

## **Quality of data in metrical stress theory**

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### **1. Why stress?**

Stress is an extremely popular topic in phonological theory. A great deal has been written about it—probably much more than any specific topic in subsegmental phonology. Perhaps its popularity is due to its apparent tractability: the major stress patterns have been identified, so a comprehensive theory of stress seems to be basically a matter of getting the right constraints/rules in the right ranking/order. It also seems easy to identify stress: every one of hundreds of my undergraduate students over the last ten years could tell me which syllable in “banana” is stressed.

However, there’s a problem lurking behind current theories: there is very little high quality stress data. Descriptions are typically too brief and unsystematic; they mostly provide impressionistic descriptions with no objective evidence. Unfortunately, metrical stress theory has developed to such an intricate state that deciding between theories depends largely on data that is questionable at best.

I’m not alone in having concerns about the empirical base for metrical stress theory. I recently interviewed René Kager for the *Cambridge Handbook of Phonology*’s website; he had similar worries, which you can hear here:

<http://handbookofphonology.rutgers.edu/chapters.php?chapter=9> (see the right column, 4<sup>th</sup> question). The latest on metrical stress theory can be seen in Kager’s and my own chapters for the *Cambridge Handbook of Phonology* (Kager 2007; de Lacy 2007). Similar concerns were expressed over ten years ago by Bruce Hayes (Hayes 1995§2.3), and can perhaps be traced back to Chomsky & Halle (1968:22-26).

So, what’s wrong with the data?

### **2. ‘Stress’**

In many cases, I’ve found it difficult to pin down exactly what people mean when they use the term ‘stress’. In some cases, it means ‘prosodic head’, with ‘primary stress’ referring to the head syllable of the head foot of the Prosodic Word, and ‘secondary stress’ meaning the other foot heads. Other times, ‘(primary/secondary) stress’ is used to refer to some phonetic/perceptual property of a syllable that is the realization of a foot head.

Of course, it’s possible for a prosodic head to not have any particular distinct phonetic realization (as claimed for Cairene Classical Arabic – Mitchell 1960, Hayes 1995:67 cf. Welden 1980). It’s also possible that a syllable might bear phonetic properties associated with a prosodic head but isn’t a prosodic head. For example, prosodic heads in some languages are realized with relatively longer duration (e.g. Finnish – Suomi & Ylitalo 2004); word-final non-head syllables

can also be realized with the same duration, but for an entirely different reason (e.g., domain-final lengthening). Without careful separation of the phonological and phonetic aspects, it's easy to falsely assume that absence of particular phonetic properties means absence of heads, and presence of phonetic properties means presence of heads.

The ambiguity of the term 'stress' is inherent in a lot of language descriptions. When there is a section on stress, it's often unclear whether the description is purporting to describe the position of prosodic heads, or is reporting where some phonetic property shows up systematically for whatever reason. So, in the rest of this article I will avoid the term 'stress' as much as possible; I'll use 'head' and '(phonetic) head realization' instead.

### 3. 'Araucanian'

I have been working on the influence on tone and sonority on prosodic heads for about ten years. Over that time I've looked through hundreds of books and articles on 'stress' (that's usually what the section is entitled). I've noticed that within a grammar of a language it's common to find a description of stress as short as two paragraphs; two pages is a long description. Are a couple of paragraphs enough to provide adequate evidence?

About a year ago, I started looking at the evidence given for 'famous' metrical stress languages – the paradigm cases that are cited in support of major theoretical devices. With Michael O'Keefe and Paula Houghton (also from Rutgers University), we started by looking at Araucanian – a language that is always cited in discussions of metrical stress theory as the paradigm case of a left-to-right iambic system without exhaustive parsing: e.g. [(ki<sup>1</sup>mu)(fa,lu)(wu,laj)] 'he pretended not to know', [(ti<sup>1</sup>pan)to] 'year'.

The language cited as Araucanian is now called Mapudungan. The most often cited source is Echeverría and Contreras (1965), a three page long *IJAL* article with two columns per page. About half a column is devoted to the description of 'stress', and about three quarters of a column is devoted to intonation (which mentions stress). The first part of the stress section is entitled "General Rule": it is seven lines long, and states that there is "main stress on the second syllable and, if applicable, secondary stresses on the fourth and sixth syllables." Five examples are given.

There is certainly a lot to be wary of here. The description lacks any objective evidence: we aren't told anything about the phonetic realization of prosodic heads, whether as increased duration, a pitch boost (e.g., Bishop 2002), or something else.

Of course, phonetic evidence is only part of the picture. Many phonological processes are sensitive to heads, including allophony and morpho-phonological processes. Luckily, section 2.0 mentions that "in final unstressed position, the nuclei /u/ and /o/ alternative: /fɪlu/ ~ /fɪlo/ *snake*." This /o/~u/ alternation might be a useful diagnostic but it's only good for detecting final foot heads. Also, there's no in-depth discussion of the process: is it truly phonological, or could it be a perceptual effect related to domain-final lengthening?

To summarize so far, we have a one paragraph impressionistic description of Mapudungan ‘stress’. However, we don’t know what ‘stress’ is – what exactly were Echeverría and Contreras describing? What were they hearing?

To make one thing very clear, I’m not criticizing Echeverría and Contreras. Their aim was to give a short sketch of the language, not to identify prosodic heads. What I am criticizing is the *use* of their work. There simply isn’t enough here to justify the claim that Mapudungan is a left-to-right iambic non-exhaustive parsing language.

Continuing to read down the page a little it turns out that the Mapudungan stress system is not as straightforward as one might be led to believe: “Two-syllable words ending in a vowel may be stressed on either syllable”. There are also two other sources on Mapudungan. Zúñiga (2006:64) reports that primary stress can fall on either the final or penultimate syllable and secondary stress can fall on either the first or second syllable in a word. Smeets (1989:60-61) reports that stress falls on a final closed syllable, otherwise a final penultimate syllable ([ˈɟuka] ‘house’, [afˈmatu,lan] ‘I did not admire’), but a number of words have lexical stress.

By this stage, any remaining certainty that Mapudungan was a straightforward left-to-right iambic system had disintegrated for me.

To try to figure out what’s going on in Mapudungan, Michael O’Keefe looked at possible phonetic realizations of heads. His work is still in its early stages, but he has found that in CVCV words the second vowel is consistently significantly longer than the first. He has also found that there is no consistent significant pitch difference between the vowels, and no intensity difference. So, at least CVCV words seem to be potentially iambic. However, his study of longer words hasn’t provided any consistent iambic pattern. Once completed, his work will tell us what Mapudungan’s prosodic system is and how it is phonetically realized. However, *only* then will we have objective, replicable evidence about Mapudungan’s prosodic system. In contrast, the extant descriptions don’t provide us with an adequate level of evidence to make any such determination.

Araucanian/Mapudungan isn’t an exception. Over the past ten years I’ve had occasion to read hundreds of stress descriptions, and I would class it as fairly typical. The descriptions where any phonetic analysis is presented are few. It’s rare to see any mention in the phonological and descriptive literature of properties such as duration, pitch boost, spectral tilt, intensity, or any perceptual measure (with important exceptions noted in section 4 below).

A challenge in figuring out where prosodic heads are is that the phonetic realization of prosodic heads differs from language to language in both type and degree. For example, work on Osage stress has shown that prosodic heads have increased duration relative to non-heads, and there is a small pitch increase too (Altshuler 2006). In contrast, O’Keefe reports significant duration increases for Mapudungan prosodic heads, but no significant pitch change. In other languages, duration might not even be a good measure (Bishop 2002). Some languages’ prosodic heads may have no distinctive phonetic realization (e.g., Cairene Classical Arabic non-main foot heads—though I’m not aware of any detailed phonetic analysis of this language).

Another challenge the descriptive linguist faces is their own perceptual system. When an impressionistic report of a ‘stress’ system is provided, the analyst is reporting data filtered through a perceptual system tuned to detect the properties associated with their language’s prosodic heads; the language they’re describing might have a different realization. So, the resulting description is not a description of the phonetic realization of prosodic heads in that language, but rather a description of the describer’s perceptual system.

Yet another challenge in description is it is far from obvious that speakers have conscious knowledge of their prosodic heads. I’ve heard consultants asked “Where is stress in the following word?”, but it’s difficult to know exactly what the consultant is listening for and reporting. I find it hard to believe that they’re listening for an abstract phonological property like prosodic heads. In some cases, it’s well known that people report the wrong phonetic property. For example, many English speakers report ‘primary stress’ to be the pitch peak caused by an H\* intonation tone. I asked a group of 28 undergraduates after several weeks of taking a phonetics course about English ‘stress’. I gave them several words and told them where the ‘stress’ was, explaining that it was the “most prominent syllable” (a phrase laden with inaccessible abstract concepts). There was widespread disagreement over where “secondary stress” falls. For “primary stress”, everyone strongly agreed that the [gwi] in *psycholinguistics* had “primary stress” when said on its own and in the sentence “I like psycholinguistics”. But the class was split evenly over whether primary stress falls on the first or fourth syllables in the sentence “The psycholinguistics class was fun”. This classic result (Ladefoged 1975:105-106) is that people are listening for the position of the H\* intonation tone, not for PrWd heads.

Even so, in a great deal of work I get the sense that if a native speaker claims that there is ‘stress’ (whatever that might be) in particular places then there is *something* phonologically relevant there. I find this view difficult to believe, especially in light of the fact that there was broad and violent disagreement over where secondary stress falls in the dialectally homogenous group of students in my phonetics class. As with the intonational tunes, when people do uniformly agree about a particular perceived property, it’s not clear that they’re agreeing on the thing that the analyst wants them to identify (as with the English H\* and the position of prosodic heads). For opposing views, compare Chomsky & Halle (1968) with Lehiste (1970), Vanderslice and Ladefoged (1972), and Gussenhoven (2004).

So, when reading an impressionistic report from an English speaker about stress in another language, could they be reporting the location of a high tone? A number of languages have been reported as having alternating metrical stress, but on close examination they seem to involve alternating high and low tones (HLHL...). Perhaps these tones are linked to prosodic heads in some way; or perhaps they are just alternating tones misinterpreted by analysts predisposed to listen for the wrong cues.

It’s clear that impressionistic descriptions raise a host of problems. It’s clearly necessary to provide an in-depth phonetic and phonological analysis of the language. Properties of the speech signal needs to be examined –duration, pitch excursions, spectral tilt, intensity (though intensity seems to be almost always irrelevant to prosodic head realization), and perhaps other perceptual factors (Gordon 1999 et seq.).

As mentioned above, another way to figure out the position of prosodic heads is to look at phonological evidence. Many phonological processes are sensitive to head position – many cases of allophony happen only within/outside heads; heads often house greater contrast than non-heads; and morpho-phonological processes are often sensitive to headedness. It has always been seen as good practice to include such information – Hayes (1995:2.3) makes this point in great detail. However, there are many languages and cases for which there is no such information, and even for languages with phonological processes the evidence for the phonological processes is often as shaky and impressionistic as that given for the position of prosodic heads. It's also surprisingly difficult to find evidence for phonological processes that refer to head position in grammars. Occasionally some can be dug up in the morphology section, where some affix may react in a particularly telling way in particular positions. However, in my experience finding such evidence often requires careful scouring of the grammar, and is often fruitless. Hayes (1995:9) comments that “[b]y carefully examining and comparing various phonological diagnostics for stress, it is possible to study the stress system, at least in English, with little recourse to intuition.” This is most certainly true, for English, and for a few other languages, but there doesn't yet exist a strong base of evidence for phonological processes in many languages.

So, the problem we face in understanding prosodic heads is that there are few relevant and detailed phonetic and phonological analyses. Most ‘stress’ descriptions are short and impressionistic; there is therefore little reason to trust them.

#### **4. Onset sensitive stress**

While I am becoming more and more skeptical of the worth of many of the descriptions commonly rely on in metrical stress theory, there are some outstanding phonetic and phonological descriptions that pave the way for future work on prosodic heads. Gordon's (1999 et seq.) work on stress has careful phonetic analyses of stress patterns, attempting to identify perceptual correlates with stress. There is also a robust literature on the phonetic realization of prosodic heads and stress perception in several languages: e.g., English (most recently Plag & Kunter 2007), Dutch (Rietveld et al. 2004), French, Finnish (Vainio & Järviö 2006), German, and several other languages, including Altshuler's (2006) work on Osage. However, the majority of paradigm cases cited as support for the typologies of metrical stress theory have not been subject to the same rigorous investigation.

Gordon's work stands out as dealing with a broad range of languages that have been central to metrical stress theories. For example, his 2005 article on onset-sensitive stress provides a perceptual analysis of three languages. One of the languages – Arrernte – is the paradigm example of an onset-sensitive stress language, but as far as I know no-one until Gordon provided any phonetic or phonological evidence that stress fell where it was reported to fall.

Even so, it's interesting to see where Gordon's article stumbles: several other languages with onset-sensitive stress are cited but not subjected to a rigorous phonetic or phonological analysis. A close look at the evidence provided for them shows them to be like the Araucanian/Mapudungan description. Topintzi (2006) observes that the evidence cited for the

majority of these cases is extremely weak. For example, the Melanesian creole Bislamá is cited as having onset sensitive stress, but Camden (1977:xiv-xv) presents the description in just two pages with no examples. The putative onset-sensitivity is very limited: in three syllable words, the final syllable will be stressed if it has a complex onset (unless the preceding syllable is closed). Unfortunately, of the other sources Lynch (1975) states that there's commonly penultimate stress with just a few stress-attracting morphemes; Crowley (2005) claims that the stress pattern is effectively lexical: words with Melanesian origin have penultimate stress, French-origin words have final stress, and English-origin words have English stress. Topintzi observes similar problems with many of the other languages cited (Nankina, Juma, Iowa-Oto). The strongest case seems to be found in Manam, but the influence of onsets on prosodic heads is limited to a particular environment; the original source does not provide detailed phonetic or phonological evidence for stress, either. Again, the source of the problem is impressionistic descriptions.

## 5. Where to from here?

We currently have intricate theories of metrical stress in a variety of frameworks. They all make strong predictions about the kind of systems that can and cannot exist. Personally, I have no idea whether any of the extant theories are right or wrong as the data they rely on is largely impressionistic. The majority of core examples cited in work on metrical stress theory simply do not have a solid core of evidence behind them. Araucanian/Mapudungan and Bislamá were given as examples of inadequate data, but I have found similar issues of trustworthiness with almost all of the now more than forty languages I have looked at. It's even possible that a right theory has been rejected based on bad data, and a wrong theory has been accepted based on bad data.

On the positive side, advances have been made in understanding the phonology of prosodic heads and the phonetics of their realization. Tools for measuring phonetic properties are more readily accessible now than ever before, and understanding of head-referring phonological processes is more advanced. What remains is to go back to every relevant language and carefully analyze it. I realize that this is a depressingly huge task; it guarantees that metrical stress theory will move forward at a much slower pace than over the last two decades. However, it is clearly the only way for metrical stress theory to move forward.

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