Element Theory

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Background

- In the preceding classes, we have presented the basic ideas of mainstream autosegmental phonology (or at least of my perception of the mainstream).
- In this class we will take a brief detour into an alternative conception of the internal structure of phonological segments.
- This alternative view, Element Theory, is still based on autosegmental phonology, but it assumes that the phonological primitives which are organized into autosegmental structure are not phonological features, but phonological elements.

1 An alternative model of the vowel system

The aim of this course is to introduce you to the most important ideas in the mainstream of present-day theoretical phonology. It is however not the case that there is absolute uniformity on every point; to the contrary, many points of the theory are still very much debated, and every assumption is questioned from time to time — as it should be, in a serious scientific discipline.

This week, we will sidestep a little bit, and consider an alternative approach to some of the assumptions underlying the work of previous weeks. This is so-called Element Theory as it has been worked out in particular in the framework of Government Phonology (Kaye *et al.*, 1985, 1990; Harris, 1994; Harris & Lindsey, 1995).

Element Theory builds on the foundations of autosegmental phonology. It assumes that phonological structure is built from autosegmental tiers which consist of primitives, which can be associated to primitives on other tiers;

that there is a central line in our representations, called the skeleton or the timing tier; and — at least in some versions of Element Theory —, that there is some sort of feature geometry. The big difference with the mainstream approaches we have seen so far, and presumably also in your introductory class to phonology, is in what are considered to be the primitive elements on those tiers. For Element Theory these are not phonological features, but phonological elements.

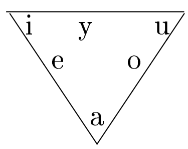
An important difference between elements and features is that the latter cannot be pronounced. A feature such as [labial] does not correspond to any single phonetic event in isolation; we always need to build a segment with many other features in order to produce it. Elements on the other hand, can be independently pronounced.

Most vowels in the world's languages, for instance, will consist of the elements |A|, |I| and |U| in some constellation. (We will concentrate in this class on the phonology of vowels, because this is what a large amount of work within this framework has been devoted to; this is not to say that the theory has not been applied to consonants as well, however.) Elements are usually spelled with a capital letter, and they are placed between || in order to distinguish them from features and phonological or phonetic strings of segments. Each of these elements can be pronounced in isolation:

(1) a. |A| is pronounced as [a]
 b. |I| is pronounced as [i]
 c. |U| is pronounced as [u]

Other vowels can be analysed as a combination of one or more of these basic, most primitive elements — it is of course not a coincidence that these correspond to the three angles of the vowel triangle:

(2)



For instance, in a typical five vowel system we will have the following combinations.

(3) a. The combination |A|•|I| (or |I|•|A|) is pronounced as [e]
 b. The combination |A|•|U| (or |U|•|A|) is pronounced as [o]

The order in which we present the combinations of features is of course irrelevant: it does not matter whether we write |X|•|Y| or |Y|•|X|, since both refer to the same autosegmental representation.

The combination $|U|\bullet|I|$ will be typically pronounced as [y], and the mid front rounded vowel [ø] would consist of the combination $|U|\bullet|I|\bullet|A|$. The system is built on the typological observation that three vowel systems usually occupy the three corners of the vowel triangle. All other vowels are typologically more 'marked': they exist in fewer languages.

This observation cannot be expressed directly in a theory which uses binary features. All vowels have equal formal complexity in such a system; if we want to express that /u/ and /a/ are each less complex than /o/, we need to set up some extra mechanism which ensures, for instance, that [-high,-low] is more marked than [αhigh,-αlow]. Similarly, it is not part of the formal system of ordinary feature theory that [+high,+low] vowels do not exist. This is something which just needs to be stipulated, or derived from the phonetic impossibility to derive such vowels. Within Element Theory, the whole option does not arise, and the theory therefore seems more restrictive.

Notice, on the other hand, that Element Theory does not provide us with an answer to the question why [e] and [o] are typologically much more frequent than [y], and why the latter often behaves as a more marked vowel in languages which have it. As already noted, it is standardly assumed that elements are organized on autosegmental tiers. The whole issue of feature geometry arises again in this connection, but for ease of exposition we will use a bottle-brush model in this class:

(4)
$$\begin{array}{ccccc} & & |A| & & \\ & & | & & \\ |I| & — & x & — & |U| \end{array}$$

We could assume that in languages which do not have front rounded vowels such as [y] or [ø], I and U are present on the same tier rather than on different tiers, so that they cannot be simultaneously realized. In languages with a three vowel system, all vocalic elements would be present on the same tier. (But this still does not explain the asymmetry between the marked $|I|\bullet|U|$ and the less marked $|I|\bullet|A|$.)

A popular metaphor of elements in the phonological literature is with colours. We only need the three primary colours *red, yellow*, and *blue* (or *red, green* and *blue*) to produce all other colours by mixing them in the appropriate quantities. In the same way, we can derive (almost) all vowels from the three elements.

2 The vowel system of Dutch

At first sight, the theory might seem obviously too restrictive. Given three elements, we can only derive six vowels — the ones we have just mentioned. But many languages have many more vowels. For instance, Dutch has 13 vowels (not counting the three diphthongs and some vowels which only occur in loanwords):

(5) i, y, u, e, ø, o, a, ɪ, ɛ, œ, ɔ, ɑ, ə

We cannot go into all the complications of the Dutch vowel system, but we can illustrate some of the strategies within Element Theory. In the first place, in our colour analogy, we mentioned that we can mix colours in the appropriate quantities.

For phonological elements, we can express this by introducing the notion *headedness*. When we combine two linguistic elements — two words in a syntactic phrase, two morphemes in a word, two syllables in a stressed unit, etc. — we can always give a special status to one of them: this one is the head. We can now extend this idea to phonological elements: if we combine them, we can assign the head status to one of the two. This doubles our representational possibilities. If we have a combination of two elements $|X|\bullet|Y|$, we can distinguish between $|\underline{X}|\bullet|Y|$ and $|X|\bullet|\underline{Y}|$, where the underlining denotes the headedness. Thus we get the following distinctions within the realm of mid vowels:

(6) a. The combination $|A|\bullet|\underline{I}|$ is pronounced as [e]
b. The combination $|\underline{A}|\bullet|I|$ is pronounced as [ɛ]
c. The combination $|\underline{A}|\bullet|U|$ is pronounced as [ɔ]
d. The combination $|A|\bullet|\underline{U}|$ is pronounced as [o]

The phonetic interpretation of headedness might appear obvious: [ɛ] and [ɔ] are lower than their counterparts, therefore they are more |A|-like, and they have this element as their head. The head of a segment thus is the one which has the strongest influence on the phonetic result.

The result obtained so far works very nicely for the many languages which have a seven-vowel system: they usually have the four vowels in (6), next to the three primary vowels of course. We are then still assuming a system in which |I| and |U| cannot be easily combined; notice, by the way that Swedish is a language which distinguishes between two front rounded vowels, and thus features a headedness distinction in $|I|\bullet|U|$ combinations.

However, this is certainly not sufficient for Dutch, since this language still has almost twice as many as seven vowels. A solution here comes from the study of one of these, the schwa ([ə]). This vowel is hard to describe in terms of the elements we have seen so far: it is the central vowel, right in the center of the vowel triangle and from an articulatory point of view it is 'targetless': it does not seem to involve the active use of any specific supralaryngeal articulatory organ.

Although we should be very careful in introducing new phonological elements — because that would run against the spirit of the program, which requires us to be as restrictive as possible — the special behaviour of schwa seems to warrant the introduction of a new element, |@| (the @ sign is sometimes used as an alternative to 'ə' in cases where the latter is not available, e.g. in e-mail conversation between phonologists).

|@| is special because it behaves like the identity element in the calculus of vowels. Since it is targetless, it does not have any effect on the realisation of the vowel.

(7)
a. $\vert\underline{\mathrm{A}}\vert\bullet\vert @\vert = \vert\mathrm{A}\vert$
b. $\vert\underline{\mathrm{I}}\vert\bullet\vert @\vert = \vert\mathrm{I}\vert$
c. $\vert\underline{\mathrm{I}}\vert\bullet\vert\mathrm{A}\vert\bullet\vert @\vert = \vert\mathrm{I}\vert\bullet\vert\mathrm{A}\vert$
d. ...

Addition of the schwa at first sight does not make our system much more powerful, but there is one escape hatch: it may be possible to extend the notion of headedness also to structures with a schwa. If schwa is the head of a combination, it does have influence on the interpretation: it **centralizes** it, it draws it into the inside of the vowel triangle. This seems to give a proper description of the difference between e.g. [i] and [ɪ] or [a] and [ɑ].

We can now give the following matrix of possibilities:

(8)

$\vert\mathrm{A}\vert$	[a]	$\vert\mathrm{I}\vert$	[i]	$\vert\mathrm{U}\vert$	[u]
$\vert\mathrm{A}\vert\bullet\vert\underline{@}\vert$	[ɑ]	$\vert\mathrm{I}\vert\bullet\vert\underline{@}\vert$	[ɪ]	$\vert\mathrm{U}\vert\bullet\vert\underline{@}\vert$	✘
$\vert\mathrm{A}\vert\bullet\vert\underline{\mathrm{I}}\vert$	[e]	$\vert\mathrm{A}\vert\bullet\vert\underline{\mathrm{U}}\vert$	[o]	$\vert\mathrm{I}\vert\bullet\vert\underline{\mathrm{U}}\vert$	[y]
$\vert\underline{\mathrm{A}}\vert\bullet\vert\mathrm{I}\vert$	[ɛ]	$\vert\underline{\mathrm{A}}\vert\bullet\vert\mathrm{U}\vert$	[ɔ]	$\vert\underline{\mathrm{I}}\vert\bullet\vert\mathrm{U}\vert$	✘
$\vert\mathrm{A}\vert\bullet\vert\mathrm{I}\vert\bullet\vert\underline{@}\vert$	✘	$\vert\mathrm{A}\vert\bullet\vert\mathrm{U}\vert\bullet\vert\underline{@}\vert$	✘	$\vert\mathrm{I}\vert\bullet\vert\mathrm{U}\vert\bullet\vert\underline{@}\vert$	✘
$\vert\mathrm{I}\vert\bullet\vert\underline{\mathrm{U}}\vert\bullet\vert\mathrm{A}\vert$	[ø]	$\vert\underline{\mathrm{I}}\vert\bullet\vert\mathrm{U}\vert\bullet\vert\mathrm{A}\vert$	✘	$\vert\mathrm{I}\vert\bullet\vert\mathrm{U}\vert\bullet\vert\underline{\mathrm{A}}\vert$	✘
$\vert\mathrm{I}\vert\bullet\vert\mathrm{U}\vert\bullet\vert\mathrm{A}\vert\bullet\vert\underline{@}\vert$	[œ]	$\vert @\vert$	ə		

The crosses ✘ in this table denote segments which could be produced given the combinatory rules but for which we do not have evidence for there being an independent segment (note that we have rather arbitrarily assigned the head status in some combinations of elements). We could try to find some reason for why certain combinations are lacking — maybe there is some reason why |U| always needs to be a head when it combines with |I|, or why |@| does not seem to be the head in complex expressions (except, strikingly, the most complex one of all: $\vert\mathrm{I}\vert\bullet\vert\mathrm{U}\vert\bullet\vert\mathrm{A}\vert\bullet\vert\underline{@}\vert$).

Be this as it may, we still predict 20 possibilities by the formal system alone, while we find only 13. However, if we compare this to a standard feature theory of the same inventory, this fares relatively well. Within such an analysis, we would need the following five features for Dutch: [±back], [±round], [±tense], [±high], [±low]. Since all these features are binary, we have $2^5 = 32$ logical possibilities. The element model thus gives a thighter fit to the data.

3 Vowel reduction

In many languages of the world, there is an interesting difference between stressed and unstressed positions of the word: in stressed positions we usually find a larger number of phonological contrast, which is **reduced** in unstressed position. In Bellorussian, we find {i, u, e, o, a} in stressed syllables, but only {i, u, a} in unstressed position (Crosswhite, 2001; Harris, 2005). This distributional preference is also responsible for alternations: if an /o/ or /e/ ends up in an unstressed position, it will be reduced to [a]:

(9)

stressed	*unstressed*
nóɣi 'legs'	*naɣá* 'leg'
kól 'pole NOM'	*kalá* 'pole GEN'
vʲósnɨ 'spring GEN'	*vʲasná* 'spring NOM'
ʃépt 'whisper'	*ʃaptátsʲ* 'to whisper'
klʲej 'glue'	*klʲajónka* 'oil-cloth'

This type of reduction can be called 'centrifugal': the vowels move to the corners of the vowel triangle when they do not carry stress. It can be opposed to 'centripetal' vowel reduction, in which all the vowels seem to move to the center of the vowel triangle in exactly the same metrical environment. An example is (informal) Dutch, in which any kind of unstressed vowel can be reduced to schwa — the difference with Bellorussian is that the process is optional in Dutch, but that is immaterial to our present discussion.

(10)

formal	*informal*
fonologie 'phonology' [fònoloɣí]	[fònələɣí]
minuut 'minute' [minýt]	[mənyt]
kantoor 'office' [kɑntɔ́ːr]	[kətɔ́ːr]

The distinction between 'centrifugal' and 'centripetal' is not very strong in natural language. Some languages show both processes. For instance, Catalan /i, e, a/ reduce centripetally to [ə], whereas /ɔ, o/ reduce centrifugally to [u] (and /i, u/ do not reduce at all):

(11)

stressed	*unstressed*
sérp 'snake'	*sərpəntí* 'winding'
pɛ́l 'hair'	*pəlút* 'hairy'
gát 'cat'	*gətɛ́t* 'kitten'
λúm 'light'	*λuminós* 'luminous'
gós 'dog'	*gusɛ́t* 'puppy'
pɔ́rt 'port'	*purtuári* 'of the port'

How can we understand these processes, and the fact that together they seem to give a fairly complete catalogue of vowel reduction phenomena in languages of the world? This is hard to see if we consider these facts from the point of view of binary features; we would need to assume that there are processes such as those in (12a), but not such as those in (12b):

(12) a. i. $\begin{bmatrix} \text{-back} \end{bmatrix} \rightarrow \begin{bmatrix} \text{-round} \\ \text{-high} \\ \text{-low} \\ \text{-tense} \end{bmatrix}$ in unstressed syllables

(centripetal reduction of front vowels to [ə])

ii. $\begin{bmatrix} \text{-back} \end{bmatrix} \rightarrow \begin{bmatrix} \text{-round} \\ \text{+high} \\ \text{-low} \\ \text{+tense} \end{bmatrix}$ in unstressed syllables

(centrifugal reduction of front vowels to [i])

b. $\begin{bmatrix} \text{-back} \end{bmatrix} \rightarrow \begin{bmatrix} \text{+round} \\ \text{+high} \\ \text{-low} \\ \text{-tense} \end{bmatrix}$ in unstressed syllables

(turning front vowels to [o])

Within Element Theory, on the other hand, it is very easy to see what is going on. All reduction processes are an instance of the following:

(13) An unstressed vowel is not allowed to carry more than one element; delete elements if necessary.

What is more, (13) itself can be understood as a sensible restriction on phonological structures. In an intuitive sense, unstressed syllables are less prominent than stressed ones. This will be formalized — later on in this course — as another headedness relation: stressed syllables are heads, unstressed syllables are not heads. Harris (2005) equals vowel reduction to 'information loss': unstressed positions can carry less information than other positions.

Centrifugal reduction now leads to one of the primary elements |I, U, A|; centripetal reduction leads to |@|. Notice that we still need to build an asymmetry into our system: /i, a, u/ may reduce in some languages to [ə], but /ə/ will never reduce to any other vowel, not even a simple one. This should of course have some relation to the fact that [ə] is the 'identity element'. The fact that |F|=|F|•|@| means that in some sense |@| is part of all vowels, but inversely, none of the primary vowel elements are part of [ə]. The fact that schwa is the targetless vowel makes it the one which carries the smallest amount of information — hardly any at all.

We have to note here that some of the properties which make Element Theory relatively succesful in areas such as these, have also been built into the mainstream feature-based models. For instance, many feature phonologists no longer assume that all features are binary: in the past classes we have seen, for instance, that it makes sense to see final devoicing as the loss of a feature [voice] rather than as a change [+voice]→[-voice]. We may similarly see at least centripetal reduction as the loss of features, and schwa as an empty vowel (e.g. a bare vocalic root node [-cons] without any other features attached to it). It will be hard, or even impossible, however, to see centripetal reduction in the same way.

Feature theory has many other virtues, and is therefore an important topic for any student of phonology. We will continue to use this theory, rather than Element Theory, as the background for the following classes. It is important, however, to realize, that fruitful alternatives exist to many of our key assumptions.

Bibliography

Crosswhite, Katherine (2001). *Vowel Reduction in Optimality Theory*. New York: Routledge.

Harris, John (1994). *English Sound Structure*. London: Blackwell.

——— (2005). 'Vowel reduction as information loss'. In: Carr, Philip, Jacques Durand, & Colin Ewen (eds.), *Headhood, Elements, Specification Headhood, Elements, Specification and Contrastivity. Phonological Papers in Honour of John Anderson*, pp. 119–132. Amsterdam: John Benjamins. URL `http://www.phon.ucl.ac.uk/home/johnh/papers/HarrisJAFest10.pdf`.

Harris, John & G. Lindsey (1995). 'The Elements of Phonological Representation'. In: Durand, Jacques & Francis Katamba (eds.), *Frontiers of Phonology*, pp. 34–79. London and New York: Longman.

Kaye, Jonathan, Jean Lowenstamm, & Jean-Roger Vergnaud (1985). 'The internal structure of phonological elements. A theory of charm and government'. *Phonology Yearbook*, 2: 305–328.

——— (1990). 'Constituent structure and government in phonology'. *Phonology*, 7: 193–232.