Review

Recall that the SPE theory placed (almost) all stresses by repeatedly placing primary stresses. This was nice in that it made something follow from something else: where secondary/tertiary stresses go follows in some way from where primary stresses can go. It was also nice in that it preserved relative prominence of syllables, which was crucial for phrasal stress (and compound stress, which we didn’t discuss).

It also predicted fairly nicely where vowel reduction would happen: on [−stress, −tense] vowels.

All of this was done using a set of contextual rules just like the ones we are used to in segmental phonology. We noticed that there was one wrinkle, which was that sometimes secondary stress did have to be placed explicitly, by the Auxiliary Reduction Rule (actually, for CH, the ARR part II).

We also noticed some redundancies in these rules:

- The Alternating Stress Rule does essentially the same thing as the Auxiliary Reduction Rule, namely, set a primary stress two syllables before another primary stress

- The Main Stress Rule is similar to the ASR in that it sets a primary stress two syllables before the last syllable

- The Stressed Syllable Rule (a rule not mentioned here) does almost the same thing as the ASR, placing a primary stress two syllables before another primary stress (actually, it can also place a primary stress immediately before another primary stress if the preceding syllable is heavy; we have not seen this, but it is necessary for words like ellipsoid and for deriving tórment from tormént)

- The “noun” clause of the MSR is mirrored in a “suffix” clause of the MSR (not mentioned here)

We also noticed one potential empirical problems that could not be fixed in principle without redesigning the system: just like for segmental phonology, each stress rule can only apply once (per cycle). The only two ways of getting multiple stress placements (and thus of getting secondary, tertiary, etc) were:

1. Have multiple stress placement rules (most notably, the MSR, the ASR, and the ARR)

2. Have multiple cycles (tied to the morphosyntactic structure of the word/utterance)

We worried that, since word length seems to be unbounded, while the number of rules applying within a single cycle is necessarily finite, we might not always be able to independently explain the existence of enough/the right morphological structure in certain words to explain the stress judgments of native English speakers. The best cases of this are foreign place names, where it seems hard to imagine why English speakers would automatically assign any morphological structure beyond a single morpheme, and yet it seems quite clear that, once we have read out the word carefully enough, we all have intuitions about where the stress should go: try Thiruvananthapuram.
This doesn’t seem right: it seems like there’s a stress on the initial syllable. But given the lack of final stress, the ASR doesn’t apply, so we just can’t get more than two stresses, no matter what we do.

However, while having multiple applications of the same rule as the only device for getting arbitrarily many stresses was problematic, having the mechanism in the first place was not without its merits: consider again the contrast between orchestration and infestation. In terms of their segmental structure, they could hardly be more similar. Yet their stress patterns contrast, with the second vowel in orchestration being reduced, while the second vowel in infestation stays full. There was a really nice explanation for this: the two verbs that these words are derived from are different. The stress that MSR assigns to infest is different from the stress that it assigns to orchestrate. And this stress is carried forward into the second cycle.

Turning back to empirical problems, actually, although we didn’t see it, there was a empirical problem with the VR rule we used:

(1) (Vowel Reduction)

\[
\begin{bmatrix}
\text{stress} \\
\text{tense} \\
\text{V}
\end{bmatrix} \rightarrow [\circ]
\]

It didn’t do enough of what it should:

Whoops. So, we need another rule, applying before VR:
(2) (Another Auxiliary Reduction Rule)

\[
\begin{array}{c}
\alpha \text{ stress} + \text{tense} \rightarrow [- \text{stress} - \text{tense}] / V C_0 - C_0^1 \beta \text{ stress} \\
\end{array}
\]

where \( \alpha \) weaker than \( \beta \).

This helps us out:

\[
\begin{array}{c|c|c}
\text{First cycle} & \text{MSR} & [\{\text{eksplen}\}_V + \text{etjon}\}_N] \\
\hline
\text{ASR} & \text{MSR} & [\{\text{eksplen}\}_V + \text{etjon}\}_N] \\
\text{PTW} & - & - \\
\text{ARR} & - & - \\
\text{AARR} & - & - \\
\text{VR} & - & - \\
\text{BE} & [\text{eksplen} + \text{etjon}\}_N] & - \\
\text{Second cycle} & \text{MSR} & \{\text{eksplen}\}^2_1 + \text{etjon}\}_N \\
\hline
\text{ASR} & \text{MSR} & \{\text{eksplen}\}^2_1 + \text{etjon}\}_N \\
\text{PTW} & [\text{eksplen} + \text{etjon}\}_N] & \{\text{eksplen}\}^3_1 + \text{etjon}\}_N \\
\text{ARR} & \{\text{eksplen} + \text{etjon}\}_N] & \{\text{eksplen} + \text{etjon}\}_N] \\
\text{AARR} & \{\text{eksplen} + \text{etjon}\}_N] & \{\text{eksplen} + \text{etjon}\}_N] \\
\text{VR} & \{\text{eksplen} + \text{etjon}\}_N] & \{\text{eksplen} + \text{etjon}\}_N] \\
\text{BE} & \{\text{eksplen} + \text{etjon}\}_N] & \{\text{eksplen} + \text{etjon}\}_N] \\
\end{array}
\]

**Metrical theory**

Here is a connection out of left field. Perhaps in highschool you were made to do *scansion* of verse. You learned to divide a line of poetry into *feet* of various sorts, which were defined by their length in syllables, and the *relative prominence* of the syllables within them (as opposed to a numerical representation of an absolute degree of stress). Different meters, then, were defined by what sequences of feet they contained. For example, a line in *iambic pentameter* consists of five *iamb* in a row:

(3)

\[
\text{when I have fears that I may cease to be} \\
\text{two house holds both a like in dig ni ty}
\]

On the other hand, a line in *trochaic tetrameter* consists of four *trochees* in a row:
The idea behind the metrical theory of word stress is to find a system for dividing up a word into feet, groups of syllables within which we have specified the relative prominence of syllables. The beginnings of metrical theory are to be found in Mark Liberman’s dissertation, which he adapted into a paper with Alan Prince in 1977. I’ve posted this paper under Additional Readings. This was an analysis of English stress that cleaned up many of the redundancies of the SPE analysis into a simpler system, but wound up with the same coverage—in fact, better coverage.

The theory basically works like this:

1. Apply rules similar to the SPE rules to assign +/− stress; they apply recursively even within a cycle
2. Divide the word into feet by constructing a metrical tree, according to a handful of simple principles; the tree will be labelled with $s, w$, for strong, weak
3. Read a metrical grid off the tree, which gives a partial order giving relative prominence of syllables
4. Apply destressing rules (a version of AARR)
5. Unstressed short vowels are by definition reduced

What I’m about to give you is an adapted version of the LP77 theory; it’s adapted to make it a bit easier to follow. There are two important differences between what I’m about to show you and the original. The first is that LP tell you how to build the metrical tree in terms of two things: principles of what trees should look like, and instructions for how to build trees. In fact, one of their crucial imperatives for building trees already differs slightly from what I’ve given you: steps 1 and 2 are interspersed, such that you build the biggest part of the metrical tree that you can as soon as the stress rules apply. I am going to mostly drop the building instructions, and just list the principles for what trees should look like, some of which are re-interpretations of their tree-building instructions. I will note where it makes a difference how we build the tree.

Second, remember that in SPE, nouns were treated as exceptional in terms of allowing the rules to ignore an extra syllable at the end. In LP77, it’s the verbs and adjectives that take final stress that are considered exceptional (along with some miscellaneous French-derived nouns with certain suffixes that force final stress, like affair, engineer, grenade, etc.). Well, I will largely ignore this, and then I’ll fill in a small part of the mechanism that corrects it at the end.

The adapted Liberman and Prince theory

(5) (English Stress Rule); (LP50,87)

\[ V \rightarrow [+ \text{ stress}] \quad \longrightarrow C_0(\begin{bmatrix} V \\ - \text{ tense} \\ - \text{ stress} \end{bmatrix} (C))(\begin{bmatrix} V \\ - \text{ tense} \end{bmatrix} C_0) \]
Now:

(6) (Stress Retraction Rule); (LP49,87)

\[
V \rightarrow [+ \text{ stress}] \quad \rightarrow C_0(\begin{array}{c}
V \\
\text{tense}
\end{array})C_a(VC_0)\begin{array}{c}
V \\
\text{+ stress}
\end{array}
\]

They actually combine the two, but I’m going to leave them separate for convenience. The importantly different thing between this theory and the SPE theory is that, unlike all the other rules in the phonological grammar, SRR is declared to be recursive: even within a cycle, the rule applies to its own output until it cannot apply any more. The \(a\)’s and \(b\)’s are just there so that individual lexical items (in particular, certain affixes) can announce that those parts don’t apply. Otherwise, those parts are just optional parts of the rule (but of course, as with optional parts of rules, they must apply if they can!).

Here are some examples:

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<thead>
<tr>
<th>#æspæræg#</th>
<th>#dʒavElIn#</th>
<th>#hɔrajzøn#</th>
<th>#sinapsis#</th>
<th>#mɔnangahila#</th>
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<tbody>
<tr>
<td>#æspæræg#</td>
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<td>#sinapsis#</td>
<td>#mɔnangahila#</td>
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<td>#mɔnangahila#</td>
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<td>(SRR)</td>
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Now we build the metrical structures. We are going to say how to do this in a declarative, constraint-satisfaction type way. This suggests that we should make use of nondeterminism to compute the answer. We will not be terribly interested in determinizing the procedure today, but I will construct the metrical trees piece by piece to make the nondeterminism manageable (it is interesting that we can afford to do this).

We need to satisfy the following principles:

(7) (Tree Principle); The final structure is a tree \(T\) (57c) such that the yield of the tree maps one-to-one to the stress markings on the Vs.

(8) (Binary Branching Principle) \(T\) is binary branching.

(9) (Contrast Principle) Each pair of sister nodes in \(T\) consists of exactly one node labelled \(s\) and one labelled \(w\).

(10) (Strength Principle); (LP18) If \(Y(i) = n\), and \(n\) is labelled \(s\), then \(S(i)\) is \([+ \text{ stress}]\).

(11) (Foot Principle); (LP22a) For each sequence \(s\) of \(\geq 2\) successive vowels in the segmental representation marked as \(+-+-, +---, +--+\), etc, there is some subtree \(t\) of \(T\) such that the subsequence of the yield of \(T\) corresponding to the yield of \(t\) maps element-wise to exactly the subsequence \(s\).

(12) (Lexical Category Prominence Rule); (LP33) For any pair of sister nodes \(n_1 n_2\), \(n_2\) is \(s\) iff it is not a leaf node (i.e., is a branching node).

(13) (Right-to-Left Principle) Add depth to the tree “right-to-left”.
Let's try our examples:

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Finally, there is a rule of destressing:

(14)  (Destressing Rule); (LP70)

\[
V \rightarrow \left[ \begin{array}{c} - \text{tense} \\ - \text{stress} \end{array} \right] \left/ \begin{array}{c} \#XVC_0 \\ \#C_0 \left[ \begin{array}{c} - \\ - \text{tense} \end{array} \right] \end{array} \right/ - C_0 V
\]

The destressing rule is subject to the following condition: the output may not violate the principle SP. So the upshot is that this can only apply to \( w \) syllables. And then we will of course reduce the weak unstressed vowels.

Let's try this now:

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There are some other facts we need to capture. A couple of revisions (we won’t go through examples):
(15) (English Stress Rule for verbs); (LP50,87)

\[ V \rightarrow [+\text{stress}] / \quad \rightarrow C_0(V(C)) \quad V \]

(16) (Lexical Category Prominence Rule); (LP33) For any pair of sister nodes \( n_1, n_2 \), \( n_2 \) is \( s \) if either (i) it is not a leaf node (i.e., is a branching node) or (ii) \( n_2 \) is marked as dominating the stem of a verb

Obviously this is supposed to fix up the stress for verbs; the details of how nodes get “marked as dominating the stem of a verb” are not really relevant here, because we are not going to go through any examples (actually, some of these details are also unclear from the paper). This is just to show that there is a fix.

It’s also worth noting that the +/- stress placement rules are still cyclic, and they almost give the right facts, provided we have (i) fixed up verbs to get the final stress on infest right; (ii) added a clause to force ++ sequences that have not been assigned any structure yet to be grouped together into a subtree.

\[
\begin{array}{|c|c|}
\hline
\#(\text{ork\-estret\-j\-on})\# & \#(\text{inf\-est\-etj\-on})\# \\
\hline
\#(\text{ork\-estret\-j\-on})\# (ESR) & \#(\text{inf\-est\-etj\-on})\# (ESR) \\
\#(\text{ork\-estret\-j\-on})\# (SRR) & \#(\text{inf\-est\-etj\-on})\# (SRR) \\
\#(\text{ork\-estret\-j\-on})\# (BE) & \#(\text{inf\-est\-etj\-on})\# (BE) \\
\#(\text{ork\-estret\-j\-on})\# (vacuous ESR) & \#(\text{inf\-est\-etj\-on})\# (ESR) \\
\#(\text{ork\-estret\-j\-on})\# (vacuous SRR) & \#(\text{inf\-est\-etj\-on})\# (vacuous SRR) \\
\hline
\ldots & \#(\text{inf\-est\-etj\-on})\# (vacuous SRR) \\
\hline
\end{array}
\]

I’ll leave the trees as an exercise (be aware of the detail I mentioned at the end of the last paragraph). The facts seem to be right—however, it’s also crucial to verify that the destressing rule does not hit the second syllable of infestation. As stated, however, it actually does (and their version, which has only a single C following the destressed syllable—plus a plea to grant them some liberties because they have not integrated syllable parsing into their theory—does not seem to help, because they also want the initial syllable of asparagus to be destressed). So close, and yet, so far (perhaps we should consider allowing the destressing of syllables that are heavy because of codas in initial position, but syllables that are heavy because of tenseness elsewhere?).

Some cross-linguistic generalizations

Bruce Hayes’ dissertation was a big empirical breakthrough. He looked through lots of grammars and attempted to advance the newfound understanding of stress as a special subsystem of phonology by looking for cross-linguistic generalizations about stress placement that could be fit into the new metrical theory. Hayes found that languages were eerily similar across quite large classes. We will dig into more of the cross-linguistic details next week. For now, let’s just look at Hayes’ basic classification.

- Maranungku-type languages: tíralk, mérepèt, yángarmàta, lāngkaràtetì, wélepènemànta
  - Main stress initial
  - Secondary stress on alternating syllables after MS

- Weri-type languages: ngintíp, kùlipú, ulùamít, àkunètepál
  - Main stress final
- Secondary stress on alternating syllables before MS

- Araucanian-type languages: wulé, tipánto, elúmuyù, elúaènew, kimúbalùwulày
  - Main stress on second syllable
  - Secondary stress on alternating syllables after MS

- Warao-type languages: yiùwàranáe, yàpurùkitànëháse, enàhoròahàkutáí
  - Main stress penultimate
  - Secondary stress on alternating syllables before MS