976). It was to be expected that with the advent of computer use, 'card collections' and 'lists' that those and other stress researchers kept were being replaced by digital records of some sort. In the next sections, I briefly describe two such projects and their merger into one new system. For a more extensive discussion of these projects I refer to Goedemans and van der Hulst (2009) and Heinz (2006).

9.1 StressTyp

Work on StressTyp was initiated by van der Hulst in 1991 as a pilot project of EUROTYP (1990-1994), a project on the typology of European languages, financed by the European Science Foundation (ESF).[53] In the course of the EUROTYP project the question regarding storing language data received special attention and in 1991 it was decided to start StressTyp as a pilot project. The idea was to develop an intelligent filing and retrieval system for data (i.e. rules, generalizations, patterns) on word stress systems. The structure of the records was developed by Harry van der Hulst. From early on, Rob Goedemans has controlled all aspects of the implementation side of the database. The first data for StressTyp were extracted from existing typological studies and, to a lesser extent, from primary sources (grammars and articles devoted to single languages). These data were first combined in so-called Data Entry Sheets (basically a paper-and-pencil version of the record structure) and subsequently entered into the database. In a second phase the information was checked for consistency and correctness by tracing the primary sources of the typological studies, and often by studying additional sources. At the end of this initial phase, StressTyp contained 154 languages. After the EUROTYP project had ended, work on StressTyp was continued which resulted in more complete coverage of the stress systems of the individual languages, more thoroughly checked records, and the addition of accentual information for 116 new languages, bringing the total to 270. From 1997-2001, StressTyp was included in the Prosody of Indonesian Languages (PIL) project coordinated by Vincent van Heuven, during which time the database implementation was improved and the number of languages went up from 270 to 510. The content of the old records was checked for errors and the language names and affiliations were updated according to the SIL Ethnologue 13th edition standard (Grimes 1996). At this point, only a handful of records for languages in StressTyp are based on secondary sources only. Using StressTyp, Goedemans and van der Hulst produced four maps (plus explanatory text) for the *World Atlas of Language Structures* (WALS), each showing the distribution of various kinds or aspects of word accentual systems (see Goedemans and van der Hulst 2005a-d). StressTyp has benefited greatly from the cooperation with the WALS editors.

[53] The outcome of 'Theme group 9' of the EUROTYP project, which investigated word stress systems in European languages, was published as van der Hulst (1999).

Among other improvements, StressTyp was expanded with 2 fields for geographical location and a procedure was developed to draw distributional maps of StressTyp data with the help of the mapping program AGIS. StressTyp is now also included in the *Typological Database System* (TDS), a joint venture of the Universities of Amsterdam, Leiden, Nijmegen, and Utrecht, which aims at the development of a common query interface for several typological databases. A prototype of the system is up and running (http://languagelink.let.uu.nl/tds).[54] To facilitate a smooth integration in the TDS, examples in IPA were converted to Unicode and the Ethnologue codes were updated to the 15th Edition (Gordon 2005). To promote the use of StressTyp various studies were combined in Goedemans et al. (1996). A second volume, based on StressTyp is van der Hulst et al. (2010), containing chapters on all language families in the world. A web version of StressTyp can be found here: http://www.unileiden.net/stresstyp/. StressTyp encodes primary stress and non-primary stress (rhythm) separately[55] in quasi-parametric fields that each have a well-defined and finite set of values. In addition, there are fields for specifying examples (in IPA), prose descriptions, syllable structures, morphological structure, stress-related processes and remarks, among others.

9.2 Stress Pattern Database

The Stress Pattern Database (SPD) was developed by Heinz in 2006 and 2007 as part of his dissertation research at UCLA. There are 403 languages represented in the database and 422 accent patterns, of which 109 are distinct. These word-accent systems are collected primarily from the typologies of Gordon (2002a) and Bailey (1995), though they have been supplemented with information in Hyman (1977) and Hayes (1995). SPD is not a replica of StressTyp. First, its technical construction differs. SPD is implemented as a fully relational database using the widely adopted, open-source MySQL database system. Second, SPD uses different descriptions of the documented dominant stress patterns of the world's languages. These are:

(22) a. a uniform English prose description of the placement of stress
b. Bailey's (1995) Syllable Priority Code extended to handle secondary stress, and
c. a representation of each stress pattern in terms of a finite-state automaton

Each of these descriptions is neutral to any particular linguistic theory of stress. There are additional advantages to the finite state representations, which are discussed in Heinz (2009). Third, the coverage of languages differs, there being an overlap with StressTyp of only about 200 languages. This means that the two databases combined will represent approximately 750 languages, and that every major language (sub)family will be represented. Finally, SPD also includes other information that is specifically relevant to Heinz's research. In particular, SPD includes results of the Forward Backward Neighborhood Learner (Heinz 2009).

[54] The TDS also contains SyllTyp, another database designed by Harry van der Hulst and Rob Goedemans.
[55] A rationale for this separation can be found in van der Hulst (1996, 2009) and in Goedemans and van der Hulst (this volume), among others.

9.3 StressTyp2

Recently, StressTyp and the Stress Pattern Database have been merged into a new database, StressTyp2 (ST2) with the goals of improving, verifying and enriching the dataset in a variety of ways and developing a web-based interface that (1) makes the information in ST2 easily available to researchers and citizens around the world, and (2) which meets or exceeds professional and scientific standards. The third goal of this project is to adopt (and, where necessary, establish) best practices for the collection, organization, dissemination and presentation of typological data pertaining to sound patterns in natural language.[56]

Like SPD, ST2 is implemented as a fully relational database within My SQL.[57] There are several advantages to relational databases that are widely acknowledged. They reduce error during data entry. The powerful query language of MySQL permits sophisticated searches. The logical, relational structure of the database permits the automatic generation of different kinds of reports in a variety of formats (XML, HTML, PDF, etc). Examples of the kind of reports that we are especially interested in pertain to generating information about particular languages, or about particular stress systems, patterns, or classes of stress systems. Additionally, since other established linguistic database systems use SQL, it becomes simple and easy for researchers to develop queries across databases to answer questions that formerly required an incredible amount of bookkeeping. For example: What kinds of stress systems are found in syntactic head-first languages?[58] More generally, relational databases permit the kind of cross-classification that yields new insights into natural language. ST2 includes several tables for languages, primary accent patterns, secondary accent patterns, syllable types (relevant for QS systems), and sources. Additionally, there are tables which link this information together; i.e. which establish the records in which tables are related. ST2 also incorporates metadata about the stress systems that can be updated automatically from scripts. The database also includes metadata regarding the changes that are made to the database over time.

The construction of databases adds problems of its own. Since the goal is generally to allow a broad group of users to benefit from the database, the encoding should not be too theory-dependent. But, as is well-known, any classification or description embodies a theory. This is what we might call the database paradox: we construct such systems in order to be able to better formulate and test theories, but in order to build the ideal database we need a complete theory of the subject. In fact, this paradox is a specific instance of a broader one, identified in Hyman (2006: 83) as follows:

> "This brings us to the following paradox concerning the role of theory in cross-linguistic research: While one needs theory to describe languages, one has to abstract away from individual theories to evaluate the resulting descriptions. That is, one has to "normalize" the data according to some general standard that minimizes the differences between the interpretations that different theories accord to the data. The final question is how to do all of the above in such a way that it is clear what would falsify a claimed universal."

[56] The project is a broad collaboration between Harry van der Hulst (University of Connecticut), Rob Goedemans (Leiden University) and Jeffrey Heinz (University of Delaware).
[57] URL address for ST2.
[58] see Tokizaki (2010) and Tokizaki and Kuwana (to appear) for this kind of work.

StressTyp2 will contain various alternative encodings of stress systems, some in prose, some in the forms of quasi parameters, some in terms of condensed and summarizing codes and still others in the form of finite-state automata and the strings of stressed and unstressed syllables that these machines permit. Another problem can be called the normalization problem. The information on which StressTyp2 encodings are based comes from many different sources which employ different terminologies, different transcriptions systems and different ways of being explicit about the morphological structure of words. In addition, there is the problem, already mentioned, that the prominence patterns of words may reflect properties that belong to higher levels, when studies in isolation. Awareness of these issues (and others) makes us careful, but in the end it is crucial to continuously improve the quality of the information based on the experience and feedback of the user group.

10 The chapters in this volume

In this section, I will briefly indicate the focus of each chapter as well as points where these foci intersect.

Chapter 1: Paul de Lacy - Evaluating evidence for stress systems

De Lacy raises the question how we can be sure that a description of a stress system is accurate and adequate for phonological research. He identifies theoretically-derived criteria for phonological evidence and presents a framework for identifying requirements on evidence presented for Generative phonological theories, while paring away the influence of performance and non-phonological modules from the influence of the phonological module on speech output. De Lacy asserts that obtaining accurate phonological evidence is extremely difficult due to the deeply 'embedded' position of the phonological module: phonological outputs are distorted by translations through the speaker's phonetic module, neuro-motor interface and articulatory apparatus, the transmission medium, the hearer/machine's auditory apparatus, neuro-auditory interface, perceptual system, and phonological system. Other cognitive modules such as the morphological modules and lexicon can also obscure evidence for phonological processes. This chapter focuses on a few core properties of generative theories of phonology, including modularity, L1 vs. L2 status, interfaces with other cognitive modules, and post-cognitive processes, and derives certain requirements on evidence from these core properties. The requirements include demonstrating that evidence for a particular module's state is sourced from a single L1 module (i.e. one speaker), and that the effect of distortions of the phonological output by non-phonological modules and factors must be taken into account. The distinction between requirements on evidence and techniques for gathering evidence is emphasized. For example, one requirement is that a dataset must be generated by a single phonological module. The techniques used to ensure this requirement can be many and varied, and change as understanding about the efficacy of certain techniques improves. The requirements on evidence that are identified are not novel or particularly surprising. However, a close examination of a stress description – Araucanian – shows that this case is rife with uncertainties, rendering it difficult to use as phonological evidence. Araucanian has been cited in support of many metrical theories and is a typical

description, suggesting that there are many more descriptions that fail to meet even fairly minimal standards set by generative theories of phonology.

Chapter 2: Matt Gordon - Disentangling stress and pitch accent: toward a typology of prominence at different prosodic levels

Gordon first hypothesizes that large typological studies of stress (and the phonological theories based on these typologies) necessarily draw most of their data from published descriptions in articles and books and notices that many, if not most, of these descriptions of stress are likely based on words uttered in isolation, where the word is equivalent to an utterance. In such cases, he asserts, the reported stress patterns more accurately reflect phrase-level pitch accents rather than true word-level stress. This chapter represents a preliminary attempt to tease apart word-level stress from phrase-level pitch accent with an eye toward creating a typological database of both types of prominence and their relationship to each other. Gordon reports on a survey which suggests that languages may be divided according to the relationship between prominence at the word- and phrase-levels and whether prominence at either the word- or phrase-level is repelled from the right edge of a word or not. He shows that many languages project phrasal accent in bottom-up fashion promoting one or more lexical stresses to a phrasal pitch accent, with a further bifurcation according to whether stress and pitch accents may fall on final syllables or not. In other languages, the conditions governing pitch accent placement operate in "top-down" fashion largely orthogonal to those dictating the location of word-level stress. The asymmetry between pitch accents and stress in non-finality effects finds an explanation in terms of intonational factors, following a proposal advanced by Hyman (1977). Pitch accents are most common in words at the right edge of an utterance. Declarative utterances cross-linguistically are characteristically associated with a low final pitch boundary target, while pitch accents are typically associated with raised pitch. In order to avoid the articulatorily and perceptually dispreferred crowding of a transition from high to low pitch onto a single syllable, the high pitch accent may be shifted leftward to a pre-final syllable. Because the intonational tones driving a leftward accent shift are present only phrase-finally, lexical stresses in phrase-medial words are not subject to non-finality effects. This account makes predictions about the relationship between the position of stress and the position of pitch accent. Predicted not to occur are systems within which pitch accent asymmetrically falls on the final syllable but word-level stress falls on a non-final system. The hypothesis that penultimate stress ultimately has its roots in penultimate pitch accent is consistent with other phenomena, e.g. final devoicing, that are also likely to have originated as phonetically motivated patterns at the phrasal level that have been generalized to apply within a smaller domain. The predictions of the intonationally-driven approach to a prominence typology (based on the various logically possible relationships between word-level stress and phrasal prominence) are discussed.

Chapter 3: Larry M. Hyman - Do All Languages Have Word Accent?

In his chapter, Hyman discusses the question of whether all languages have accent, whether accent is taken to be word stress or, possibly, other phenomena which privilege a single syllable per word. He asserts that it is difficult to address this question without first establishing some consensus concerning what is meant by stress. He adopts a "property-driven" typology, which, rather than pigeon-holing languages and giving them names, focuses on properties. While English represents one end of a continuum where stress is manifested by a wide variety of properties, therefore perhaps being the central issue of its word-level phonology and morphology, there are other languages at the opposite end which "care" much less about stress, e.g. Hungarian and Turkish. In this respect, stress is just like nasality: some languages care a great deal about the feature [nasal], allowing it to contrast not only on consonants but also vowels or making it into a prosody while nasality is more restricted in most languages (e.g. as a segmental feature on consonants only), or even absent entirely as in several Lakes Plain languages of New Guinea. Asking whether it matters if stress is "universal" or if it is only very common, Hyman concludes that even if stress is not universal, the reason(s) why it is required in many, if not most, languages still requires an explanation and the deserved attention it has—and will continue—to receive. To characterize why languages have accent, Hyman draws from Prague School functionalism and proposes a "canonical approach". With respect to the question whether other phenomena that display some of the canonical properties of stress should be regarded as accentual Hyman remains skeptical. While there is some typological value in grouping together all such phenomena, the question for him is not one of determining what should vs. should not be called "accent", but rather what properties can be obligatory vs. culminative in marking words and other domains. Rather than taking a strong (and often arbitrary) universalist stand, he suggests that it will be more revealing to map out the diversity—as StressTyp and others have been doing.

Chapter 4: Brett Hyde - Symmetries and Asymmetries in Secondary Stress Patterns

Hyde's point of departure is the long-standing observation about the typology of binary stress systems that trochaic patterns are attested in a greater variety than iambic patterns. The typological imbalance is typically described in terms of directional foot construction: trochaic feet can occur in a greater number of directional parsing configurations than iambic feet, but Hyde argues that the imbalance results from the influence of two asymmetrical constraints, STRESS INITIAL and NONFINALITY, which determine the status of peripheral syllables stress-wise.

(23)

a.	STRESS INITIAL:	The initial syllable of a prosodic word is stressed.
b.	NONFINALITY:	The final syllable of a prosodic word is stressless.

To see why STRESS INITIAL and NONFINALITY are the key to iambic-trochaic asymmetries, it is helpful to focus directly on the distribution of stressed and unstressed syllables, temporarily setting aside feet and their directional parsing patterns. Hyde shows that while patterns that avoid clashes and lapses (patterns based on perfect alternation), whether trochaic or iambic, display symmetry, patterns with clash or lapse are not symmetrically attested. If a trochaic version is attested, its iambic mirror image is not, and vice versa. Hyde

points out that since patterns that contain a clash or lapse are not attested in mirror image pairs, the theory must be able to introduce clashes and lapses only in appropriate circumstances. This is where the asymmetrical formulations of STRESS INITIAL and NONFINALITY play a key role. When a clash or lapse arises near the left edge in an attested pattern, for example, it is always to accommodate an initial stress. It never arises near the right edge to accommodate a final stress. STRESS INITIAL's asymmetric formulation helps to predict just this situation since it requires stress on initial syllables but not on final syllables. Similarly, when a clash or lapse arises near the right edge, it is always to accommodate final stresslessness. It never arises near the left edge to accommodate initial stresslessness. NONFINALITY helps to predict this situation since it can require final syllables to be stressless but not initial syllables. Hyde continues to discuss some problematic cases. He shows that close examination of the descriptive sources suggests that there is good reason to doubt that the crucial cases actually have the alleged problematic patterns.

Chapter 5: Rob Goedemans and Harry van der Hulst - The separation of accent and rhythm: Evidence from StressTyp

This chapter offers a demonstration of various applications and uses of the StressTyp database. The first part of this chapter presents overviews of the major types of stress systems as these are represented in StressTyp, both in tabular form and plotted in maps. In the second part of this chapter Goedemans and van der Hulst focus on the use of StressTyp in providing support for a particular theoretical claim, namely the separation of (primary) stress and rhythm. Many languages display stress patterns that involve a distinction between one primary stress and one or more non-primary stresses (or rhythmic beats). Approaches to the formal analysis of stress patterns differ in various ways, one being whether primary stress and non-primary stress are derived in terms of a single algorithm or two separate algorithms. This chapter supports a theory of word stress that separates the representation of primary stress (called the accent) and syllables that are rhythmically strong, the idea being that the rhythmic beats are accounted for independently, although 'with reference' to the accent location. The authors provide support from StressTyp for several arguments that underlie 'the separation theory'. Goedemans and van der Hulst conclude that there is good empirical support for the decision to separate the treatment of primary stress (accent) and rhythm, despite the fact that in specific stress systems, the two can also share resemblances. In the concluding section they mention several examples of such correspondences which they attribute to the fact that primary stress locations may be historically grounded in rhythmic principles or tendencies (as well as in functional factors that relate to edge demarcation), but they maintain that, synchronically, accent location is rhythm-based.

Chapter 6: José I. Hualde & Marianna Nadeu - Rhetorical stress in Spanish

A somewhat troublesome fact for our understanding of stress systems is that, whereas a relatively large number of languages have been described as displaying post-lexical patterns of rhythmic secondary stress, acoustic investigation, in the few languages where it has been conducted, has often failed to find evidence for this phenomenon. This group of languages includes Spanish. In spite of the negative results of previous experimental work on Spanish secondary stress, the authors claim it would be a mistake to conclude that there is nothing to

it beyond opinion. They observe that in certain speech styles it is common to hear stress prominence on syllables without lexical stress. This is typical of public speech, when the speaker is addressing a group of listeners for some extended period of time. They refer to this phenomenon as *rhetorical stress*. The authors then report on an experiment where rhetorical stress was elicited by providing a model. They hypothesize that there are two main patterns of rhetorical stress: initial stress (*sòlidaridád* 'solidarity')—what van der Hulst (this volume) calls edge prominence—and alternating stress two syllables before the lexically stressed one (*solidàridád*). Optionally, but less frequently, alternating stress can be reiterated (*sòlidàridád*). An additional hypothesis was that these two patterns of rhetorical stress differ in their acoustic properties, initial stress being more emphatic. The two stimuli the participants heard contained exactly two pretonic syllables, so that initial and alternating stress resulted in the same pattern ò-o-ó-o. Subjects were asked to generalize to words with different numbers of pretonic syllables. An important result is that all subjects produced a stress clash configuration in words with a single pretonic ò-ó-o, against previous description of Spanish secondary stress. In words with three pretonics, the subjects preferred the alternating pattern o-ò-o-ó-o regardless of the phonetics of the stimulus. This means that the hypothesis regarding the different phonetic properties of initial and alternating stress was not confirmed: a greater degree of emphasis at the beginning of the word in a phonologically ambiguous stimulus did not trigger initial stress in unambiguous cases. The authors also show that primary (lexical) and secondary (postlexical) stress differ in their phonetic cues. In words with rhetorical stress the syllable with lexical stress has durational prominence, whereas the syllable with postlexical stress anchors a pitch accent.

Chapter 7: Harry van der Hulst - Representing rhythm

Like Hyde's chapter, this chapter provides an account of word rhythm. Here it is assumed, however, that there is an accentual module which pre-selects an accented syllable which functions as the reference point for rhythm. Van der Hulst provides a brief overview of the accentual module, after which this chapter focuses on the rhythmic module which is fleshed out in terms of a grid-only approach. A distinction is made between regular rhythm and irregular rhythm, the latter mostly involving so-called bidirectional systems. The proposal is made that bidirectionality is a consequence of a 'polar accent rule' which places a beat on the edge opposite to the accent that underlies the primary stress, creating a 'hammock pattern'. Subsequent rhythm operates in the valley between these two prominent peaks and can echo either one or the other. Van der Hulst also discusses a subclass of the irregular systems, so-called clash systems, proposing that these systems too can be seen as having two opposite prominence peak with rhythm bouncing into the lesser, polar peak. He proposes a specific set of rhythm parameters which account for all and only the attested patterns.

Chapter 8: Jeffrey Heinz - Culminativity times harmony equals unbounded stress

In this chapter, Heinz provides a formal-language theoretic analysis of simple unbounded stress patterns. The main result reveals that simple unbounded stress patterns over syllables are of the same formal character as simple harmony systems over consonants and vowels,

once the notion that there is exactly one primary stress in every stress domain is factored out. In other words, this analysis shows that long-distance phenomena in two seemingly different phonological domains are actually of the same kind modulo the culminative and obligatory nature of primary stress. The argument proceeds by analyzing simple unbounded stress patterns in terms of the sets of strings of syllables they generate. Any particular generative analysis of simple unbounded stress patterns yields this same infinite set of strings. Next, the computational concept of "regular" sets is introduced, which are those which can be defined by a finite-state acceptor. The chapter concludes with several broader implications. One is that this approach and its results simplify the problem of understanding how simple unbounded stress patterns could be learned. Another important implication is that this chapter demonstrates how insights can be obtained from computational analysis that would otherwise be difficult to obtain. To this end, this chapter shows that unbounded stress patterns can be factored into two parts, each recognizable to phonologists. One part is the culminative and obligatory nature of stress patterns, and the other part, like simple segmental harmony systems, can be described exactly in terms of ‘forbidden subsequences of length two’. This unification of long-distance phenomena in different phonological domains was made possible by a computational analysis which emphasizes *what* is being computed as opposed to *how* it is computed. In other words, the analysis is independent of any particular generative theory. It will be interesting to see how far this result can be pushed when more complicated unbounded stress patterns and segmental harmony patterns are considered.

Chapter 9: Carlos Gussenhoven - Possible and impossible exceptions in Dutch word stress

Gussenhoven examines exceptions to the regular stress pattern in Dutch, showing that the types of lexical exceptions are limited. It is demonstrated that ungrammatical exceptional stress can be ruled out by an OT grammar assuming free lexical foot marking and a constraint hierarchy that allows possible exceptions to go through, but disallows unattested exceptions. Crucial to the analysis is the assumption that Dutch tense vowels are short (V) when occurring in open unstressed syllables and long (VV) otherwise, and that lax vowels are either short and followed by a coda C (VC) or long (VV). After showing how the regular distribution of stress is accounted for, Gussenhoven reviews nine types of exceptions and argues that one of the attractive properties of Optimality Theory is that it distinguishes between possible and impossible exceptions. Given an appropriately rich input, the interleaving of faithfulness constraints with markedness constraints must yield an impossible structure whenever the markedness constraint outranks the faithfulness constraint, while the reverse ranking will preserve the rich structure. Unrestricted lexical inclusion of foot structure and the suitable ranking of markedness constraints therefore ought to explain the difference between attested and impossible exceptions in Dutch.

Chapter 10: Keren Rice - Accent systems in contact: examples from North America

While there are a number of phonological features that have been argued to characterize the linguistic areas of North America (e.g., size of inventories, presence of particular types of features such as ejectivity and tone, types of contrasts such as velar/uvular, types of

morphophonemics), stress is rarely discussed in the literature as an areal trait although it is also argued to be a feature that is easily shared in contact situations. It is thus worth examining whether there might be borrowing of accent patterns under contact. Rice examines this issue from three major perspectives. She begins with an investigation of loanwords from a European language into an indigenous language of North America to see if there is evidence that accent might be borrowed in loanwords. She concludes that accent patterns are borrowable. Rice then examines whether accent systems themselves might be borrowed independent of loanwords, providing some evidence for this. Finally she examines some of the linguistic areas in North America to see if there is evidence for contact effects. There are striking tendencies in terms of accent systems in some of the linguistic areas. For instance, in Northern California, many of the languages have quantity sensitive stress systems, with a realization as pitch, and in the South Coast Range, accent is generally oriented to the right edge of the word. In the Pueblo area, accent is generally oriented towards the left edge with a tonal manifestation. Rice questions whether it can be concluded that contact is the cause of these similarities. She further addresses possible predictions about what might be shared and also examines some of the empirical issues that arise (e.g., the need for basic information to include phonetic correlates, the difference between word- and phrase-level patterns, the types of social differences between different languages).

11 Conclusions and perspectives for future research

In this chapter it has been my goal to set the stage for the 10 chapters that follow. We have reviewed a host of issues that deserve our attention in studying word stress systems. In various places, I have indicated that additional work is needed and it is our hope that the StressTyp2 project will help researchers in addressing various angles on word stress. Here I summarize some of these which stand out:

(24)
a. The nature of exceptionality and thus the role of the lexicon
b. The interaction between morphology and stress
c. The nature of unbounded systems
d. The separation of word-level and phrase-level prominence properties and their interaction
e. The correlation between weight types in relation to other aspects of stress such as rhythm, and (un)boundedness
f. The relative independence of primary stress and rhythm
g. The role of accent as driving surface prominence phenomena
h. The formal nature of stress rules or patterns
i. The areal distribution of stress type and consequences of language contact
j. The diversity of approaches outside generative quarters
h. What standards to apply before accepting descriptions as evidence

Undoubtedly other issues or concerns can be added (such as the function of word stress in sentence parsing and lexical access; historical change), but here I have limited myself to topics that are dealt with in the chapters in this volume. The study of word stress remains of

great interest, presenting researchers with broad typological diversity and intriguing complexity and as such it will continue to command our interest and attention for a long time to come.

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