
Introduction to Stress

Jeff Heinz

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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 syll. 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,

1.1 Detecting Stress

If there are no certain 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).)

declarative tune	M H* L
question tune	M L* H

- ★ For the two tunes above, on which syllable does the pitch accent fall in the words *assimilation*, *preliminary*, *pontoon*?

Vowel reduction {æ, a, ε, ə, ɪ, ʊ, ʌ} reduce to schwa or [ɪ] when stressless.

ex. Iceland vs. Icelandic

Flapping t,d → r / [-cons] _____ [+syl,-stress]

ex. data vs. attain

/t/ Insertion ∅ → t / n _____ s[+syl,-stress]

ex. Mensa vs. insane

/l/ Devoicing l → [-voice] / s _____ [+syl,-stress]

ex. Iceland vs. Icelandic

Medial Aspiration [-cont, -voice] → [+spread glottis] / [-stri] _____ ([+son])[+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 (and often these are displayed on vowels).

σ	unstressed syllable
$\grave{\sigma}$	secondary-stressed syllable
$\acute{\sigma}$	primary-stressed syllable

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.	$\acute{\sigma}\sigma$	páŋa	‘earth’
b.	$\acute{\sigma}\sigma\sigma$	t ^j úŋaya	‘many’
c.	$\acute{\sigma}\sigma\grave{\sigma}$	má awàna	‘through from behind’
d.	$\acute{\sigma}\sigma\grave{\sigma}\sigma$	pú ŋkàlat ^j u	‘we (sat) on the hill’
e.	$\acute{\sigma}\sigma\grave{\sigma}\sigma\grave{\sigma}$	t ^j ámulìmpat ^j ùŋku	‘our relation’
f.	$\acute{\sigma}\sigma\grave{\sigma}\sigma\grave{\sigma}\sigma$	tí ŋìŋulàmpat ^j u	‘the fire for our benefit flared up’
g.	$\acute{\sigma}\sigma\grave{\sigma}\sigma\grave{\sigma}\sigma\grave{\sigma}$	kúran ^j ùlulìmpat ^j ùŋa	‘the first one who is our relation’
h.	$\acute{\sigma}\sigma\grave{\sigma}\sigma\grave{\sigma}\sigma\grave{\sigma}\sigma$	yúma.ŋŋkamàrat ^j ùŋaka	‘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

The location of stress is not always predictable. Sometimes the right generalization has yet to be discovered. If stress is unpredictable, then it may be marked as part of the underlying representation. Many languages have some combination of lexical marking

3 The typology of stress patterns

3.1 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.

3.2 Quantity-insensitive, Quantity-sensitive, and Quality-sensitive 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 H H	‘friend, kind’
b.	gu.ber.ná:bunt	L H H H	‘they will reign’
c.	i.ni.mi:kì.ti.a	L L H L L L	‘hostility’
d.	do.més.ti.kus	L H L H	‘belonging to the house’
e.	mán.da:	H 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.

Quality-sensitive stress patterns refer to the fact that in some languages, vowel quality is important for predicting the placement of stress (Kenstowicz 1996). Kenstowicz gives Kobon (Papua New Guinea) as an example.

hagápe	‘blood’
gáʎe#gáʎe	‘to cry, of pig’
alágo	‘snake species’
kidolmáj	‘arrow type’
ki.á	‘tree species’
háu.i	‘vine species’
ái.ud	‘story’
áñim#áñim	‘to lightening’
wái.əŋ	‘cassowary’
ái.ən	‘witch’
mó.u	‘thus’
si.óg	‘bird species’
gíró#gíró	‘to ”talk” - of mother pig to piglet’
gaʎínəŋ	‘bird species’
wí.ər	‘mango tree’
ʎú.əʎ	‘horizontal house timbers’
mú.is	‘edible fungus species’
gisó#gisó	‘to tap’

Kenstowicz writes “Unaffixed word’s stress is restricted to one of the final two syllables, seeking out the most prominent nucleus in this disyllabic window,” and he suggests that the following prominence hierarchies are active.

$$a, e, o, i, u > ə, i$$

$$a > e, o > i, u > ə > i$$

3.3 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’	bóldogtálan	‘unhappy’
bóldogsà:g	‘happiness’	bóldogtálansà:g	‘unhappiness’

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

ulàamít	‘mist’	àkunàtepál	‘times’
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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.pu.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.wu.lày ‘he pretended not to know’

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

Hungarian	Araucanian
ó	ó
óσ	σó
óσò	σóσ
óσòσ	σóσò
óσòσò	σóσòσ
óσòσòσ	σóσòσò
...	...
Weri	Warao
ó	ó
σó	óσ
òσó	σóσ
σòσó	òσóσ
òσòσó	σòσóσ
σòσòσó	òσòσóσ
...	...

4 Representing Stress

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

4.1 The Grid

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

line 3:									lines can be labelled with prosodic units:
									Prosodic Word
line 2:	x								Composite Group?
									Foot
line 1:	x		x						σ
line 0:	x	x	x	x	x	x			
	a	pa	la	chi	co	la			

When people work with grid-based representations, grammars contain rules or constraints that generate the correct grid-based representations of stress from underlying forms. So

like syllable structure, the grid is part of the surface representation, not the underlying representation. In rule-based theories, rules are given which add grid marks in certain locations, but not others (Halle and Vergnaud 1987a). In constraint-based theories, optimal satisfaction of the constraints determine the location of stress (Gordon 2002:e.g.). In theories utilizing principles and parameters, these principles and parameter settings determine how the grid is constructed (Prince 1983).

4.2 Feet

Another common way stress is represented is with metrical 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:

(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.

When people work with foot-based representations, grammars contain rules or constraints that generate the correct foot-based representations of stress given underlying forms. In rule-based theories, rules are given which add foot boundaries marks in certain locations (Chomsky and Halle 1968). In constraint-based theories, optimal satisfaction of the constraints determine the location of feet Tesar and Smolensky (1998). In theories utilizing principles and parameters, these principles and parameter settings determine how feet can be placed (Hayes 1995).

Some theories combine feet with the grid: grids grouped into feet and words (Idsardi 1992, Hayes 1995).

				x	
(x				x)
(x		x)	(x)
(x	x)	(x	x)	(x	x)
a	pa	la	chi	co	la

5 Theories of Stress

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

5.1 Principles and Parameters (simplified!)

In the original Grid-based theories (Lieberman and Prince 1977, Prince 1983), the strong tendency toward rhythmic alternation is accounted for by mapping to the **perfect grid**:

$$\dots x \overset{x}{x} x \overset{x}{x} x \overset{x}{x} x \overset{x}{x} x \overset{x}{x} x \overset{x}{x} \dots$$

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

Directionality parameter	Starting parameter	End Rule
Hungarian		
Weri		
Warao		
Araucanian		

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’
$\begin{array}{ccccccc} x & x & x & & & & \\ x & x & x & x & x & x & x & x \end{array}$	$\begin{array}{ccccccc} & & & & & x & x & x \\ x & x & x & x & x & x & x & x & x \end{array}$ (cf. tones)	$\begin{array}{ccccccc} & & & & & & x & & \\ & & & & & x & x & x & x & x \\ x & x & x & x & x & x & x & x & x & x \end{array}$ 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}

It is not hard to realize that for the simple cases, these theories are notational variants. Differences do appear when more complex cases are considered, but the details of the particular theory being invoked really matter in those complex cases.

5.2 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.

1. Parse-Syllable: Syllables should be in feet.
2. BinaryFoot: Feet should contain exactly two syllables.
3. Trochaic: Feet should be trochaic.
4. Iambic: Feet should be iambic.
5. Align(Ft,L): Align feet to the left edge of a word.

òσòσòσòσ
 òσòσσòσ
 òσòσσò
 òσσσò
 òσσσ
 òσσ
 σσò
 σσ
 σò

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

σóσσòσσò
 σóσσòσσ
 σóσσòσ
 σóσσò
 σóσσ
 σóσ
 σó
 σó

Gordon (2002) catalogues all of these patterns.

6.2 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.	[ilisó:mit]	L L H L	‘we lived’
c.	[qó:kítìʃ]	H L L	‘deaf’
d.	[qumo:qlíʃ:]	L H L H	‘your two friends’
e.	[u:có:mit]	H H L	‘we work’
f.	[u:cíkkó:qi]	H L H L	‘they two are working’
g.	[qúmmin]	L L	‘human being’ (gen.)
h.	[ámirna]	L L L	‘eats’
i.	[qólʃcimpatì]	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 (1987b), Dresher and Kaye (1990), Prince (1992), Idsardi (1992), Bailey (1995), Hayes (1995), Walker (2000), Gordon (2002), Elenbaas and Kager (1999), Hyde (2002), van der Hulst *et al.* (2010), van der Hulst (2014a,b), Heinz *et al.* (2016), Goedemans *et al.* (2019).

There is also an online database of stress patterns that can be browsed and queried here: <http://st2.ullet.net/>.

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