# 1 Background I: A Phonological Refresher

## 1.1 The Basics of Phonology

To begin with: what is *phonology*? To be more precise, we will usually be talking about the phonology of either a language or a speaker – and our working definition will be that a phonology is a characterization of all the mental representations and unconscious knowledge that speakers have about abstract speech sounds. Studying phonology, then, is studying the nature of this knowledge, and also the characterization of this knowledge.

We will often talk about this abstract knowledge in terms of phonological *generalizations*. To exemplify: one generalization about Zack's speech from the Preface is that he begins all of his words with only one consonant, and never with two consonants side-by-side. At the same time, a different generalization about English as spoken by the native speaker adults around him is that words begin with two or three consonants in a row all the time! By looking at Zack's own version of English words, we can see that he systematically modifies all words beginning with more than one consonant so that they are consistent with his own pattern – the 'sp' of *special* comes out as just [p], the 'fl' of *fleece* as just [f], and so on. The task of a phonological grammar is to capture a speaker or population's generalizations, explicitly enough that an algorithm plugged into some otherwise-dumb computer could approximate the phonological knowledge of a human language speaker.

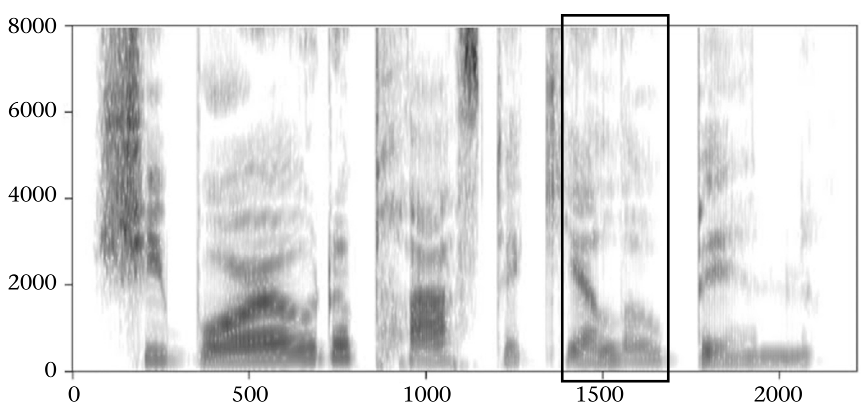
Most phonological grammars (and all the ones we will use in this text) operate on representations of two kinds: stored forms in the mental lexicon, called *underlying representations* (URs), and forms that can actually be produced by a speaker or heard by a listener, called *surface representations* (SRs). This text will also refer to these URs and SRs respectively as *inputs* and *outputs*, and the mapping from one to the other is illustrated as /input/ → [output]; note the / / vs [ ] notation. The grammars we will use in this textbook are ones in which you can feed the grammar <u>any</u> input and it will always generate[1]

[1] This property – though certainly not always cached out in this format – is the source of the term *generative linguistics*, associated as you probably already know with the pioneering work of Noam Chomsky.

a *legal* output – that is, an output that a native speaker would judge to be a possible surface form in the language. If you give it input /blɛp/, and it is a phonology of English, it will simply return [blɛp] again, because that string of sounds is a well-formed possible English word. If you give it /pɛlb/, though, it will map that input onto some modified form to accord with English phonological generalizations, perhaps as [pʰɛɫ]. In this way, you might think of a phonological grammar as a language-specific filter. The job of phonologists is to spell out how these filters work: what building blocks they are composed of, how they differ between languages, and what kinds of structures they can rule out or in (and eventually why). When studying acquisition, phonologists take on the further tasks of describing how these filters become language-specific (through learning), and how children use them and refine them in the years before they have acquired a fully-adult grammar.

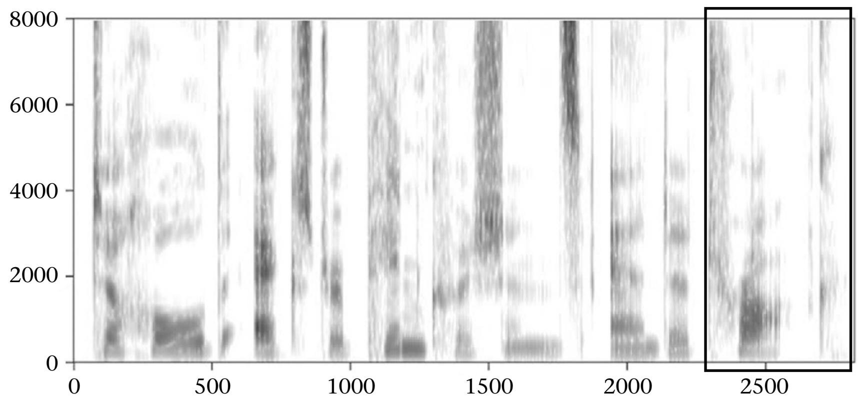
To build a phonological grammar, we first need to understand the objects that it manipulates: what are these underlying and surface representations made of? The basic phonological building blocks of URs and SRs are *segments*. Segments are abstractions away from the raw acoustic signal of speech, made into manageable mental chunks that we can manipulate with the grammar. To see the value of this approach consider the two *spectrograms* below, which together represent much of the raw acoustics of the author saying an English sentence. If you are not familiar with reading spectrograms, these will be rather messy and hard to interpret. The only crucial aspects of the graph are that the x-axis measures time in milliseconds, and the y-axis indicates the strongest resonating frequencies[2] measured in Hertz, and overall intensity of the sound, indicated by the darkness of each bar.

(1a) ‘She borrowed a plastic yellow bin…



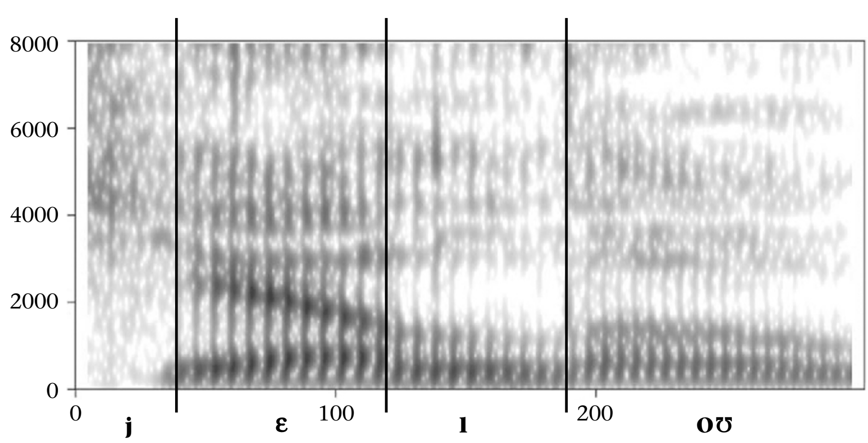

[2] Which you may already know are called *formants*.

(1b) '… to hold extra pin cushions and a trock'

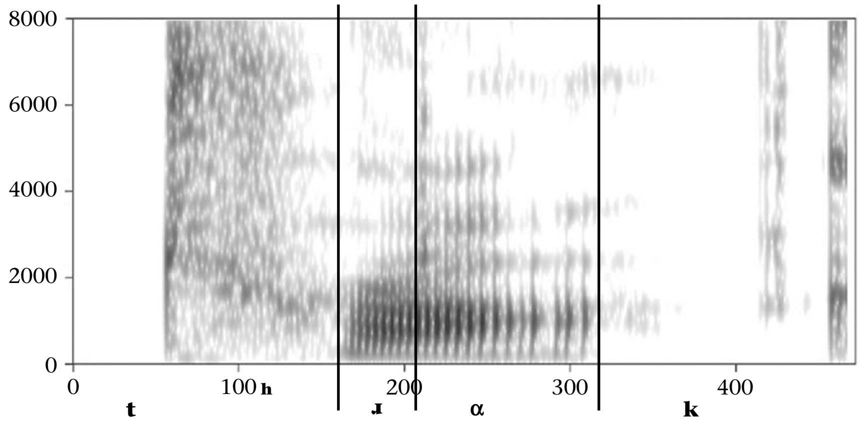



Let us just consider the two boxed portions of the sentence, which correspond to the word *yellow* in the (1a) spectrogram and *trock* in (1b). (Yes, *trock* is not a real word of English, on which there will be more in a minute.) It is somewhat hard to process this visual representation, with its continuous time dimension and myriad phonetic dimensions. But from a phonological viewpoint, one basic question is: how many segments does each word contain? If we examine each spectrogram for steady-state periods of sound, expecting some noise during the transitions, then we can perhaps come up with a rough approximation of the words' segments. Below this has been done for zoomed-in spectrograms of *yellow* and *trock,* where each segment has been transcribed with an IPA symbol.

(2a) *yellow*, segmented:



(2b) *trock*, segmented[3]:




Segments are thus at least a method of abstracting away from continuous phonetics to more discrete phonology. Phonologists (and others) have also found some compelling evidence that grammars and speakers manipulate their phonologies at the level of the segment, so it is not just a convenient notation. These arguments will be developed as we go. Note also that the fact of *trock* not being an English word has caused us no difficulty in segmentation and transcription – and that is precisely the point, that is that phonology is about the legality of speech sound interactions in a language, not just the particular words that happen to occur in your mental dictionary (which we will usually refer to as the mental *lexicon*). This issue will also be raised many times in the pages that follow.

**Exercise 1**: Identify all the letters in the English words of (1) which correspond to multiple IPA symbols, and vice versa.

A phonological grammar is a mechanism for regulating phonological segments, their parts and their combinations. The first kind of phonological knowledge we will ascribe to our grammar is *phonotactics*, by which we will mean the regulations that describe how segments can or can't be strung together. It is the phonotactics of English that tell you that *trock* could be a word, as in our previous example, but for example **tlock* could not – English word-initial phonotactics rule out the sequence #[tl].[4] You also know, via English phonotactics, that *trock*'s second segment is a voiceless [ɹ] and that the similar second segment in *plastic* is a voiceless [l], while *borrow* and *yellow*

[3] The second symbol 'h' indicates that the segment [t] was *aspirated*. If you have forgotten what this term means, read on . . .
[4] # is a word boundary sign.

have a voiced [ɹ] and [ɫ] respectively. Note, however, that this knowledge is usually completely unconscious – you almost certainly knew nothing overt about voiced and voiceless versions of ‘r’ and ‘l’ until you encountered them in a linguistics class, but you were already devoicing ‘r’ and ‘l’ whenever appropriate for your dialect without knowing you were doing it.

How does a phonological grammar capture this knowledge? There are many theories, which actually turn out to have rather different consequences. For example, an English grammar could contain a *rule* that maps word-initial /tl/ onto something else (see 3) – this would mean picking a way of fixing #tl so it conforms to English, for example:

| | | |
|---|---|---|
| (3a) | /t/ → [k] / # __ l | (Turn /t/ into [k] when word-initial and followed by l) |
| (3b) | /0/ → [ə] / # t __ l | (Epenthesize a schwa between word initial t and l) |

Alternatively, the grammar could have a *constraint* that says ‘No Word-initial [tl]’, which would mean relying on other bits of the grammar to decide what to do about an input /#tl/ should it appear. In this textbook, our first crucial choice will be to use constraints to capture phonological patterns like this, so we will spend some time justifying that choice in later chapters.

One other big job for the phonological grammar is to regulate sound sequences via *alternations* when they are concatenated by multiple *morphemes*, that is the meaningful building blocks of words and phrases. An English example of alternation which you have probably seen before comes from our plural morpheme, which has multiple phonological forms. Returning to the nonsense noun *trock*: whatever a trock is, if you have more than one trock, you have two … [tɹɑk**s**] (*trocks*).[5] And if you found another one that needed storage, you would probably want to get more … [bɪn**z**] (*bins*). Both words end with a morpheme meaning ‘plural’, but the phonology of English dictates two different surface *allomorphs* [-**z**] and [-**s**] in these two phonological environments. In the grammars that we will build in this textbook, the same kinds of constraints that tell you why **tlock* couldn’t be an English word also tell you that *trock*’s plural is *trock*[**s**] and not **trock*[**z**].

## 1.2 Phonology at and below the Segmental Level

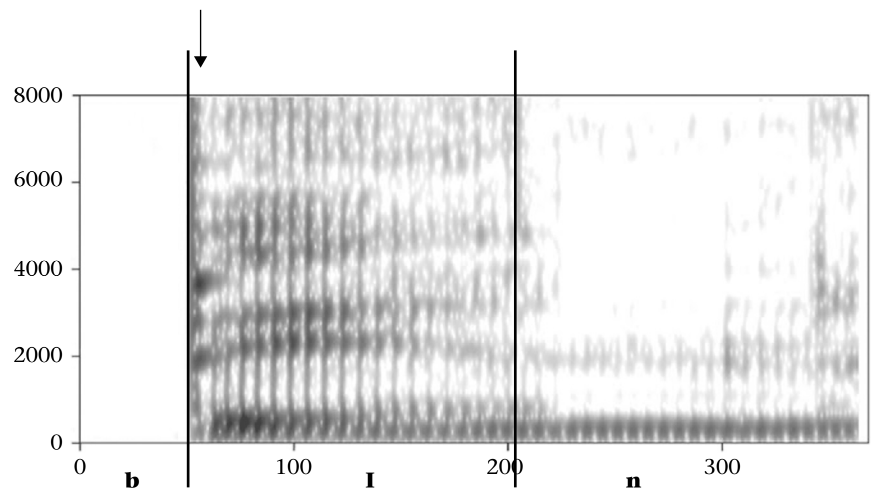
While *segments* are a very useful phonological unit for analysis and study, phonologies also organize their segments according to many different subsegmental properties. To see which of these properties are important for phonological purposes, let us consider one basic way that they are used: defining a language’s phonological *categories*.

[5] This game of fill in the blank is in fact a common experimental device; see Chapter 8.

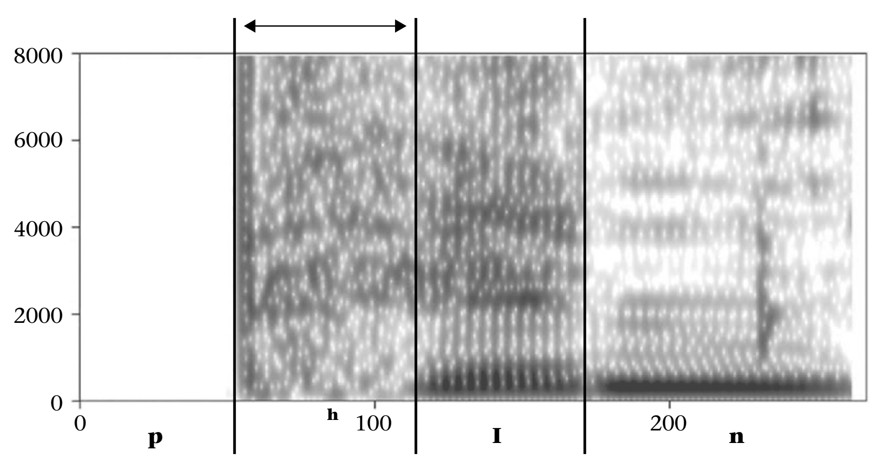
One classic example of a property used to categorize phonological segments is *voice onset time* (VOT). In the simple case of a stop followed by a vowel, VOT indicates the number of milliseconds between the burst of air caused by releasing the stop and the beginning of vocal fold vibrations for the vowel. If voicing begins exactly when the stop is released, VOT is zero. If it is negative, voicing had already begun during the stop's closure; if it is positive, then the stop was followed by a period of voiceless *aspiration* before vowel voicing began.

Here are two spectrograms of two English words within that previous phrase, with an arrow indicating the period of aspiration in each case (very little in the first, a fair bit in the second):

(4a) *bin*




(4b) *pin*



For these particular two tokens, the VOT for the initial segment in (4a) was measured at around five milliseconds, while the VOT for the initial segment of (4b) is 50 milliseconds. Whatever the precise difference, the phonological question is whether English speakers treat these two segments as same or different. In this case, the difference in their VOT causes you to perceive two different words: (4a) is *bin* and (b) is *pin*, so these two labial stops belong to two different phonological categories. (We refer to any such useful pair of words like *pin~bin* that highlight the contrast between two categories in a language as a *minimal pair*.)

In comparison, many English dialects distinguish two different *lateral* ('l'-like) segments: the alveolar, non-velarized [l] of *p**l**astic* and the velarized [ɫ] of *ho**l**d*. Unlike the difference in VOT of 5 vs 50 milliseconds, though, the segments in *plastic* and *hold* belong to a single English category; there are no minimal pairs like *hold* vs **ho[l]d* or *plastic* vs **p[ɫ]astic*, and English speakers cannot change the meaning of a word by replacing one lateral with the other. Instead, the English distribution of alveolar vs velarized laterals is *predictable*. Comparing just these two words, you might come up with a prediction as to the *contexts* in which lateral can be used: for example, before a [d] laterals are velarized (as in *hold*), but after word-initial [p] (as in *plastic*) they are not. Of course, this analysis is only built from two data points, and it is so specific that you should suspect it is missing some broader generalizations (keep reading!).

The traditional terminology is that /p/ and /b/ are different English *phonemes*, whereas alveolar [l] and velarized [ɫ] are both *allophones* of a single English phoneme /l/. What is crucial in this textbook is the notion of predictability: part of the phonological grammar's job is to predict which of the allophones from a single category can occur in any specific phonological context. It is also crucial to note that phonemic or allophonic status is language-specific: the question of whether two different segments are part of two different categories (i.e. different phonemes) or a single category (i.e. both allophones of a single phoneme) is answered differently from language to language. As one quick example: nasalizing a vowel in English doesn't change the vowel's category – so that the vowels in *lap* [læp] and *lamb* [lǣm] are allophones of the same phoneme /æ/ – whereas in French nasalized and oral versions of the same vowels are often different phonemes, as shown in minimal pairs like *beau* [bo] 'beautiful' and *bon* [bõ] 'good'.

The descriptions given so far of a segment's properties have been fairly grounded in articulatory terms: voice onset time, vowel nasalization and velarization[6] are all measurable phonetic aspects of a sound. In a

[6] Which means some raising of the tongue body or *dorsum*: not very detectable on a spectrogram although possibly discernable as movement or 'pinching' of F3 relative to F2, and definitely detectible if you happen to have an ultrasound recording.

phonological grammar, however, these articulatory properties do not all have the same status, and it is therefore useful to describe segments and their properties using a formal language of *phonological features*. Many of these features should not be news to you, but many of them also have definitions that span multiple categories in the IPA chart, so some discussion is necessary.

In the case of the phonetic property of voice onset time, there are a couple of different phonological features that we might need for describing cross-linguistic categories. One feature is *aspiration*, which distinguishes between the long positive VOT at the beginning of 'pin' and the short or nearly-zero VOT at the beginning of 'bin', meaning that their true IPA transcriptions might be [pʰɪn] and [b̥ɪn] or [pɪn] respectively. In some environments, aspiration is a predictable feature – meaning that for example in the context [s__ɪn] (as in *spin*), the English grammar will judge [p] or [b̥] as grammatical but [pʰ] as ungrammatical. The other most common phonological feature that involves VOT is *voicing*, which in languages like Spanish and Dutch will distinguish either of these 'voiceless' English stops from a truly prevoiced [b], where voicing begins during the closure, resulting in a negative VOT.

A long phonological tradition has argued that features give us insight into how languages arrange their phonemes, allophones, contexts and predictability.[7] Our quick discussion of *spin* (where aspiration of 'p' is banned) vs *pin* (where 'p' aspiration is obligatory) suggested that these aspirated and unaspirated allophones of English /p/ are in *complementary distribution*, only one appearing in each potential English phonological context. A more interesting point is that other pairs of English segments with similar distributions: *stick* vs *tick*; *scoff* vs *cough*, where again the s_V context requires an unaspirated allophone [p, t, k] and the #_V contexts requires an aspirated one, [pʰ tʰ kʰ]. Why these three? Not only are {p,t,k} all voiceless stops, they are also the language's *only* voiceless stops – in other words, they form the English *natural class* of voiceless stops. So rather than listing the unrelated behaviours of three phonemes, the English phonology can make broader generalizations like 'voiceless stops are aspirated word-initially' (and so on, describing other environments).

Given the wealth and complexity of phonological processes, it is not surprising that several different sets of phonological features have been proposed. This textbook is not designed to provide much insight into choosing between their specifics, and our feature set will lack many necessary bits, but it will

[7] To see this history in its original unfoldings, see: Trubetzkoy (1939); Jakobson (1941); Jakobson, Fant and Halle (1952); Jakobson and Halle (1956); Chomsky and Halle (1968).

make use of a crucial, small set of feature types that most phonologists would recognize. Here we will present them by trying to introduce as little confusing detail as possible. Let's begin with features describing *place of articulation*:

(5)

<table>
<tr><td colspan="3">Place features</td></tr>
<tr><td>Major/Primary Place</td><td colspan="2">Minor/Secondary Place</td></tr>
<tr><td>labial</td><td>+/–labiodental</td><td></td></tr>
<tr><td>coronal</td><td>+/–anterior</td><td>[+ant] = dental, alveolar<br>[–ant] = postalveolar, retroflex</td></tr>
<tr><td></td><td colspan="2">note: palatal = [coronal AND dorsal]</td></tr>
<tr><td>dorsal</td><td>+/–low</td><td>[–low] = velar<br>[+low] = uvular</td></tr>
<tr><td>pharyngeal</td><td colspan="2"></td></tr>
<tr><td>glottal</td><td colspan="2"></td></tr>
</table>

Note that the major place features are *monovalent* in this table, meaning they are simply attributes that a segment does or does not have – you can be labial or not, those are the only two options. Those minor places features within a major place class, however, are treated as *bivalent*, so that for example all [coronal] segments can in principle be specified as either [+/–anterior].

Turning to *manner* features: these are sometimes the hardest for students to get a handle on, so the table in (6) adapts a way of laying them out from Hayes (2009):

(6)

<table>
<tr><td colspan="7">Manner features</td></tr>
<tr><td>stops</td><td>affricates</td><td>fricatives</td><td>nasals</td><td>liquids</td><td>glides</td><td>vowels</td></tr>
<tr><td colspan="3">[-sonorant]</td><td colspan="4">[+sonorant]</td></tr>
<tr><td>[-delayed release]</td><td colspan="2">[+delayed release]</td><td colspan="4" rowspan="2"></td></tr>
<tr><td></td><td colspan="2">[+/-strident]</td></tr>
<tr><td colspan="2">[-continuant]</td><td colspan="5">[+continuant]</td></tr>
<tr><td colspan="3" rowspan="3"></td><td>[-approx imant]</td><td colspan="3">[+approx.]</td></tr>
<tr><td colspan="2">[-vocalic]</td><td colspan="2">[+vocalic]</td></tr>
<tr><td colspan="3">[-syllabic]</td><td>[+syllabic]</td></tr>
</table>

The first big distinction in manner is [+/–sonorant], distinguishing the *obstruents* from the *sonorants*; we will have much more to say about this property of *sonority* in later chapters. Notice that most other manner features are only defined for a subset of the manners discussed here; note too that the status of nasals as [+continuant] is a rather non-standard assumption here (you will eventually see why in Chapter 5). There are also a few missing features here: two that we will need are [+/–lateral], [+/–tap] (or flap) and [+/–trill]. Finally, we will also use the feature [+/–nasal] which can be used to describe any consonant or vowel.

The *laryngeal* features we will use include [+/– voice], [+/–aspirated] and [+/–constricted glottis], the last of which describes sounds such as *ejectives*, 'tense' consonants (see Chapter 5), and *creaky* vowels.

Beyond the manner information above, we will have fairly little to say about *vowel* features, simply because this text is quite vague about the acquisition of vowels. However, we will use the terms [+/–high], [+/–low], [+–back] and [+/round] to describe them, in accordance with their location in the vowel space (see again the IPA vowel chart on page **28**). Note also that in Chapter 6.2 we will spend some time discussing how the place features of consonants and vowels line up. In addition, we will need to be able to refer to two *prosodic* qualities of segments as features: [+/–long], which distinguishes phonemically long vowels and geminate consonants, as well as [+/–stress] (which is not that common a feature, and very possibly for good reason, but is used in e.g. Hayes, 2009). These will appear when necessary.

To re-iterate: this text is not especially committed to the details of any particular featural description, but there are times when we will have evidence from child phonology to prefer one version to another. If this is your first time using phonological features to understand speech patterns, you will want more background, for which see the chapter's further readings. If you are not sure whether you need more or not, make sure to use the exercises here and at the end of the chapter to evaluate.

**Exercise 2:** Using the features just introduced, how could you describe the English ban on #tl ? That is, what features are not allowed in that word-initial sequence?

**Exercise 3:** Now look at this larger set of data, listing possible and impossible word-initial segments in the author's dialect. Can you give a more general featural account of what features cannot co-occur word-initially?[8] It's not a completely simple pattern, but you can get started …

[8] Some speakers may also judge *dwin* or *gwin* as bad enough to be impossible, and may judge *bwin* as good enough to be possible. We do have rather few #dw words in English – e.g. *dwarf, dwell* and the name *Duane*; #gw is really only found in names like *Gwenneth* so its status may be truly marginal. While we have no native words with #bw, some speakers may be too familiar with Spanish words like *bueno* to keep the English judgments crisp.

(7)

| | | | | | |
|---|---|---|---|---|---|
| *prick* | *brick* | *trick* | *drip* | *crick* | *grit* |
| *plot* | *blot* | **tlick* | **dlip* | *click* | *glock* |
| **bwick* | **pwit* | *twin* | *dwindle* | *quick* | *Gwin* |

This question is designed to show you two things: first, that featural description makes more sense out of a list of facts like (7) than was previously possible, and second, that features are often not well-suited to explaining *all* the details of a phonological phenomenon, such as the intricacies of place dissimilation among word-initial consonant sequences. Both of these claims will be reinforced throughout our study of child phonology, and we will build a grammar that uses features to describe patterns, but uses other mechanisms to describe the relative importance of each pattern and their individual (principled) exceptions.

**Exercise 4:** Below are examples of alveolar and velarized English laterals, in just four environments. What's the distribution of the two laterals?

(8)

| *alveolar*[l] | | *velar* [ɫ] | |
|---|---|---|---|
| *light* | *police* | *wilting* | *shrill* |
| *lavender* | *delirium* | *alpine* | *cudgel* |
| *lopsided* | *igloo* | *wholesome* | *elemental* |
| *lasagne* | *resolution* | *palm* | *impossible* |
| *lewd* | *clubs* | *bulbs* | *school* |

First *describe the phonological environment* of each column – that is, find a phonological context that includes all the members of each column, without including any members of any other column. Secondly, *describe the context for each lateral allophone*, and then see if you can describe the two allophone's contexts each with a single description. If not, how close can you get?

## 1.3 Phonology above the Segmental Level

This section moves on to larger groupings of speech sounds above the segment, called *prosodic* units, which the phonological grammar can constrain and organize. This textbook will be primarily interested in the acquisition of three prosodic units: *syllables*, *feet* and words.

### 1.3.1 Syllables

To begin with the smallest of these units: what's a syllable? One place to begin is the notion of words containing multiple 'beats'. Just as we perceive a beat to music, we can also ask how many beats a word has (though people's intuitions on this matter differ in their strength and reliability.)

Consider these sets of English words: how many beats would you say each one has? And can you identify any linguistic element that you are tracking with these beats?

(9)

| | | | | |
|---|---|---|---|---|
| a) | *banana* | *canasta* | *Canada* | *activate* |
| b) | *America* | *Northumbria* | *Indonesia* | *avocado* |
| c) | *proliferation* | *organization* | *inescapable* | *inescapably* |
| d) | *diversification* | *discombobulation* | *onomatopoeia* | *originality* |
| | | | | |
| e) | *ease* | *rough* | *grease* | *squeeze* |
| | *foe* | *foal* | *fold* | *folds* |
| | | | | |
| f) | *baby* | *shady* | *elbow* | *singlet* |
| | *obey* | *chalet* | *portray* | *barrette* |

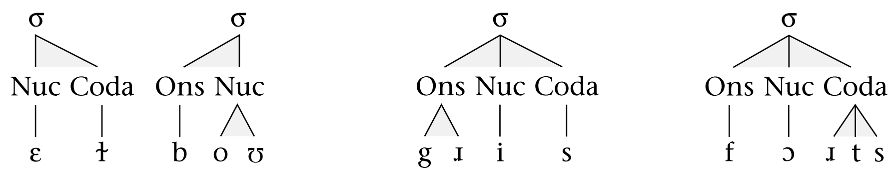
Your intuitions about how many *beats* are in these words also track how many *syllables* there are – and in all of these cases, the common predictor of the number of beats is the number of *vowel segments* there are. The examples in (3) in particular suggest that the number of consonants is fully irrelevant[9]: for example the set *foe* ~ *foal* ~ *fold* ~ *folds* ends with between zero and three consonants, yet we perceive all four words as taking the same amount of 'time', in having just only 'beat'.

Thus, we have the foundation of a syllable, indicated with the Greek letter sigma σ: a perceived grouping of speech sounds, organized as a single timing unit around (most often) a vowel, called the syllable's *nucleus*. Beyond their obligatory nuclei, syllables often have consonants on either side of them: segments before the nucleus are part of the *onset* and those after the nucleus are the *coda*. This structure is illustrated by means of a tree diagram like the ones in (10), but whenever we can (which will be most of the time)

[9] Although this isn't always true – keep reading on to the data in (11).

the text will boil down this structure simply by using periods to indicate syllable breaks, e.g. [ɛɫ.boʊ].

(10)

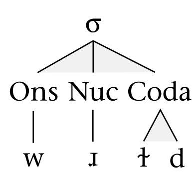



Many aspects of syllable structure are relevant to the early stages of phonological acquisition, especially in languages like English, so we will now review some. One complication is that it's not always vowels that give a word its beats and so gives the syllables their nuclei. In your estimation, how many syllables are in the following words?

| | | | | |
|---|---|---|---|---|
| (11) | *bought* | *bottom* | *bottle* | *bottler* |
| | *mitt* | *mitten* | *middle* | |

In the case of words like *bottom* and *mitten*, which segments make up the second syllable? In their transcription, no vowel seems to be in evidence – instead, the nucleus of these syllables seems to be the *nasal* consonants [m] and [n]. Similarly, *bottle* and *middle* both end with a syllable whose nucleus is the velarized lateral, whether [bɑɾɫ] or [baʔɫ] or similar. And what about words like *her* or *earl* or *world?* For speakers of *rhotic* dialects, these monosyllabic words appear to contain *no* vowels, their single nucleus is [ɹ]. While nasal and lateral consonants are fairly reluctant nuclei – showing up in limited contexts, very often word-finally – [ɹ] is nucleus enough to sit in the middle of a syllable, surrounded by typical onsets and also codas.

(12)




Quiz time: can you find a natural class that describes all and only the English consonants that can act as nuclei? Look back at the manner features in table (6), and you should be able to find one … they are the *sonorants*.[10] Cross-linguistically, we find that phonologies differ in their requirements for syllable nuclei – but in every language, vowels are the *most* likely nuclei and always the most preferred.

[10] What about glides? It is probably right to assume that if a glide is put in nuclear position, it simply becomes a vowel.

Like its nuclei, English also imposes many restrictions on onsets and codas that relate to *sonority,* a concept which we will now examine in greater detail. Beyond the obstruent/sonorant divide, sonority is a rather more fine-grained scale, which orders the manners roughly top-to-bottom on the IPA chart:

(13) *A sonority scale*[11]

| | | | | | |
|---|---|---|---|---|---|
| stops | fricatives<br>affricates | nasals | liquids | glides | vowels |

⟵――――――――――――――――――⟶

less sonorous ... more sonorous

Now what is the use of this sonority scale for English syllables? Let us consider which manners of consonants can occur in onset *clusters*, meaning the adjacent consonants within an onset, like the [gɹ] of *grease*. This [gɹ] is part of the very common sequence of stop + liquid, as we saw in all those examples in (7).

If you try to come up with other English onset cluster types, in terms of their natural classes, you will notice that nearly all such clusters *rise in sonority* – that is, the first member is less sonorous than the second. Recall that the nucleus is restricted to a set of *sonorous* segments – and prefers to contain a vowel, the most sonorous manner there is! Overall, then, can we say that syllables represent the peaks and troughs of sonority throughout a word?

Often, but not always. In English, although most onset clusters rise in sonority, there is a special cluster type that violates this profile. You may be able to think of it off the top of your head – in fact, there was an example of one such cluster in the previous sentence. Consider:

(14) *special* *student* *school*
*spray* *strife* *squeeze*

These cases show a <u>drop</u> in sonority between the first and second consonants: [s] is a fricative, already not very sonorant, but [p, t, k] as voiceless stops are even less so. This exception to the sonority rise generalization should perhaps give us pause – how good a generalization is it, really? Notably, it is only this one fricative [s] that can occur before stops in onset clusters – but more compellingly, it turns out that <u>many</u> languages allow [s]+stop onsets but otherwise obey the sonority rise restrictions (in other languages like German it is the very similar [ʃ]+stop that is given special sonority privileges).

[11] More detail may sometimes be necessary to include in this scale: for instance, voiceless obstruents are less sonorous than their voiced counterparts; high vowels are less sonorous than low ones.

Much phonological ink has been spilled trying to understand the correct characterization of the [s]-exception to onset sonority profiles; for now we simply note that s-initial onsets are special.

The last note about syllabification concerns cross-linguistic variation. Phonologies around the world differ greatly in terms of syllable *shape* – to use two famous examples, Hawaiian has no onset clusters or codas at all, while Polish can build words which begin with such cluster surprises as [fʂt͡ʂɲɛʂ] and [mgwa].[12] Many languages show slight variations on the English theme – Spanish for example shares many onset clusters with English, but it does prohibit [s]+stop onsets (see the next exercise). But regardless of differences in syllable inventories, one universal appears to be that languages never use syllabification *contrastively*. In other words: given as string of segments, two grammars might syllabify them differently, or rule them out entirely because they are unsyllabifiable, but no grammar will allow two different syllabifications which mean different things.

All other things being equal, that is. As for when things are not equal: see next section.

**Exercise 5:** The fact that Spanish does not allow [s]+stop onsets is reflected in several English/Spanish cognates: for example, *Spain* vs *España* [ɛspaɲa] and *school* vs *escuela* [ɛskwela]. Given this fact, figure out how these Spanish words must be syllabified – that is, where their first syllable ends and their second syllable begins.

**Exercise 6:** Do you remember the constraint against word initial [tl] clusters, or its more general version, as revealed from looking at (7)? With that in mind, now look at some other English words, as pronounced in the author's dialect:

| | | | | |
|---|---|---|---|---|
| (A) | *mattress* | *mantra* | *atlas* | *antler* |
| | [mætɹɪs] | [mæ̃ntɹɑ] | [æʔlɪs] | [æ̃nʔlɚ] |

How do you think they are syllabified? That is, where do their syllable breaks fall? How does your knowledge of the constraint against #[tl] figure into this reasoning? Can it be tweaked to help explain the distribution of t vs glottal stop in these words?

**Exercise 7**: How many syllables do you think there are in *opener* and *lightener?* How many in *world* and *squirrel?* English speakers tend to disagree on such items, and it's probably the case you can produce them all with two

[12] meaning 'you (sg.) will initiate', and 'fog, mist' respectively.

different numbers of syllables. Try transcribing the two different versions, and try thinking about why there might be two syllabifications.

### 1.3.2 Stress and Feet

Having just learnt that syllabification is not contrastive look at the pairs of words below, which have nearly the same segments in them, and therefore the same English syllabification:

(15) *record* (ancient object for playing music) *record* (to encode information)
*address* (a precise location) *address* (to direct speech at someone)
*convict* (a person found guilty) *convict* (to find someone guilty)

How do these words differ? Their segmental transcriptions are slightly different, but speakers also have an intuition that there is a more fundamental difference between the two columns of words. The difference might be described as one of 'emphasis', or in the terms of the previous section, as which of the beats is the strongest. The phonological term for this word-internal emphasis or strongest beat is *stress*.

Even though native speakers perceive word stress quite easily and unconsciously, the raw acoustic reflex of a word's stress – that is, the measurable properties that distinguish *REcord* the noun and *reCORD* the verb – are rather complicated. To be very brief: stress is a property of a syllable (at least of its nucleus), and when compared phonetically to their unstressed counterparts, stressed syllables are typically longer, higher in pitch, and higher in amplitude (louder), though the relative importance and reliability of these phonetic cues are different between languages.

Stress is a fundamental part of organizing speech sounds, in many if not most phonological grammars, but its role in defining the meaning of words is very variable. In some languages the position of stress in a word is just as unpredictable as a phoneme: that is, all words are in some sense like *record*, where speakers must memorize which syllable gets stressed. In such languages, like Russian, stress can create minimal pairs: for example ['muki] '*torments (nom. pl.)*' vs [mu'ki] '*flour (gen. sg.)*'. Notice that stress is best transcribed with a superscript straight apostrophe, placed <u>before</u> the stressed syllable.[13]

[13] This IPA transcription for stress is safer than placing an accent on the stress vowel itself, as in recórd, because that accent is the IPA symbol for high tone and confusion can ensue.

On the other hand, many languages have much more predictable stress patterns – here stressed and unstressed syllables are like allophones, and the phonological grammar determines which one is chosen in each location of the word. Predicting the placement of stress involves many moving parts, but it will be crucial to the child data we will look at. (Notably, English falls somewhere in the middle of this stress continuum – with no purely contrastive stress or minimal pairs, but far from a purely predictable stress pattern either – making its acquisition all the more complicated.)

So what are the properties involved in predicting stress? First, stress is almost always an ‘edge-oriented’ phenomenon. In some languages this is very obvious: look at these representative words from Persian (an Indo-Aryan language spoken in Iran) and Hungarian (Ugro-Finnic) and describe their stress pattern:

(16)

| Persian stress (data adapted from Windfuhr, 1997) | | | |
|---|---|---|---|
| dæst | *hand* | of'tad | *fell* |
| dæs'tɛ | *handle, bunch* | ofta'dɛ | *fallen* |
| mærda'nɛ | *manly, men's* | kɛ'tab | *book* |
| sæb'zi | *greenness, vegetables* | kɛtab'ha | *books* |
| di'gær | *other (adj.)* | ruzna'mɛ | *newspaper* |
| digæ'ran | *others* | haftɛ'gi | *weekly* |

(17)

| Hungarian stress[14] | | | |
|---|---|---|---|
| ['ʃaːrgɒ] | *yellow* | ['tɛlihold] | *full moon* |
| ['ɛrdøː] | *forest* | ['tyːzoltoːʃaːg] | *fire department* |
| ['tørveːɲeʃ] | *legal* | ['pɒrɒditʃom] | *tomato* |
| ['pɒlotɒ] | *castle* | ['eːksiːnkeːk] | *sky blue* |
| ['ʃyːrgøːʃ] | *urgent* | ['øsːɛkøtːɛteːʃ] | *connection* |

Describing the location of surface stress in these languages is easy: every initial syllable is stressed in Hungarian, while every word-final syllable is stressed

[14] Data from M. Molnar, p.c.

in Persian.[15] But this is a much broader pattern: generally, word edges are the most likely place for stress to occur. As we will see in Chapter 2, the edge-oriented property of stress also turns out to be very crucial to how infants learn to parse out new words from fluent speech. As we have already seen, though, English stress is not so well behaved as Persian or Hungarian: the noun *record* looks like it follows the Hungarian pattern, and the verb *record* seems to follow the Persian pattern.

There are also many languages with more than one stress per word (called *iterative* stress); English is definitely such a language, and in longer words we can begin to see more predictable patterns to our stress-assigning phonology. Here are two fairly long words: *Mississippi* and *onomatopoeia*. Determine how many syllables each one has, and which ones get stressed. If you are not convinced you're doing it right, imagine the word was your pet's name, and you were trying to call him or her back to you from very far away. What syllable would you sing out the longest? That one is definitely stressed. So, for example: 'MississIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIpi!'

Here are the full words with their stressed syllables marked in IPA. (For the moment we are using the primary stress mark on every stressed syllable ˈσ, but we will refine this soon.)

(18) [ˈmɪ.sɪ.ˈsɪ.pi] [ˈɑ.nə.ˈmæ.tɪ.ˈpi.jə]

Think about some other English words with the stress pattern as Mississippi: *Alabama*, *Aberystwyth*, *coronation*, *elemental*, *institution*, *influential*, *margarita*, *perturbation*, *sentimental*; something similar is found in *alligator*, *helicopter*, *elevator*, *Halliburton* and *Tonypandy*. Words with six syllables are rather less common – and those that follow the pattern of *onomatapoeia* are place names, such as *Apalachicola*.

This stress pattern could be worded many different ways, but one description is that every *odd* syllable is stressed: that is the first, third, fifth syllable and so on. It turns out that this *alternating* stress pattern is derived from the interaction of more basic constraints – and those constraints are crucial to how children build up early words with many syllables, so let us delve into them a little closer.

To see how English iterative stress might be constructed, we turn to two languages that you have probably never heard of. First look at the stress

[15] In fact, the placement of Persian stress is a little more complicated because 'phrasal' stress, for example in the vocative, can overrule stress in the first word of a phrase, and certain functional morphemes are stressless; see discussion in Windfuhr (1997). For recent discussion and argumentation about Hungarian stress, see Blaho and Szeredi (2011).

pattern of Garawa (a language native to northeastern Australia) – what generalizations can you make?

(19)

| Garawa (data from Furby, 1974) | |
|---|---|
| ['ja.mi] | *eye* |
| ['wat.jim'pa.u] | *armpit* |
| ['ja.ka'la.ka'lam.pa] | *loose* |
| ['am.pa'la.in'mu.kun'ji.na] | *at our many* |

These words contain two, four, six and eight syllables, and each word bears stress on the first, third, fifth, seventh syllables … and so on. Now examine stress in a completely unrelated language, Tiriyó (a Cariban language spoken in Brazil and Surinam):

(20)

| Tiriyó (data from Meira, 1998) | | | |
|---|---|---|---|
| pɑ'wɑːnɑ | *friend* | [ə'kəːrə'puːkə] | *species of otter* |
| pɑ'koːro | *house* | [i'kɑːpu'ruːtu] | *cloud* |
| i'jɑːrɑ'mɑːtɑ | *his/her chin* | [a'poːto'mɑːtɑ'təːkə] | *you all help!* |
| [ɑ'mɑːtɑ'kɑːnɑ] | *species of toucan* | | |

Here we see words with three, five and seven syllables, with stresses on the second, fourth and sixth syllables![16]

Although they differ from English dramatically in other ways, Garawa and Tiryó phonology show a commonality in their stress patterns: syllables generally alternate strong, then weak, then strong and so on. In other words, all three languages' phonologies use *rhythmic* stress – and this turns out to be a very common pattern.

So why is iterative stress rhythmic? The guiding idea we will use here is that syllables are grouped into a prosodic unit made up of two syllables, called a *foot*, and that it is actually these *feet* that receive stress. Each foot is rhythmically asymmetric: if it is weak-strong it is an *iamb*; if it is strong-weak it is a *trochee*.[17] With these assumptions, Garawa builds trochees, and Tiriyó builds iambs.

[16] For what happens in Garawa words of odd-numbered syllables, or Tiriyó words of even-numbered syllables, see Hayes (1995) and many references therein.

[17] You may remember these terms from a poetics class – for example, the term *iambic pentameter* describes the rhythm of Shakespeare's poetry, with five iambs (i.e. weak-strong feet) per line.

When we represent phonological string with foot structure, we use parentheses to group syllables together regardless.

(21) [(ˈmɪ.sɪ).(ˈsɪ.pi)] [(ˈɑ.nə).(ˈmæ.tɪ).(ˈpi.jə)]

We can now finally say something more predictable about English – that it must build *trochees*. If the grammar were building iambs, they would be stressed like [(mɪ.ˈsɪ)(sɪ.ˈpi),] which most English speakers find hard even to pronounce reliably.

Now let's go back to a different type of predictable but *non-iterative* stress pattern: Dakota (a Siouan language spoken in the Midwestern US and Canada), and Polish. Where does the *main* or *primary* stress fall in these two languages? (As before, main stress is marked with the superscript [ˈ]; we now include *secondary* stress with a subscript [ˌ] before the target syllable.)

(22)

| Dakota (data from Shaw, 1985; Kyle, 1994) | | | |
|---|---|---|---|
| wakˈsa | *he cut it (absolutive)* | waˈmijetʃiksa | *you cut it for me* |
| waˈkiksa | *he cut his own* | waˈwitʃʰajetʃiksa | *you cut it for them* |
| waˈkitʃiksa | *he cut it for him* | waˈwawitʃʰajetʃiksa | *you cut something for them* |
| waˈjetʃiksa | *you cut it for him* | | |

(23)

| Polish: (data from Newlin-Łukowicz, 2012: 273, 275 see also Rubach and Booij, 1985)[18] | | | |
|---|---|---|---|
| ˈdvujka | *two* | rɛˈpɔrtɛr | *reporter (nominative)* |
| ˈdvutakt | *two-stroke (engine)* | ˌrɛpɔrˈtɛra | *reporter (genitive)* |
| lisˈtɔvnɨ | *letter (adjectival)* | ˌrɛpɔrtɛˈrɔvi | *reporter (dative)* |
| lisˈtɔnɔʃ | *mailman* | ˌzaraˌpɔrtɔˈvanɨ | *report (past part. nom.)* |
| ɔˈɕɛmsɛt | *eight hundred* | ˌzaraˌpɔrtɔvaˈnɛmu | *report (past, dative)* |

[18] Exceptions to this stress pattern appear in a small set of borrowings, and words with a conditional suffix; see Newlin-Łukowicz (2012).

These two languages, like many pairs we have seen, appear as mirror images of each other: Dakota is consistently stressed on its second syllable, and Polish's main stress falls on its second last (or *penultimate*) syllable.

Our reason to focus on these two patterns is their edge-orientations: across languages, predictable non-iterative stress is nearly always on the syllable at the edge of a word, or one syllable in from the edge. Can you explain that pattern more insightfully by making reference to feet? Try to do so in your own words before reading on.

* * *

To summarize thus far: we have seen three dimensions of difference between stress patterns. The first is which edge of the word feet (and therefore stressed syllables) are built. A second difference is between iterative and non-iterative systems, which we might think of as whether or not the grammar continues stacking up more feet after the first one. A third difference is what kind of foot the grammar builds: building a trochee at the right edge or an iamb at the left edge will result in stress on the second or second-last syllable, as in Dakota or Polish.[19]

We will need to understand one other crucial dimension along which stress system differ: the fact that not all feet contain two syllables. Below are some words from Hopi (a Northern Uto-Aztecan language of Arizona), whose main stress pattern involves a foot built at the left edge of the word. But the precise location of stress varies: sometimes the first syllable is stressed, and sometimes the second. Figure out the pattern that predicts which of the first two syllables are stressed before reading on.

(24)

| | Hopi stress (Whorf, 1946; Hayes, 1981: 77–79)[20] | | | | |
|---|---|---|---|---|---|
| a) | ˈtuː.van.gu | *usually throws* | b) | i.ˈta.mu.mi | *towards us* |
| | ˈiː.sa.wuj | *coyote* | | hi.ˈmut.ski | *shrub (nom.)* |

*Continued*

[19] A crucial note: we also find languages that frequently stress the third-last syllables, and occasionally the third-last alone. One common understanding of this pattern is that it combines the desire to stress the second last syllable of the 'available' syllables, so to speak, combined with a pressure to not stress the last syllable – this is in fact the case with four syllable words in Tiriyó as in (20). For more on this, see especially Hayes (1995).

[20] This data has been simplified with regards to what happens when the word has only two syllables; see Hayes (1995: 261).

| | | | | | |
|---|---|---|---|---|---|
| | ˈat.kja.miq | *all the way to the bottom* | | i.ˈta.muj | *we/us* |
| | ˈpaː.hut | *spring water* | | kaˈwajo | *horse* |
| | ˈas.kwa.li | *thank you* | | nuˈvakwahu | *eagle* |

The deciding factor is the shape of the word's first syllable. When the word begins with CV or V, stress falls on the second syllable (24a), just as in every word of Dakota in (22). This makes it look like the language is building an iamb at the left edge of the word. But when the word begins with CV: or CVC (24a), stress falls on the first syllable. It therefore appears that the longer syllables CV: or CVC are making up a foot *all on their own*. In languages like Hopi (and many others), syllables are divided into two types, called *heavy* and *light*, with reference to how much segmental material is included in their nucleus and coda (because they pattern together in this and other ways, the nucleus and coda of a syllable are referred to together as the *rime*.) To build a foot in *weight-sensitive* or *quantity-sensitive* languages, you don't need two whole syllables necessarily, just two units of weight. Since Hopi builds iambs, words whose first syllable is *light* (24b) get their stress on the second syllable of a two-syllable foot, (**V**.ˈC**V**) or (C**V**.ˈC**V**). But when the first syllable is heavy (24a), it acts as a foot all on its own and so bears stress: (ˈC**VC**) or (ˈC**VV**).[21]

To finish with edge-oriented stress: compare the stress pattern of *helicopter* and *coronary*. If you underlined their stressed syllables as you did for *Mississippi*, you would still find that all three have two trochees, and yet we feel that their stress is different. Why? *Primary* vs *secondary* stress. To wit:

(25) [(ˌmɪ.sɪ)(ˈsɪ.pi)] vs [(ˈhɛ.lɪ)(ˌkɑp.tɚ)]
[(ˌɑ.nə)(ˌmæ.tɪ)(ˈpi.jə)] [(ˈkʰɔ.ɹɪ)(ˌnɛ.ɹi)]

Again, English seems fairly permissive as to the location of main stress. But many languages are more picky: the Garawa words from (19) are now transcribed with both levels of stress:

(26)

| Garawa, again (data from Furby, 1974) | |
|---|---|
| [ˈja.mi] | *eye* |
| [ˈwat.jimˌpa.u] | *armpit* |

*Continued*

[21] You can't hear that CV: or CVC is stressed on the first or second or anything, because stress is heard across the syllable – we know that the language is iambic only because of how it stresses the CVCV feet. For other properties of trochees vs iambs and quantity-sensitive systems, see Hayes (1995) and many references therein.

| | |
|---|---|
| [ˈja.kaˌla.kaˌlam.pa] | *loose* |
| [ˈam.paˌla.inˌmu.kunˌji.na] | *at our many* |

Now we can see that the main stress always resides on one of the edgemost feet: Garawa's first foot is the main one. This is again a cross-linguistic pattern: for example, the *second* foot is never consistently chosen for main stress.

A final aspect of word-level prosodic patterning that we will consider is a language's smallest possible phonological word, also known as the *Minimal Word*. In some languages a word or a class of words must be at least two syllables long; nothing monosyllabic is grammatical (such is the case for example for verbs in Mohawk, as described in Michelson, 1988). In English, we can get away with one syllable, but not just any one – here are some minimally-small grammatical words, compared to some ungrammatical ones:

(27)

| Some small grammatical and ungrammatical English words | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *bee* | [bi] | *bay* | [bej] | *bit* | [bɪt] | *bet* | [bɛt] | | *[bɪ] |
| *boo* | [bu] | *bow* | [boʊ] | *but* | [bʌt] | *put* | [pʊt] | | *[bʌ] |
| | | | | *bin* | [bɪn] | *Ben* | [bɛn] | | *[bɛ] |
| | | | | *bun* | [bʌn] | *book* | [bʊk] | | *[bʊ] |

The generalization is that to be a one syllable English word, you must have either a coda, or a *long* or *tense*[22] vowel in the nucleus. Why should this be? How do we represent this ban?

The key to seeing how the Minimal Word relates to this section is that most languages can only build up higher prosodic units from smaller units: to build a syllable, you need at least one segment (a nucleus); to build a foot, you need some syllables (on how many see below), and to build a word, you

[22]The featural system of vowels that we built at the beginning of this chapter did not include the feature [+/–tense], though it turns out to be a crucial one in English phonology, at least. There is clearly a phonetic length component to this abstract feature – the vowels that are considered [+tense] and which can hold up a minimal word on their own are all produced with much longer durations in English than their [tense] counterparts. In many English varieties the distinction is usually also one of quality, for example [i] vs [ɪ], but in for example Southern British English varieties the vowels in *ship* and *sheep* can be [i] and [i:] – see for example values in Boersma and Escudero (2001).

need a foot. In languages like Mohawk mentioned above, feet have to contain two syllables – this means that if every word must contain a foot, no word can be just monosyllabic. In English, however, you *can* get monosyllabic words – so it must be the case that English like Hopi is *quantity-sensitive*, and that a single syllable can make up a foot, so long as that syllable's *rime is heavy* (i.e. contains either a coda or a tense nucleus).

## 1.4 Two Conceptual Issues

Now that we have taken a whirlwind tour through some basic aspects of phonology, you know our starting place. If any terms or concepts in the previous section have been completely foreign to you, now is the time to take a break and do some additional reading before continuing (recommendations are made at the end of the chapter). One exception is the notion of using *constraints* to describe phonological pattern. If you are familiar with rules like /p/ → [$p^h$] / # __ V, but not with any notion of constraints to do the work of such rules, don't worry; Chapters 3–5 will get you up to speed. But before we move onto children, two bigger-picture issues need to be addressed.

### 1.4.1 Competence vs Performance

In a previous linguistic class or context, you have probably come across the distinction between linguistic *competence* or knowledge on the one hand, and linguistic *performance*, being all the behaviour reflecting that knowledge, on the other. This textbook treats competence and performance as distinct in the traditional Chomskyian sense, and this text is about learning phonological *competence*. The question is: since competence is something unconscious in our minds, how do we get at it and study it?

The first way is *introspection*, simply asking native speakers or learners for their linguistic intuitions. This on-demand introspection can answer some questions very simply and directly – 'could *bnick* be an English word?' – but is not maximally effective in many contexts. At the very least, requests for introspection or intuitions will not get us closer to answering the question 'does a four month old know that *bnick* could not be a English word?'

A second way might be called pure observation: simply recording everything a native speaker or learner says, in as carefully-observed a context as possible. From there we must make some inferences: perhaps that everything they say represents something(s) they know to be grammatical, and everything they do not say represents something(s) they know to be ungrammatical (or whose ungrammaticality they are not yet sure of). This might also be a very good way of answering some questions – for example, ‘can you pronounce the cluster [bl] in word-initial position?’ or ‘do you understand that a question like “Are you hungry” requires an answer of something like *yes* or *no*?’ – but again, observation is not going to suffice as a method of answering the question ‘do you know that **bnick* could not be an English word?’ And even seeing that you can pronounce ‘cats’ and ‘dogs’ with the right voiced and voiceless final fricative *alternation* does not shed any clear light on whether you or your grammar ‘know’ in any sense that **ca*[tz] could not be an English word.

To access competence – in all learners, but particularly infants and very young children – researchers must use some cunning techniques to determine what is known and what is accidental, and what the nature of that knowledge is. These issues motivate researchers to use a wide range of data collection and experimental methods, many of which we will discuss at the ends of chapters throughout the book. And whenever we examine learning data of any sort, we will always need to consider carefully its methods, and how competence vs performance are being tapped.

### 1.4.2 Perception and Production

Using a phonology is not just about producing the words and segments of your language – it’s also about perceiving them when produced by other people. At some basic level this is very central to studying learning: to acquire your phonology, you listen to other people using theirs, and figure out what they are doing so that someday you can approximate it.

It’s probably already intuitively clear to you that your native language experience affects not only how you produce speech but how you hear it. When hearing people speak a completely foreign language on the radio for instance, it is extremely hard to pick out the words within the stream of speech, and an entire conversation can seem like one big long undifferentiated sound mass. Contrast that with the ease of picking out word breaks in a nonsense poem like *Jabberwocky*[23] – even if you’ve never heard it before, you perceive subtle aspects of English spoken phonology that tell you where one word ends and another begins.

The fact is that your experience with your first language (or languages, and also experience with later ones to some extent), has a tremendous influence on your experience of speech – in a crucial sense you are also a native ‘listener’ of your mother tongue(s). Thus we have to keep in mind that learners are acquiring both, and as you are about to see, phonological acquisition is

[23] Being a poem by C.S. Lewis, which begins ‘Twas brillig, and the slithy toves/ Did gyre and gimble in the wabe: All mimsy were the borogoves/ And the mome raths outgrabe’.

preceded by a lot of perceptual learning. The next chapter introduces you to a wild area of research, pioneered in the 1970s and 1980s and still finding astonishing results in recent years: the area of *infant speech perception*, studying what children can perceive, discriminate and expect about their language(s) long before they have functioning productive phonologies – between birth and up until their second birthday. After reading Chapter 2, you will never look at drooling babies the same way again.

## 1.5 Further Reading

### The International Phonetic Alphabet

(In addition to the full chart on page **28** of this chapter)
An interactive version of the IPA chart with sound files for each sound is available at: http://web.uvic.ca/ling/resources/ipa/charts/IPAlab/IPAlab.htm

### Introductions to phonology, especially to segments and features

Hayes, Bruce. 2009. *Introductory Phonology.* Oxford: Blackwell.
Flynn, Darin. 2012. *Phonology: The Distinctive Features of Speech Sounds.* Ms., University of Calgary. Available at: http://www.ucalgary.ca/dflynn/files/dflynn/flynn12_distinctive_features.pdf
– *this book is all about features, and while they will not always match the specific features adopted in this book, it provides a wealth of data.*

### Other perspectives on and introductions to child phonology

Johnson, Wyn and Reimers, Paula. 2010. *Patterns in Child Phonology.* Edinburgh, Scotland: Edinburgh University Press.
Kiparsky, Paul and Menn, Lise. 1977. On the acquisition of phonology. In John Macnamara (ed.) *Language Learning and Thought*. New York: Academic Press. 47–78.
Rose, Yvan and Inkelas, Sharon. 2011. The Interpretation of Phonological Patterns in First Language Acquisition. In Colin J. Ewan, Elizabeth Hume, Marc van Oostendorp and Keren Rice (eds) *The Blackwell Companion to Phonology.* Malden, MA: Miley-Blackwell. 2414–2438.
Vihman, Marilyn M. 2014. *Phonological Development*. 2nd edition. Oxford: Basil Blackwell.

## Exercises

Q1: As discussed with respect to English vs French nasal vowels: phonemes are language-specific. *What consequences does that have for* *learning? What might a child be able in principle to learn about phonemes and allophones when they don't yet know any words?*

Q2: Let's return once more to the English ban on [tl]. From the exercise at the end of 1.3, you may now realize that it's a ban on [tl] within *onsets,* and from the data in (7) you may have a way of defining a more general ban on stop+liquid sequences that share *place of articulation* (though that doesn't tell us why [tr] and[dr] are ok).

With all this in mind, here are some further questions to answer about this constraint:

*(a) Should our representation of this constraint make reference to the fact that the [l], were it to appear after [t], would be voiceless? Does it make any difference?*

*(b) English also doesn't have any [fw], [zl] or [ðl] clusters in onsets. Can you write a constraint to ban them as well? Can they be subsumed into a more general constraint that will also ban all the problematic clusters in (7)?*

Q3: Here are a few examples of the way Finnish has borrowed some English and French words into its phonology. (Data from Suomi, 2004: 94–95; Suomi, Toivanen and Yitalo, 2008: 71, and Tuuli Morrill, p.c.) Examine how they differ from the originals, and then read the question below:

| Finnish borrowing | English gloss | | Finnish borrowing | English gloss |
|---|---|---|---|---|
| [bɪt:ɪ] | *bit* | | [mɑkɑsɪ:nɪ] | *store* (from French '*magasin*') |
| [hɪt:ɪ] | *hit* | | [mɔ:t:ɔrɪ] | *motor* |
| [pɔp:ɪ] | *pop* | | [kɛtsʊp:ɪ] | *ketchup* |
| [pɪn:ɪ] | *pin* | | [sɔsɛt: ɑ] | *sauce* |
| [fɑnɪ] | *fan* | | | |
| [nɛt:ɪ] | *net* | | | |

*What accounts for the major difference between the first row of Finnish borrowings and their English source words?* One possibility is that these words are too small to meet the Finnish *minimal word* requirement (as discussed in Section 1.3) *If that were so, what might be the size minimum for a Finnish word? And how does the second column support or challenge this explanation?*

## THE INTERNATIONAL PHONETIC ALPHABET (revised to 2005)

CONSONANTS (PULMONIC) © 2005 IPA

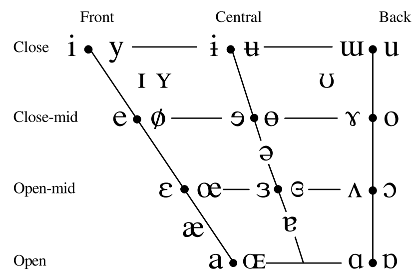
| | Bilabial | Labiodental | Dental | Alveolar | Postalveolar | Retroflex | Palatal | Velar | Uvular | Pharyngeal | Glottal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Plosive | p b | | | t d | | ʈ ɖ | c ɟ | k ɡ | q ɢ | | ʔ |
| Nasal | m | ɱ | | n | | ɳ | ɲ | ŋ | ɴ | | |
| Trill | ʙ | | | r | | | | | ʀ | | |
| Tap or Flap | | ⱱ | | ɾ | | ɽ | | | | | |
| Fricative | ɸ β | f v | θ ð | s z | ʃ ʒ | ʂ ʐ | ç ʝ | x ɣ | χ ʁ | ħ ʕ | h ɦ |
| Lateral fricative | | | | ɬ ɮ | | | | | | | |
| Approximant | | ʋ | | ɹ | | ɻ | j | ɰ | | | |
| Lateral approximant | | | | l | | ɭ | ʎ | ʟ | | | |

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

CONSONANTS (NON-PULMONIC)

| Clicks | | Voiced implosives | | Ejectives | |
|---|---|---|---|---|---|
| ʘ | Bilabial | ɓ | Bilabial | ʼ | Examples: |
| ǀ | Dental | ɗ | Dental/alveolar | pʼ | Bilabial |
| ǃ | (Post)alveolar | ʄ | Palatal | tʼ | Dental/alveolar |
| ǂ | Palatoalveolar | ɠ | Velar | kʼ | Velar |
| ǁ | Alveolar lateral | ʛ | Uvular | sʼ | Alveolar fricative |

VOWELS




Where symbols appear in pairs, the one to the right represents a rounded vowel.

OTHER SYMBOLS

- ʍ Voiceless labial-velar fricative
- w Voiced labial-velar approximant
- ɥ Voiced labial-palatal approximant
- ʜ Voiceless epiglottal fricative
- ʢ Voiced epiglottal fricative
- ʡ Epiglottal plosive
- ɕ ʑ Alveolo-palatal fricatives
- ɺ Voiced alveolar lateral flap
- ɧ Simultaneous ʃ and x

Affricates and double articulations can be represented by two symbols joined by a tie bar if necessary. k͡p t͜s

SUPRASEGMENTALS

- ˈ Primary stress
- ˌ Secondary stress ˌfoʊnəˈtɪʃən
- ː Long eː
- ˑ Half-long eˑ
- ̆ Extra-short ĕ
- | Minor (foot) group
- ‖ Major (intonation) group
- . Syllable break ɹi.ækt
- ‿ Linking (absence of a break)

DIACRITICS Diacritics may be placed above a symbol with a descender, e.g. ŋ̊

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ̥ | Voiceless | n̥ d̥ | ̤ | Breathy voiced | b̤ a̤ | ̪ | Dental | t̪ d̪ |
| ̬ | Voiced | s̬ t̬ | ̰ | Creaky voiced | b̰ a̰ | ̺ | Apical | t̺ d̺ |
| ʰ | Aspirated | tʰ dʰ | ̼ | Linguolabial | t̼ d̼ | ̻ | Laminal | t̻ d̻ |
| ̹ | More rounded | ɔ̹ | ʷ | Labialized | tʷ dʷ | ̃ | Nasalized | ẽ |
| ̜ | Less rounded | ɔ̜ | ʲ | Palatalized | tʲ dʲ | ⁿ | Nasal release | dⁿ |
| ̟ | Advanced | u̟ | ˠ | Velarized | tˠ dˠ | ˡ | Lateral release | dˡ |
| ̠ | Retracted | e̠ | ˤ | Pharyngealized | tˤ dˤ | ̚ | No audible release | d̚ |
| ̈ | Centralized | ë | ̴ | Velarized or pharyngealized | ɫ | | | |
| ̽ | Mid-centralized | e̽ | ̝ | Raised | e̝ | | (ɹ̝ = voiced alveolar fricative) | |
| ̩ | Syllabic | n̩ | ̞ | Lowered | e̞ | | (β̞ = voiced bilabial approximant) | |
| ̯ | Non-syllabic | e̯ | ̘ | Advanced Tongue Root | e̘ | | | |
| ˞ | Rhoticity | ə˞ a˞ | ̙ | Retracted Tongue Root | e̙ | | | |

TONES AND WORD ACCENTS

| LEVEL | | | CONTOUR | | |
|---|---|---|---|---|---|
| e̋ or | ˥ | Extra high | ě or | ˩˥ | Rising |
| é | ˦ | High | ê | ˥˩ | Falling |
| ē | ˧ | Mid | e᷄ | ˦˥ | High rising |
| è | ˨ | Low | e᷅ | ˩˨ | Low rising |
| ȅ | ˩ | Extra low | e᷈ | ˧˦˧ | Rising-falling |
| ꜜ | | Downstep | ↗ | | Global rise |
| ꜛ | | Upstep | ↘ | | Global fall |

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