1 What is stress?

Stress refers to the relative prominence of portions of an utterance (Liberman and Prince, 1977). Phonetic properties correlated with stress (with cross-linguistic differences): amplitude, length, high/low pitch or pitch changes.

a. But: “The definition of stress is one of the perennially debated and unsolved problems of phonetics” (Hayes 1995: 5).

Here are some ways in which stress ‘expresses’ itself.

- High tone on stressed syllable in Creek; High tone before stressed syllables in Greek.
- Low tone on stressed syllable in Chamorro, Malayalam.
- Stressed syllables have the ability to carry more tone distinctions in Chinese dialects.
- In English, stressed syllables have the ability to carry more vowel distinctions, and vowels in stressed syllables are more resistant to coarticulation.

Irene’s stress group is investigating the phonetic manifestations of stress.

1.1 Detecting Stress

If there are no clear phonetic properties of stress, than how can we detect it? There is no invariant physical realization of stress, even within a single language. This is true of rhythm in general, and implies that we have to use phonological diagnostics.

For example, here are some diagnostics for stress in English (Hayes 1995: Ch.1)

Attraction of Nuclear Intonational Tunes: pitch accent (T*) falls on stressed syllable. (For more on intonational contours see (Ladd, 1996).)

<table>
<thead>
<tr>
<th></th>
<th>declarative tune</th>
<th>question tune</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M H* L</td>
<td>M L* H</td>
</tr>
</tbody>
</table>
For the two tunes above, on which syllable does the pitch accent fall in the words *assimilation, preliminary, pontoon*?

**Vowel reduction** \{æ, a, e, ə, i, u, ʌ\} reduce to schwa or \[i\] when stressless.

ex. Iceland vs. Icelandic

**Flapping** \(t, d \rightarrow r / [-\text{cons}] \quad [+\text{syl,-stress}]\)

ex. data vs. attain

/t/ **Insertion** \(\emptyset \rightarrow t / n \quad [+\text{syl,-stress}]\)

ex. Mensa vs. insane

/l/ **Devoicing** \(l \rightarrow [-\text{voice}] / s \quad [+\text{syl,-stress}]\)

ex. Iceland vs. Icelandic

**Medial Aspiration** \([-\text{cont}, -\text{voice}] \rightarrow [+\text{spread glottis}] / [-\text{stri}] \quad ([+\text{son}]) [+\text{syl, +stress}]\)

ex. append vs. campus, accost vs. chicken

The moral is when investigating stress in another language, maybe you can hear the stress but it is useful to find diagnostics such as these to verify the presence or absence of stress.

### 1.2 Primary and Secondary Stress

Two levels of stress are generally recognized: primary and secondary. Primary stress is *stronger* than secondary stress. Say the English place name “Appalachicola.” Can you identify the primary and secondary stresses?

The principle of Obligatoriness says that every (content) word must have at least one stressed syllable. The principle of Culminativity says that every content word has at most one primary stress. More generally the idea is that every domain has a single peak of prominence.

### 1.3 Property of stress or vowels?

Stress is generally considered to be a property of *syllables*, and not vowels. This is reflected in stress diacritics in the IPA, which are placed before the stressed syllables. However, it is common to use the acute and grave accents to represent primary and secondary stressed syllables, respectively.

\[
\begin{array}{c}
\sigma & \text{unstressed syllable} \\
\hat{\sigma} & \text{secondary-stressed syllable} \\
\hat{\sigma} & \text{primary-stressed syllable}
\end{array}
\]
2 Many Stress Patterns are Predictable

Often the location of stress in words is predictable. Here is an example from Pintupi (Hansen and Hansen, 1969).

- a. σσ pánα 'earth'
- b. σσσ tújaya 'many'
- c. σσσ máławána 'through from behind'
- d. σσσ púluŋkáláṭu 'we (sat) on the hill'
- e. σσσσ támulmpluŋku 'our relation'
- f. σσσσ tširiŋulmpluŋku 'the fire for our benefit flared up'
- g. σσσσ kutranmpluŋku 'the first one who is our relation'
- h. σσσσ yúmaŋŋukaratuŋku 'because of mother-in-law'

The generalizations that emerge can be stated as follows:

- Secondary stress falls on nonfinal odd syllables (counting from left)
- Primary stress falls on the initial syllable

Let's analyze this with rules and in OT.

3 Quantity-insensitive stress patterns

Stress patterns like Pintupi above are called quantity-insensitive because it doesn’t matter if syllables have codas or not, or whether they have long vowels or not. It is unnecessary to distinguish among potentially different types of syllables.

For some stress patterns, the generalization about where stress occurs can only be made if reference is made to syllable types. These types are usually talked about in terms of weight with syllables categorized into types such as light, heavy, or superheavy.

In Latin (C)V syllables are light, all other syllables are heavy. Thus syllables with codas or long vowels are of the same type: they are heavy. (Jacobs, 1989; Mester, 1992; Hayes, 1995).

- a. a.mí:kus L Ê H 'friend, kind'
- b. gu.ber.ná:bunt L H Ê H 'they will reign'
- c. i.ní.mí:ki:ti:a L L H L L 'hostility'
- d. do.més.ti:kus L Ê L H 'belonging to the house'
- e. mánda: Ê H 'entrust (2sg.imp)'
- f. ká:nis L H 'dog'
- g. hé:ri L L 'yesterday'

When syllables are categorized in this way, a generalization emerges: In words at least three syllables in length, stress the penult if it is heavy, otherwise stress the antepenult. In shorter words, stress the initial syllable.
4 The typology of stress patterns

4.1 Motivations

In the same way it is asked “What is a possible phonological generalization?”, we can ask “What is a possible stress pattern?” Linguists have examined the stress patterns of hundreds of languages. What is the range of the variation that exists across languages? What universal properties do they share? We can imagine lots of logically possible stress assignment generalizations. But which of these are attested? Which of these are phonological?

Linguists have developed theories which make predictions about which stress systems are possible and which are not.

4.2 Examples of simple stress systems (from Kager 1996)

**Hungarian.** Main stress is on the initial syllable; secondary stresses fall on all odd-numbered syllables.

- bóldog 'happy'
- bóldogtalan 'unhappy'
- bóldogsà:g 'happiness'
- bóldogtàlansà:g 'unhappiness'

**Weri.** Main stress is on the final syllable; secondary stresses fall on preceding odd-numbered syllables counting from the word end.

- ùlùamít ‘mist’
- àkonàtepál ‘times’

**Warao.** Main stress is on the penultimate syllable (penultimate = immediately before the last syllable); secondary stresses fall on all even-numbered syllables counting back from the main stress.

- yà.pù.rù.ki.tà.ne.há.se ‘verily to climb’
- e.nà.ho.rò.a.hà.ku.tá.i ‘one who caused him to eat’

**Araucanian.** Main stress is on the second syllable; secondary stresses fall on following even-numbered syllables.

- e.lá.a.à.new ‘he will give me’
- ki.mú.fa.lù.wù.lày ‘he pretended not to know’

Here is a summary of the four simple stress patterns shown above.
5 Representing Stress

We will look at two ways of representing stress: the grid and with feet.

5.1 The Grid

Linguistic stress is represented by a hierarchy of grid lines, with higher columns representing greater prominence (Liberman and Prince, 1977; Prince, 1983).

<table>
<thead>
<tr>
<th>Hungarian</th>
<th>Araucanian</th>
</tr>
</thead>
<tbody>
<tr>
<td>ó</td>
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<td>...</td>
<td>...</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Weri</th>
<th>Warao</th>
</tr>
</thead>
<tbody>
<tr>
<td>ó</td>
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<td>σσσσσ</td>
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<tr>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

5.2 Feet

Feet are groups of syllables. In many theories, feet are maximally bisyllabic. One of the syllables is designated Strong and the other Weak. Assuming the bisyllabic maximum for now, there are two basic foot types drawn from poetic meter.

Trochaic: if there are two syllables, the stressed syllable is on the left. (The stressed syllable is strong and the undetressed one is weak.)

(s w) or (x .)
Iambic: if there are two syllables, the stressed syllable is on the right:
\[(w\ s)\ (.\ x)\]
Hayes (1995) elaborates these basic foot types.
Here is a foot-based representation of *Appalachicola*. Here, the feet are trochees.
\[(a\ pa)\ (la\ chi)\ (co\ la)\]
Feet by themselves don’t distinguish which syllable is the primary stressed one. We would need to indicate that the primary stressed syllable is the rightmost stressed one.
Some theories combine feet with the grid (contemporary theory): grids grouped into feet and words (Idsardi, 1992; Hayes, 1995).
\[
\begin{array}{cccc}
 x \\
(x & x) \\
(x & x & x) \\
(x & x) \\
(a & pa\ & la\ & chi\ & co\ & la)
\end{array}
\]

6 Theories of Stress

Mainstream theories of stress come in to two types: Principles and Parameters theories and Optimality Theory.

6.1 Principles and Parameters (simplified!)

In the original Grid-based theories (Liberman and Prince, 1977; Prince, 1983), the strong tendency toward rhythmic alternation is accounted for by mapping to the perfect grid:
\[
\ldots\ x\ x\ x\ x\ x\ x\ x\ x\ x\ x\ x\ \ldots
\]
Mapping to the perfect grid has two binary parameters:

- Directionality parameter: Right-to-left, Left-to-right.
- Starting parameter: Begin with peak, Begin with trough.

**End Rules** strengthen rightmost/leftmost stresses by adding one grid mark above them (Prince 1983:27).

- ER(L,Wd): place a grid mark above the leftmost (initial) grid mark on the Ft level.
- ER(R,Wd): place a grid mark above the rightmost (final) grid mark on the Ft level.

So there is the **End Rule** parameter which can either be Left or Right.
Operation of the End Rules is (implicitly or explicitly) subject to a well-formedness condition called the **Continuous Column Constraint** (formulation after Hayes 1995):
A grid containing a column with a mark on line \( n + 1 \) and no mark on line \( n \) is ill-formed. Phonological rules are blocked when they would create such a configuration.

Basically, for every grid mark not on the bottom layer, there must be a grid mark in the same column on the layer below.

To summarize here is the basic P&P approach with the grid.

- **Principles (Universals)**
  - The Perfect Grid
  - The Continuous Column Constraint

- **Parameters (Ways languages can differ)**
  - Directionality
  - Start with Peak/Trough
  - End Rule Left/Right

★ Describe the four patterns above within the grid theory

<table>
<thead>
<tr>
<th>Directionality parameter</th>
<th>Starting parameter</th>
<th>End Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hungarian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weri</td>
<td></td>
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</tr>
<tr>
<td>Warao</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Araucanian</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Many unattested stress system cannot be described within the grid theory, and are therefore correctly predicted not to occur.

- ‘Stresses pile up on the left’
- ‘Stresses pile up on the right’
- ‘Main stress in the middle, with alternation outwards in both directions’
- ‘Cute, but unattested’

Contemporary P&P theories employ foot-based representations. So the parameters that are employed are like the following.
1. FootType=\{Trochaic, Iambic\}
2. HeadFoot=\{Left, Right\}
3. AlignFoot=\{Left, Right\}

### 6.2 Optimality Theory (simplified!)

In Optimality Theory, there are no parameters, only constraints. Most OT theories also employ foot-based representations (Gordon (2002) is a notable exception). So the constraints that are employed are like the following.

**Parse-Syllable:** Syllables should be in feet. Assign a violation for every unfooted syllable.

**BinaryFoot:** Feet should contain exactly two syllables. Assign a violation for every non-binary foot.

**Trochaic:** Feet should be trochaic. Assign a violation for every foot which does not have a strong syllable at the left interior edge of the foot.

**Iambic:** Feet should be iambic. Assign a violation for every foot which does not have a strong syllable at the right interior edge of the foot.

**Align(Ft,L):** Align feet to the left edge of a word. Assign a violation for every syllable between a foot and the left word edge.

**Align(Ft,R):** Align feet to the right edge of a word. Assign a violation for every syllable between a foot and the right word edge.

**Align(HeadFoot,L):** Align the head foot to the left edge of a word. Assign a violation for every syllable between a head foot and the left word edge.

**Align(HeadFoot,R):** Align the head foot to the right edge of a word. Assign a violation for every syllable between a head foot and the right word edge.

### 6.3 More quantity-insensitive stress patterns

There are more kinds of QI patterns than the ones listed above (Gordon, 2002).

1. Single systems
   (a) Stress only the initial syllable
   (b) Stress only the final syllable
   (c) Stress only the peninitial syllable
   (d) Stress only the penultimate syllable
(e) Stress only the antepenultimate syllable

2. Dual systems
   (a) Stress only the first and the last syllable
   (b) Stress only the first and penultimate syllable

3. Binary systems (The simple systems above were binary.)
   (a) Binary with clash. These are a combination of dual systems (stresses are required on syllables at opposite edges) and binary systems so stress *clashes* exist. Here is an example based on Central Alaskan Yupik.
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
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   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$

   (b) Binary with lapse. These are a combination of dual systems (stresses are required on syllables at opposite edges) and binary systems but clashes are not permitted so stress *lapses* exist instead. Here is an example based on Piro.
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
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   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$

4. Ternary. Stress falls on every third syllable. Here is an example based on Ioway-Oto.
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
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   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$
   $$\sigma\sigma\sigma\sigma\sigma\sigma$$

Gordon (2002) catalogues all of these patterns.
6.4 More quantity-sensitive stress patterns

There are more kinds of QS patterns that are catalogued in databases (Goedemans et al., 1996; Heinz, 2007; van der Hulst et al., 2010). The main classification among QS systems is **bounded** vs. **unbounded**. Bounded stress patterns are ones where the primary stress has to fall within some bounded distance of the word edge. In unbounded patterns, the primary stress may fall arbitrarily far from either word edge.

Consider the following data from Selkup (an Ostyak-Samoyed language of West Siberia). Long voweled syllables count as heavy, everything else is light. (Halle and Clements, 1983; Idsardi, 1992; Walker, 2000):

a. [pynakisó:] L L L H ‘giant!’

b. [ilisómit] L L H L ‘we lived’

c. [qókitil] H L L ‘deaf’

Consider the following data from Selkup (an Ostyak-Samoyed language of West Siberia). Long voweled syllables count as heavy, everything else is light. (Halle and Clements, 1983; Idsardi, 1992; Walker, 2000):

d. [qumoqqlilí:] H L H H ‘your two friends’

e. [ucómit] H L L ‘we work’

f. [ucikkoq] H L H L ‘they two are working’

g. [qummí] L L ‘human being’ (gen.)

h. [ámírra] L L L ‘eats’

i. [qóloqmpatí] L L L L ‘found’

★ There is a clear pattern here. What is it?

Systems like Selkup are called **unbounded** stress patterns. All four types are attested.

1. Rightmost Heavy otherwise Leftmost (Selkup)

2. Leftmost Heavy otherwise Leftmost (Murik)

3. Rightmost Heavy otherwise Rightmost (Golin)

4. Leftmost Heavy otherwise Rightmost (Komi)

7 Some Further Reading on Stress

There is lots to read on stress: Liberman and Prince (1977); Hyman (1977); Prince (1983); Halle and Vergnaud (1987); Prince (1992); Idsardi (1992); Bailey (1995); Hayes (1995); Walker (2000); Gordon (2002); Elenbaas and Kager (1999); Hyde (2002)
References


