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Monophthongization and Diphthongization in Precedence-Free Phonology*

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ABSTRACT. In phonological studies, rules for describing monophthongization and diphthongization (Spread right/left) typically refer to directionality which is based on precedence relations between phonological categories such as CV units or X slots. This paper, on the other hand, analyses the processes by referring to the head-dependency relations in the context of Precedence-free Phonology (Nasukawa 2014, 2015 ab, this volume).

Keywords: Precedence-free Phonology, elements, head-dependency relations, monophthongization, diphthongization

1. Elements as the basic building blocks of phonological architecture

In phonology, it has been acknowledged that the categories for building structures are segments (in formal terms, CV units, X slots or Root nodes) which are not minimally contrastive categories. The minimal categories are usually thought to be phonological features, not segments (or CV units). This is a significant point that makes phonological representations different from syntactic ones. In morpho-syntactic studies, the categories employed for building structures are morphemes, which are regarded as minimal contrastive categories in their respective domain.

Unlike mainstream models of phonological representation, the precedence-free approach to phonological architecture developed by Nasukawa (2014, 2015ab) eliminates phonological categories (such as CV units, X slots and Root nodes) which carry properties associated with precedence relations. Instead, phonological *features* are regarded as the basic building blocks of phonological structure. This view contrasts with mainstream models of phonological representation, in which features are considered to be the inherent properties of segment-sized units and it is these segments (or CV units) that are taken to be the basic categories of phonological structure.

In the Precedence-free model, on the other hand, features perform the function not only of CV units but also of prosodic constituents: a feature functions as the head of a structural expression, and by adding another feature to this head feature a complex expression is constructed. The phonological shape of a morpheme is assumed to be formed by recursive operations of this kind. The feature model which uses primitives which are not

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structurally-fixed and which may concatenate freely is the version of Element Theory developed by Nasukawa (2014, 2015ab), in which each feature or element is single-valued and is able to exist without support from the other primitives. Therefore, unlike in models of Feature Geometry (Sagey 1985, McCarthy 1988), elements can combine freely with one another.

Like most types of features, elements are strictly linguistic in nature and are reckoned to be mental objects that emerge through the observation of phenomena. However, a crucial difference between elements and distinctive features is their reference to phonetic exponence. In theories employing distinctive features, for example, the phonetic exponence of features is concerned primarily with speech production rather than perception. By contrast, Element Theory (Harris and Lindsey 2000, Nasukawa and Backley 2008) rejects this production-oriented view in favour of a perception-oriented view along the lines of the work of Jakobson (Jakobson, Fant and Halle 1952, Jakobson and Halle 1956). Unlike the production-oriented approach, the perception-based approach to features successfully captures some important generalizations such as the correlation between labials and velars: they are linked in acoustic terms by a similar 'dark' spectral pattern (Backley and Nasukawa 2009). In addition, the perception-based approach is able to account for a stage on the acquisition path where infants begin to build mental representations for their native lexicon on the basis of perceiving adult inputs.

In Element Theory (Nasukawa and Backley 2008, Backley 2011), melodic structure is represented employing the following six single-valued elements, which are assumed to be active in all languages.

(1) Typical acoustic exponence of elements (Nasukawa 2015a, cf. Harris 2005, Harris and Lindsey 2000, Nasukawa and Backley 2008, Backley and Nasukawa 2009, Backley 2011)

	label	*spectral shapes*
|A|	'mass'	mass of energy located in the center of the vowel spectrum, with troughs at top and bottom
|I|	'dip'	energy distributed to the top and bottom of the vowel spectrum, with a trough in between
|U|	'rump'	marked skewing of energy to the lower half of the vowel spectrum
|ʔ|	'edge'	abrupt and sustained drop in overall amplitude
|H|	'noise'	aperiodic energy
|N|	'murmur'	broad resonance peak at lower end of the frequency range

These elements appear in both consonants and vowels. The different phonetic categories associated with each element are given in (2).

(2) The phonetic manifestation of elements (Nasukawa 2014, Nasukawa and Backley 2008)

	label	*manifestation as a consonant*	*manifestation as a vowel*
|A|	'mass'	uvular, coronal POA	non-high vowels
|I|	'dip'	palatal, dental POA	front vowels
|U|	'rump'	labial, velar POA	rounded vowels
|ʔ|	'edge'	oral or glottal occlusion	creaky voice (laryngealised Vs)
|H|	'noise'	aspiration, voicelessness	high tone
|N|	'murmur'	nasality, obstruent voicing	nasality, low tone

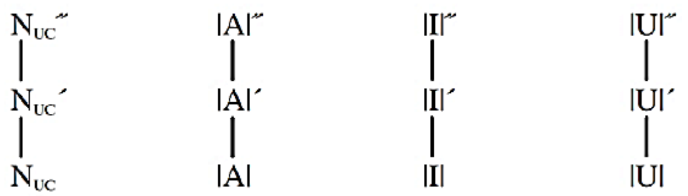
The first three elements |A I U| may be grouped together as resonance elements because they are typically associated with vocalicness and prosodic phenomena in vowels, and because they also express the resonance (place of articulation or POA) properties of consonants. The remaining three elements |ʔ H N| refer to non-resonance properties such as occlusion, aperiodicity and laryngeal-source effects.

2. |A I U| as the head of the vowel expression

In Precedence-free Phonology (Nasukawa 2015ab), it is elements (minimal contrastive units) rather than syllabic constituents which are regarded as the building blocks of phonological structure. Since the nucleus—which phonetically manifests itself as a vowel, and as such, constitutes the obligatory part of a word—is taken to be the structural head in orthodox models, it is natural to assume that one of the resonance elements |A I U| (which show an affinity for the syllable nucleus) should function as the head of the domain (Harris and Lindsey 1995, 2000; Nasukawa and Backley 2008).

On this basis, one of the resonance elements must determine the quality of an empty nucleus: as an acoustically weak form, |A| is phonetically realized as *ə* in English, |I| as *i* in Cilungu and |U| as *ɯ* in Japanese. In this framework, then, |A|, |I| or |U| serves as the head of any nuclear expression in English, Cilungu and Japanese respectively. This allows us to explain why the central vowel is usually chosen from only three possibilities, rather than five or six. On this basis, the empty nucleus is replaced by the following three types of X-bar structure.

(3) a. empty NUC b. *ə* c. *i* (*ɨ*) d. *ɯ*

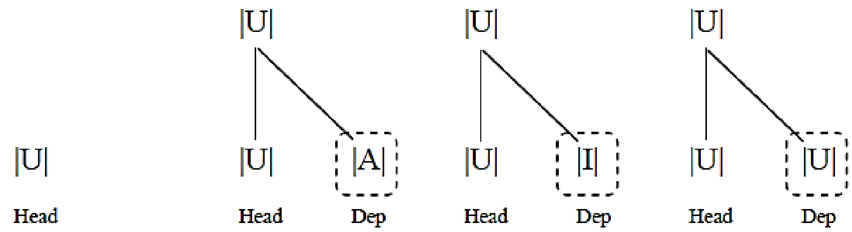


If a structural expression is formed by the single element |A|, then, it is phonetically interpreted as *ə*, as in (3b). This is the case in English, French, Dutch and German. In Cilungu and Yoruba, an ‘empty’ nucleus (in the traditional sense) is replaced by a sole |I|. And in Japanese, it is |U| that takes the place of an empty nucleus. Accordingly, depending on the choice of head element (the foundation of the structure), languages are divided into three types in terms of the quality of the head element: |A|-type (*ə*), in |I|-type (*i*) and |U|-type (*ɯ*).

Taking Japanese as an example, Nasukawa (2015b) demonstrates how the five-vowel system is represented. The structure in (4a) is the representation of the Japanese vocalic baseline (a single |U|) which defines the phonetic quality of the default epenthetic vowel (*ɯ*).

(4) Element representations of vowels in Japanese

a. *ɯ* b. *a* c. *i* d. *u* (*ɯ*)



In addition, this baseline may also have a dependent element, its acoustic pattern being superimposed on to the acoustic pattern of the baseline. Accordingly, the dependents |A| in (4b), |I| in (4c) and |U| in (4d) all exhibit acoustic patterns with greater prominence than those of their baseline |U| (the head of the whole structure). Note that there is no phonetic difference between (4a) and (4d). Phonologically, however, they behave differently: the former (4a) (which is insensitive to phonological processes) is restricted to verb endings and to inter-consonantal and post-word-final consonantal positions in the nativization of loanwords, whereas the latter (4d) appears in other contexts.

The above relation between structural head-dependency and phonetic prominence is attributed to an argument developed by Nasukawa and Backley (2015).

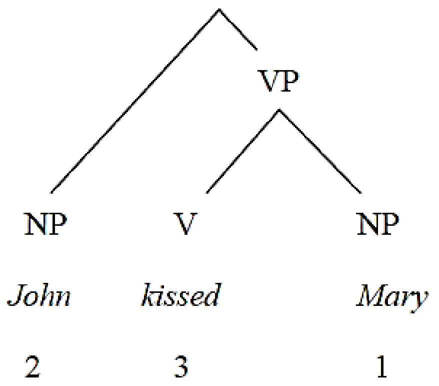
(5) The relation between structural head-dependency and phonetic prominence

a. Heads: important and unmarked for structure-building but phonetically less prominent

b. Dependents: unimportant for structure-building but phonetically more prominent

The same relation between structural head-dependency and phonetic prominence is found in other modules of the grammar. In syntax, for example, the default pattern of stress assignment in the verb phrase [kissed Mary] of [John [$_{\text{VP}}$ kissed Mary]] indicates that the complement (dependent) of the verb phrase [Mary] is phonetically more prominent than the head [kissed].

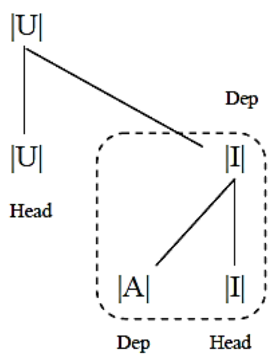
(6) [John [$_{VP}$ kissed Mary]]



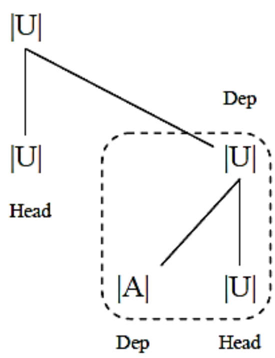
('1' = the most prominent)

In the five-vowel system of Japanese, the remaining two vowels *e* and *o* are represented by the complex expressions |A I| and |A U| respectively. Referring to the area enclosed by the dotted line in (7a), the part of the structure in which |I| takes |A| as its dependent is phonetically interpreted as *e*. In acoustic terms, the additional (dependent) 'mass' pattern is added to the structurally headed 'dip' pattern. In this configuration, the dependent 'mass' pattern is more prominent than the head 'dip' pattern since |A| is the most deeply embedded dependent, making it phonetically more prominent than the head (Nasukawa and Backley 2015).

(7) a. *e*



b. *o*



The same structural relation is found between |A| and |U| in (7b). In the |U|-headed set of |U| and |A|, the dependent |A| is acoustically more prominent than the head |U|. The validity of these vocalic structures for Japanese is discussed in Nasukawa (2014, 2015ab), where the element structures for consonantal expressions are also discussed in detail. In Nasukawa (2014, 2015ab), however, there is little discussion of the element structure of English vowels. The next section is devoted to the representations of English vowels in the precedence-free and concatenation-based approach to phonological representation.

3. English vowels in Precedence-free model

3.1 Short vowels (*ə, ɪ, ʊ, ʌ, e, æ, ɒ*)

At this point, the representations of other English (RP: Received Pronunciation) vowels are considered. English has a large and relatively complex vowel system. For convenience, the

RP system is given below.

(8) RP (Received Pronunciation) (Backley 2011)

a. Short vowels: *ɪ ʊ ʌ e æ ɒ*

b. Long vowels: *iː uː ɑː ɔː ɜː*

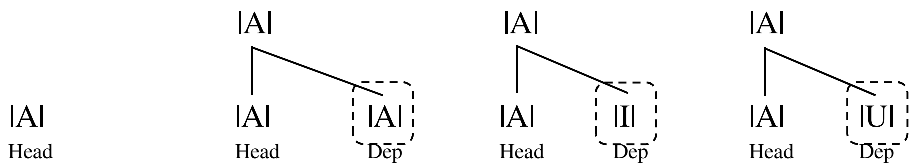
c. Diphthongs: *aɪ eɪ ɔɪ aʊ əʊ ɪə eə ʊə*[1]

d. Reduced vowels: *ə ɪ ʊ*

In the case of English, the head is assumed to be |A|, the structure formed by this sole head |A| being phonetically realized as *ə* (or in some dialects, as *ɨ*) as in (9a). When the head |A| takes |A|, |I| or |U| as its dependent, then the acoustic signature of the baseline |A| is masked by those elements and the overall structure phonetically manifests itself as *ə*, *ɪ*, or *u* respectively.

(9) Vowel representations for English

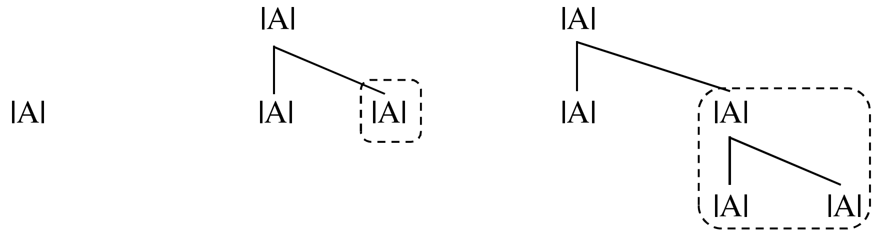
a. *ə* (*ɨ*) b. *ə* c. *ɪ* d. *ʊ*



Note that like the two *ɯ*s in Japanese, there is no phonetic difference between (9a) and (9b). Phonologically, however, they behave differently: the former (9a) (which is insensitive to phonological processes) is restricted to domain-final positions and to positions which make impossible sequences legitimate in the nativization of loanwords, while the latter (9b) appears in all other contexts.

First, the degree of vowel sonority is considered. In terms of element composition, vowel sonority is associated with the number of tokens of |A|: the more |A|s there are, the higher degree of sonority the vowel expression has. The |A|-headed set of two |A|s in (10b) is phonetically realized as *ə* while the |A|-headed set of three |A|s in (10c) manifests itself as *ʌ*, which has a higher degree of sonority than *ə*.

(10) a. *ə* (*ɨ*) b. *ə* c. *ʌ*



Similar representations are found in Backley (2011) where an empty nucleus is phonetically interpreted as *ɨ* while *ə* and *ʌ* are phonologically represented by a sole |A| in a nucleus.

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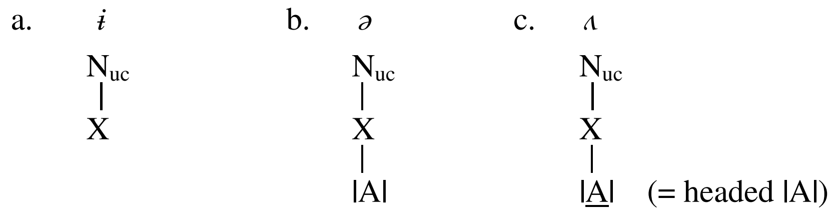
[1] A recent tendency among younger RP and Estuary English speakers is to pronounce *ʊə* as ɔː (e.g., *pʊə* > *pɔː* ‘poor’ and *ʃʊə* > *ʃɔː* ‘sure’).

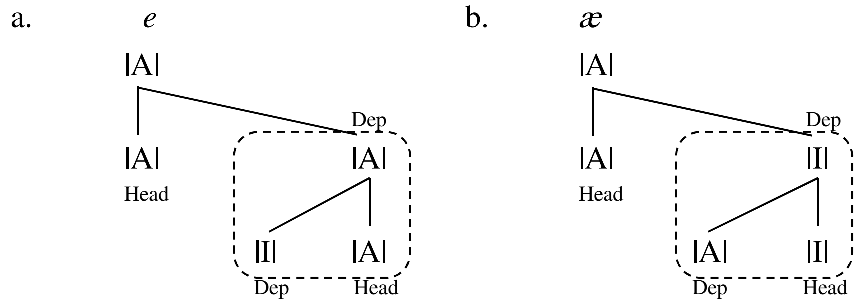
Following the Government Phonology tradition, the difference between *ə* and *ʌ* is attributed to the headship of |A|: it is non-headed (and phonetically recessive) in the structure for *ə* but headed (and phonetically more prominent) in *ʌ*, where headedness is represented by underlining.

(11) Backley (2011)



Returning to the segment-internal representations used in Precedence-free Phonology, we now discuss the other short monophthongs *e*, *æ*, and *ɒ* in English. The front mid short vowels *e* and *æ* are both assumed to be the realization of the set of |A| and |I| in the complement of the baseline.

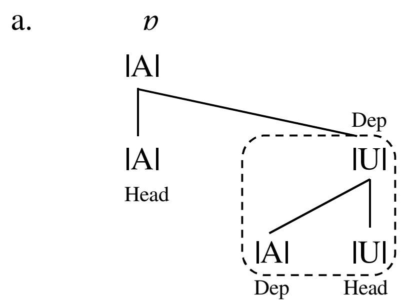
(12)



In both cases, |A| and |I| are combined asymmetrically to form a vowel expression. The structural roles of |A| and |I| for *e* are different from those for *æ*: within the domain marked out by a dotted line in (12a), |A| is the head and |I| the dependent, while the reverse dependency relation holds between |A| and |I| in the corresponding part for *æ* in (12b). In acoustic terms, the dependent 'dip' pattern is added to the 'mass' pattern in (12a). In this configuration, the dependent 'dip' pattern is more prominent than the head 'mass' pattern since |I| is the most deeply embedded dependent, making it phonetically more prominent than the head |A|. The reverse relation holds between the dependent |A| and the head |I| in the structure for *æ* in (12b).

The remaining mid short vowel *ɒ* is represented as follows.

(13)

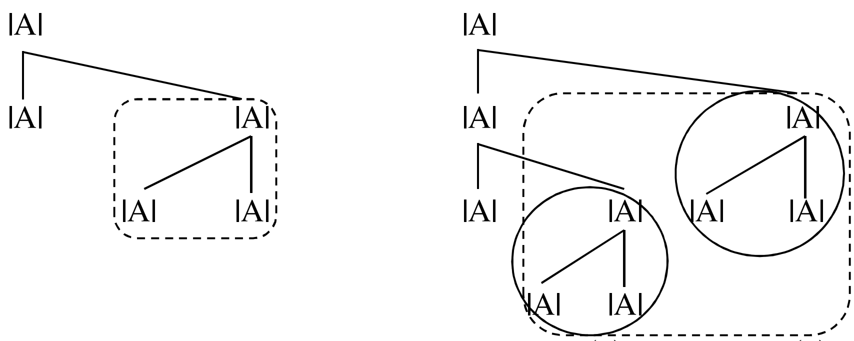


In the domain marked out with a dotted line, the |U|-headed set consisting of |U| and |A| phonetically manifests itself as *ɒ*. When the reverse dependency relation holds between |U| and |A|, the whole expression is phonetically interpreted as *o*, which is not employed in RP English.

3.2 Long vowels (*iː*, *uː*, *aː*, *ɔː*, *ɜː*)

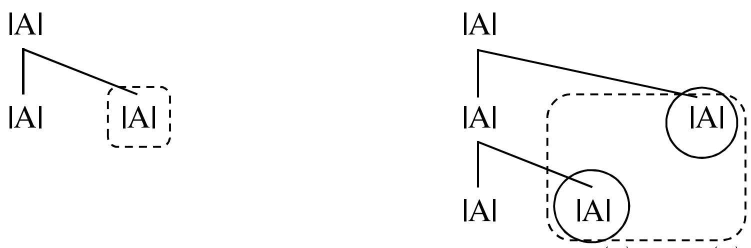
In Precedence-free Phonology, vowel length differences correspond to differences in the number of levels to which the vocalic part (consisting of elements) attaches in the hierarchical structure. Given Backley's claim (2011) that *aː* is phonologically the long counterpart of *ʌ*, the difference between the structures for *ʌ* and *aː* is attributed to the number of levels which take |A| as a dependent. This is illustrated below.

(14) a. *ʌ* (*a*) b. *aː*

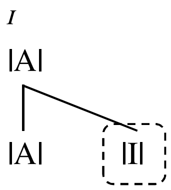


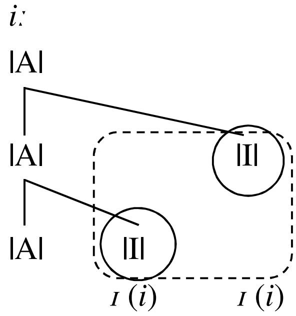
The same applies to the other long vowel structures. For example, the structure for *ɜː* is illustrated in (15b), where the structure for *ə* (15a) appears twice: at the level of the first projection and at the level of the second projection. This configuration is phonetically realized as the long vowel *ɜː*.

(15) a. *ə* b. *ɜː*

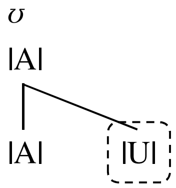


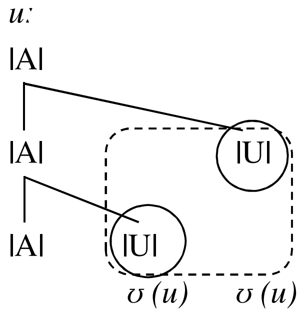
The remaining long vowels *iː*, *uː*, *ɔː* are also represented in the same manner. In the structure for *iː* in (16b), the structure for *ɪ* (16a) can be found not only at the level of the first projection but also at the level of the second projection.

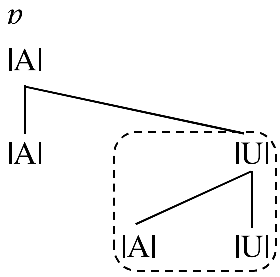
(16) a.


b.


The same is true for the representations for *u:* and *ɔ:*: the structures (17b) and (18b) contain the structures (17a) and (18a) twice, respectively.

(17) a.


b.


(18) a.


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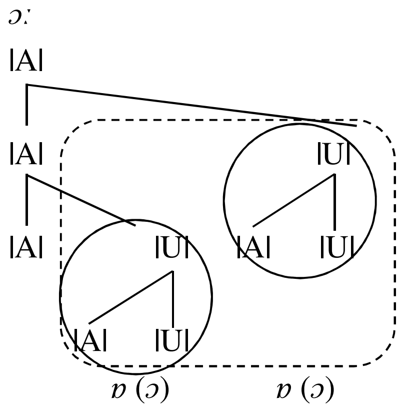
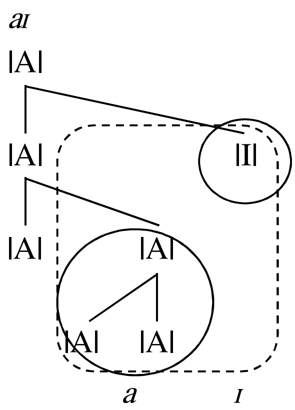


3.3 Diphthongs (*aɪ, eɪ, ɔɪ, aʊ, əʊ, ɪə, eə*)

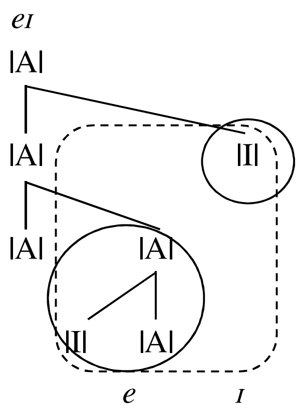
Finally, I consider how the English diphthongs (*aɪ, eɪ, ɔɪ, aʊ, əʊ, ɪə, eə*) are represented in Precedence-free Phonology. Diphthongs are primarily classified into two groups: closing (or ascending) diphthongs (*aɪ, eɪ, ɔɪ, aʊ, əʊ*) and centering diphthongs (*ɪə, eə*). Furthermore, the closing diphthongs are divided into two sub-groups: diphthongs ending in the high front vowel *ɪ* and those ending in the high back vowel *ʊ* (Oishi and Nasukawa 2011).

First, we consider the high-fronting closing diphthongs. In English, the first portion of a diphthong is significantly more prominent than the second portion. For example, the first part *a* of the diphthong *aɪ* (as in words such as 'ice') is pronounced with greater duration and strength than the second part *ɪ*. This difference between the two parts is represented structurally in (19), where the prominent part *a* is more deeply embedded while the less prominent part *ɪ* has a higher position in the hierarchical structure.

(19) a.

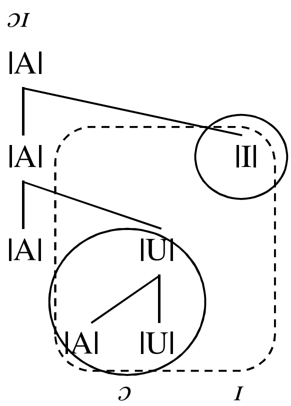


b.



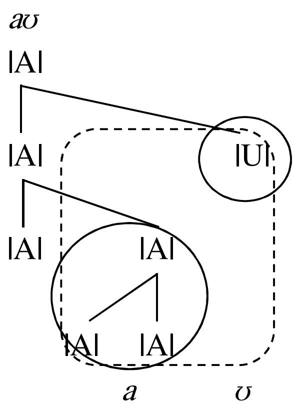
The structures for the other high-fronting closing diphthongs (*eɪ* (19b) and *ɔɪ* (20)) also embed the prominent portion (*e* (19b) and *ɔ* (20)) more deeply than the recessive portion (*ɪ* in both (19b) and (20)).

(20)

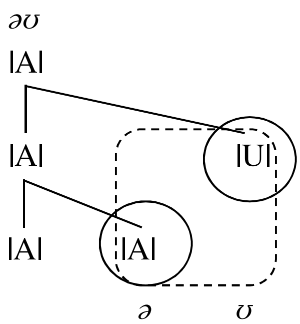


In the case of the high-backing closing diphthongs (*aʊ*, *əʊ*), the element set corresponding to the recessive portion (*ʊ* represented by a sole |U|) is dependent on the baseline element |A| at the top level, while the set for the prominent portion (*a* of *aʊ* in (21a) and *ə* of *əʊ* in (21b)) is the most deeply embedded, as illustrated below.

(21) a.



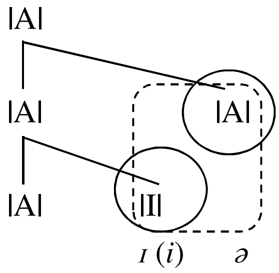
b.



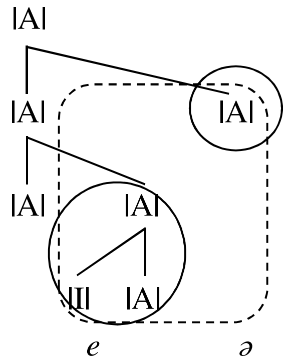
The same also applies to the centering diphthongs (*ɪə*, *eə*, *ʊə*), which show a transition from a peripheral vowel towards the mid central 'weak' vowel schwa (*ə*). Since the schwa portion in all three ((22a), (22b) and (22c)) lacks prominence, it should be the highest dependent in the structure while the more prominent parts (i.e. *ɪ* of *ɪə* in (22a), *e* of *eə* in (22b) and *ʊ* of *ʊə* in

(22c)) occupy the most deeply embedded position, as depicted below.

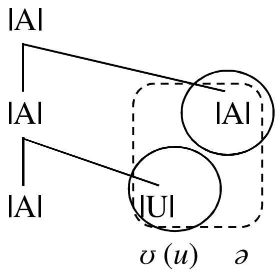
(22) a. *iə*



b. *eə*



c. *ʊə*



4. Monophthongization and diphthongization

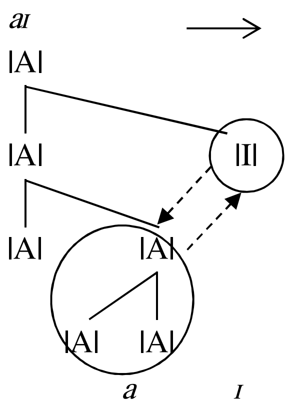
4.1 Monophthongization

Employing the proposed representations of English vowels, this section considers two fundamental operations, which are often characterized as (i) *fusion* (composition) and (ii) *fission* (decomposition). A recurrent pattern involving (i) is vowel coalescence, which typically produces the mid vowels *e* and *o* from the sequences *a-i* and *a-u* respectively. A frequently cited example comes from a historical monophthongization process by which the Early Modern English diphthongs *aɪ* and *aʊ* developed into *ɛ:* and *ɔ:* respectively (Harris 1994).

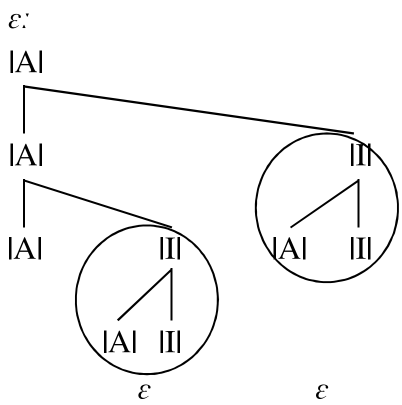
(23) earlier	>	later English	word class
aɪ	>	*ɛ:*	BAIT <bait, maid, day, stay>
aʊ	>	*ɔ:*	CAUGHT <caught, taut, trawl, bought, call>

The above process can be depicted as in (24), where the |A| (the dependent at the lower level) copies itself as a dependent of |I| (which is also a dependent at the highest level of the structure). Simultaneously the |I| (the dependent at the highest level) copies itself as a direct dependent of the ultimate head |A| at the first level of the |A| projection. As a result, each level has two identical |I|-headed sets of |I| and |A|. The whole structure is phonetically realized as *ɛ:*.

(24) a.

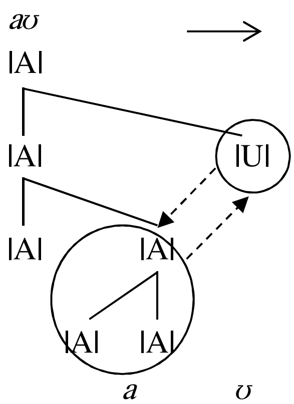


b.

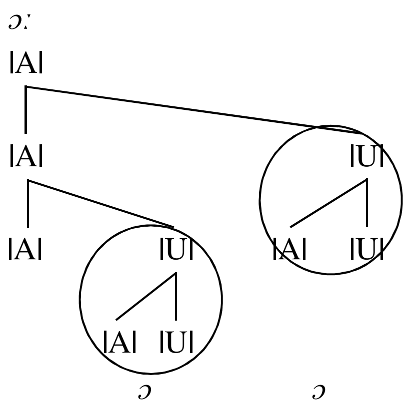


The same mechanism is observed in the historical monophthongization by which the Early Modern English diphthong *aʊ* developed into *ɔː*. As illustrated in (25a), the dependent |U| at the top level is multiplied at the lower level as a dependent, and at the same time the |A| (the dependent at the lower level) copies itself as a dependent of |U| at the higher level. As a result, the derived structure in (25b), which is phonetically interpreted as *ɔː*, contains two identical |U|-headed sets of |U| and |A|.[2]

(25) a.

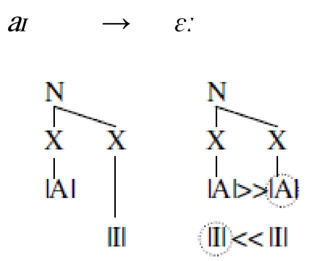


b.



Another example of monophthongization is observed in Estuary English, a present-day variety of English, as well as in modern forms of RP spoken by younger speakers, in which

[2] In this version of Element Theory, monophthongization has the appearance of a melodic fortition process, in the sense that structure increases in complexity. In other versions of Element Theory, it also seems that a fortition requires each X-slot to make a copy of an element, which effectively increases the number of elements in the expression.



|A| in X_1 (the first part of *aɪ*) and |I| in X_2 (the second part of *aɪ*) extend to X_2 and X_1 respectively. As a result, both positions are phonetically interpreted as *ɛ* which is the phonetic manifestation of acomplex expression combining |A| and |I|.

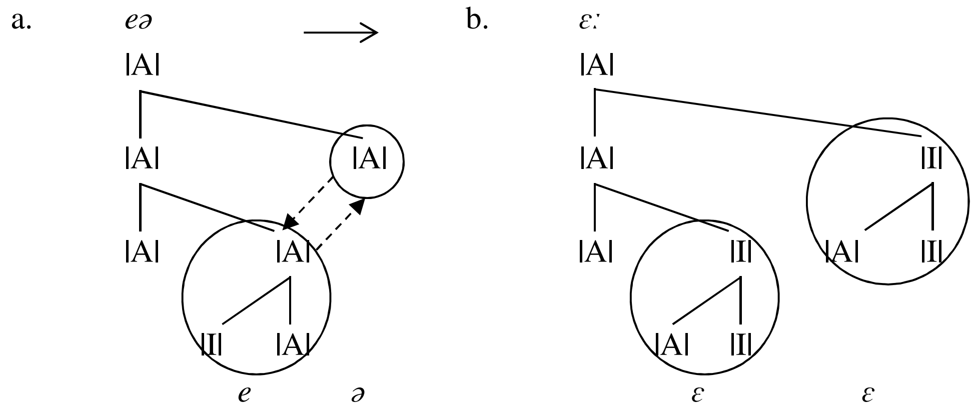
the diphthongs *eə* and *ʊə* are realized as *ɛː* and *ɔː* respectively.

(26)

RP		Estuary	Examples
eə	>	*ɛː*	*tʃeə* ‘chair’, *heəri* ‘hairy’
ʊə	>	*ɔː*	*pʊə* ‘poor’, *tʊə* ‘tour’

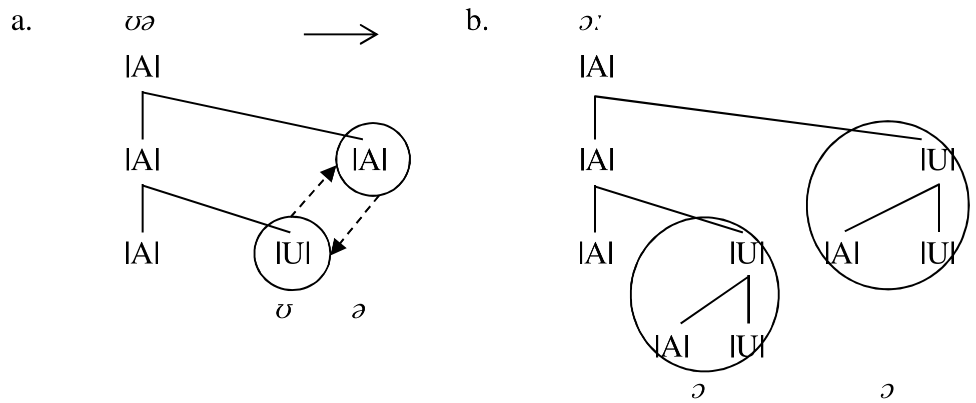
In the *eə*-to-*ɛː* alternation, as depicted in (27), the |A|-headed set of |A| and |I| for *e* of *eə* is copied at the higher dependent part with the reverse dependency relation holding between |A| and |I|. The representational outcome is phonetically realized as *ɛː*.

(27)



The same mechanism observed in the case of the development of *ʊə* to *ɔː*: |U| for *ʊ* of *ʊə* copies itself as the head at the higher level dependent part. At the same time, |A| at the higher level copies itself as the dependent of |U| at the lower level. The resulting structure phonetically manifests itself as *ɔː*.

(28)



4.2 Diphthongization

Returning back to historical changes in English, the following types of diphthongization are observed (Harris 1994).

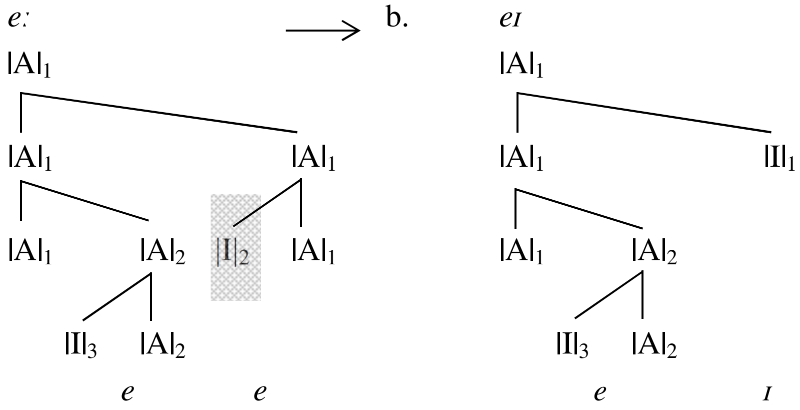
(29)

					word class
eː	>	*eɪ*	>	*aɪ*	BAIT = MATE <make, fate, same, tale>
oː	>	*oʊ*	>	*aʊ*	BOAT <boat, home, go, road>

The reflexes at each stage are found in different present-day dialects. The original monophthongal reflexes (*eː* and *oː*) are retained in some dialects spoken in Scotland, Ireland and the North and the West of England. The reflexes corresponding to the intermediate stage (*eɪ* and *oʊ*) are the most widespread across different dialects. The reflexes at the final stage in (29) (*aɪ* and *aʊ*) are identified in the southeast of England and in the southern hemisphere (Harris 1994).

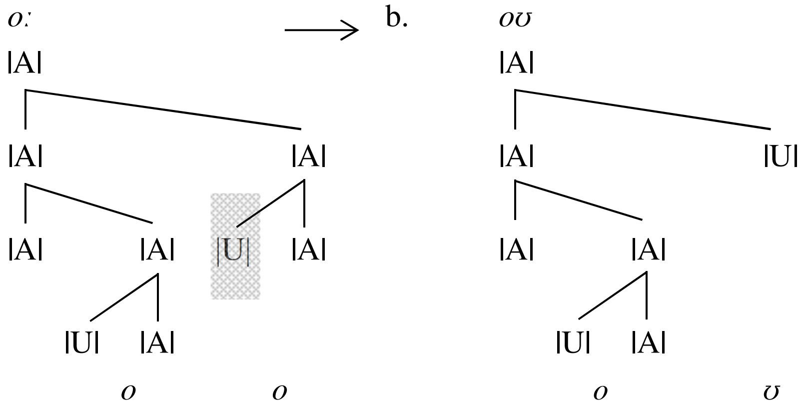
In terms of representation, the diphthongization of the mid front vowel (*eː* > *eɪ*) in (29) is illustrated in (30) where $|I|_2$, the dependent of $|A|_1$, is simply suppressed. Then the resulting structure is phonetically interpreted as *eɪ*.

(30) a. b.



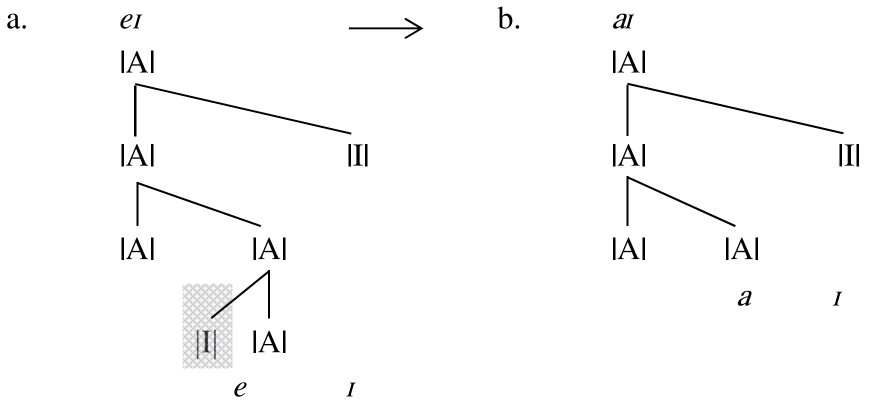
The development of *oː* to *oʊ* is accounted for in the same fashion, as illustrated below.

(31) a. b.



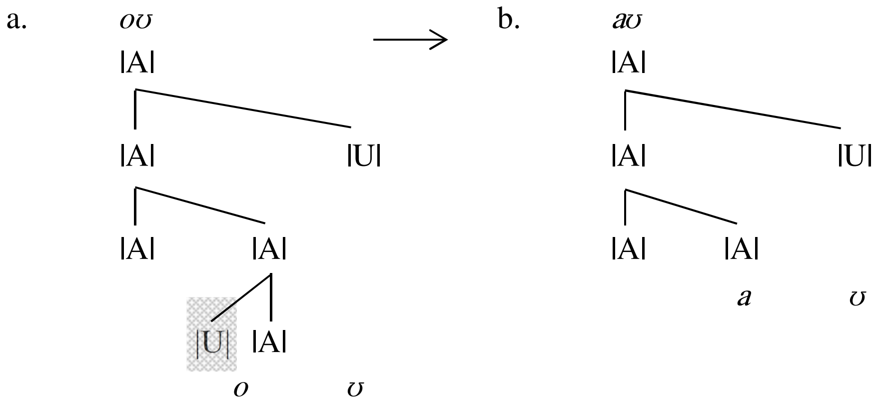
The next development of *eɪ* to *aɪ* in (29) is, unlike the above, not straightforward. In this process, |I|, the head of the most deeply embedded domain, is targeted for suppression. At the same time, the element |A|, the dependent of the |I| in the most deeply embedded domain, is duplicated in the same domain and they enter into a dependency relation. This may be considered to be the process which enhances the most deeply embedded element locally (within the lowest domain). As a result, as shown in (32b), the phonetic manifestation of the whole structure is *aɪ*.

(32)



As shown in (33), the development of *oʊ* to *aʊ* is also explained in the same manner.

(33)



Thus, the patterns observed in diachronic and dialectal monophthongization and diphthongization processes in English are not straightforward. At least the following operations are confirmed. (Below |α| and |β| may be one of the three elements |I U A|.)

- Copy |α| (to enhance the property)
- Make |α| dependent on |β|
- Make |α| dominant over |β|

Some phenomena employ only one of the three operations while others involve two or all of them. The choice of the operations and their variables (i.e., |α| and |β|) appears to be parametric.

5. Summary

In this paper, I discussed the representations of English vowels by referring only to dependency relations between elements in the context of Precedence-free Phonology (Nasukawa 2014, 2015 ab, this volume), whereby the notion of precedence is formally eliminated from phonological representations. In order to validate the proposed melodic structures for English vowels, the two processes monophthongization and diphthongization were analysed by employing operations which do not refer to precedence. Further research will be required in order to investigate whether other phonological phenomena can be analysed according to the same head-dependency-based mechanism rather by referring to precedence relations.

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