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CHAPTER 29

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VOWEL HARMONY IN DEPENDENCY-BASED MODELS

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HARRY VAN DER HULST AND JACQUES DURAND

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29.1 INTRODUCTION

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VARIOUS models have introduced the use of head–dependency relations in phonology. An asymmetrical head–dependency relation is established when units are combined or enter into a relation such that one unit is ‘dominant’ in either determining the nature of the resulting combination or determining (or ‘licensing’) a property of the non-head, dependent unit. This relation plays a central role in so-called *dependency grammar approaches* (with Tesnière 1959 as the foundational work), where it replaces constituent structure approaches, but it has also been incorporated into many constituent-based generative grammar models as an augmentative device. The dependency relation takes center stage in *Dependency Phonology* (DP), which is a theoretical framework that emerged in the 1970s and was first articulated by Anderson and Jones (1972, 1974, 1977). Thereafter, beside Ewen (1980), the major exposition of DP was Anderson and Ewen (1987). A recent detailed overview can be found in ~~Anderson and Durand (1986)~~ and van der Hulst and van de Weijer (2018).¹ Developments in DP, following Anderson and Ewen (1987), have been proposed by John Anderson in a wide range of publications (see Anderson 2011a,b,c, 2022 for extensive references).² From the start and in all his ongoing work, Anderson has formulated a linguistic theory that applies the dependency approach to phonology *and* syntax, taking as one of its central tenets that both planes are *structurally analogous*, albeit different in their alphabets—that is, the basic units (primitives) that are grounded in acoustic percepts and semantic concepts, respectively, both being cognitive in nature (see Anderson 1987).³ The primitives in both planes are *unary* and all combinations of units (both the primitives and

¹ See Staun (2021) for another discussion of the origin and development of DP and some related approaches.

² See Ewen (1995) for a general discussion of dependency relations in phonology and van der Hulst (2011) for a review of dependency approaches in phonology.

³ The level of morphology has no distinct alphabet: It is called ‘interplanar,’ functioning ‘relationally’ between the planes of syntax and phonology; for details, we must refer to Anderson (2011b).

larger, structurally complex expressions) are subject to dependency relations, while allowing for differences between the planes being caused by their differing sets of primitives. These analogies and reasons for divergences from analogies are explored in depth in Anderson (2011c, 2022).⁴

C29P2 In this chapter, we will briefly discuss Anderson's dependency approaches to vowel harmony (VH). Section 29.3 will then review another dependency-based approach to VH, developed in van der Hulst (2018) in the context of *Radical cv Phonology* (RCVP; van der Hulst 2020). The unifying theme of both DP and RCVP is the use of unary 'features' and dependency relations, the difference being that DP formalizes VH in terms of a 'percolation' device, whereas RCVP regards harmony as the result of a licensing mechanism which is seen as a head–dependency relation.

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29.2 VOWEL HARMONY IN DEPENDENCY PHONOLOGY

C29P3 As mentioned, Anderson (2011c) pursues the observation that phenomena such as VH and other types of 'prosodic' or 'suprasegmental' phenomena are not expected to be limited to the phonological plane. Rather, following the *Structural Analogy Assumption*, it is to be expected that there are syntactic analogies to such phenomena. Anderson (2011c) offers a host of examples of cross-planar analogies as well as explanations for where such analogies seem to be lacking, which for the most part appeal to the substances that phonology and syntax accommodate, the phonetic and the semantic substance, respectively.

C29P4 The syntactic analogue to VH is found in syntactic agreement and concord patterns that are widely attested throughout the languages of the world. Whatever mechanisms account for such phenomena should be equally available in phonology, notwithstanding the differences in the alphabets involved.⁵

C29P5 Turning to Anderson's treatment of VH, we first draw attention to the fact that his approach shares characteristics with the Firthian approach (see Chapter 25, this volume). Firstly, both theories represent the harmonic property as being placed outside the segmental structure (called 'extrasegmental'), and as such being a property of a phonological or morphological domain.⁶ Secondly, another commonality between DP and the Firthian Prosodic Analysis approach is the insistence on *polysystematicity*, which means that different

⁴ A model that closely resembles DP in various ways is Government Phonology (see Chapter 28, this volume), which also adopts a pivotal role for dependency relations as well as using unary primitives. Also see: van der Hulst and Ritter (1999); Ritter (2022). Dependency relations were introduced as the fundamental structural relation at the supra-segmental level in metrical phonology, proposed in Liberman and Prince (1977), while various authors also explored dependency between autosegmental tiers (Mester 1988a). General discussions of dependency-based approaches in phonology are Ewen (1995) and van der Hulst (2011).

⁵ That VH, as an agreement phenomenon, can be compared with syntactic agreement has also been pointed out elsewhere (see, for example, Chomsky 2000; Nevins 2010; Chapter 22, this volume).

⁶ The autosegmental approach (Goldsmith 1976) is likewise indebted to the Prosodic Analysis approach of the Firthian school (e.g., Firth 1948); see Chapters 24 and 25, this volume.

phonotactic positions in words can have different inventories of contrasting units. The idea that there is one segmental inventory for languages as a whole is thus rejected.

C29P6 As mentioned, DP uses unary ‘features’ (called components in this model). In classical DP, three unary components are central for the characterization of vowel systems (although these same components are relevant for consonants as well).⁷ These three components correspond closely to the triangular vocalic system, so common across the languages of the world:⁸

- (1) Vocalic components⁹
 |i| = acute/palatal
 |u| = grave/round
 |a| = compact/open

C29P7 Other primitives such as |ə| for centrality/energy reduction have also been put forward, as well as the need for an advanced tongue root (ATR) and retracted tongue root (RTR) component, ~~as well as RTR~~. In a system with only three contrastive vowels /i, a, u/, other things being equal, these three vowels would be exhaustively characterized as {i}, {u}, and {a}, showing that elements by themselves can occur as pronounceable entities (thus unlike binary features). In a slightly more complex system that has the five contrastive vowels /i, e, a, o, u/, the representation of these vowels would involve the simple combination of some of these primitives (symbolized by a comma between the components here):

- (2) Characterization of /i, e, a, o, u/ systems:
 /i/ = {i}, /e/ = {i,a}, /a/ = {a}, /o/ = {a,u}, /u/ = {u}

C29P8 Note that the comma indicates the mere co-presence of elements (which amounts to *under-specification* of the dependency relation) and that the left-to-right order has no significance here as in standard set notation: {i,a} = {a,i} and {a,u} = {u,a}. Following the principle of contrastivity, there is no need to burden the phonology with specifying a dependency relation in this case. If, however, there is a contrast among mid vowels as being high-mid or low-mid, this would require the specification of a dependency relation—that is, {i;a} [e] versus {a;i} for [ɛ] or [æ], where the element to the left of the semicolon is the head.

C29P9 Anderson (2011c: 166–218) presents partial analyses of VH in Finnish and Turkish. In both languages, we encounter non-participating vowels, which respectively are transparent to palatal harmony (the vowels /i/ and /e/ in Finnish) or opaque to labial harmony (/a/ in Turkish). Both languages are amply discussed and analyzed in Chapters 67 and 59, this volume, respectively. Here we will only briefly discuss the Finnish case. With regard to Finnish, of special interest are the *neutral* vowels /i/ and /e/, which do not have harmonic

⁷ In this respect, DP (like Government Phonology; see Chapter 28, this volume) adopted a unified approach to the primitives that are needed for consonants and vowels, which was central in Jakobson et al. (1952), being later abandoned by Chomsky and Halle (1968) and subsequently partially resurrected in Feature Geometry (see especially Clements and Hume 1995).

⁸ A complete review of DP’s set of components and various developments can be found in den Dikken and van der Hulst (1988) and in van der Hulst (2020: Chapter 2).

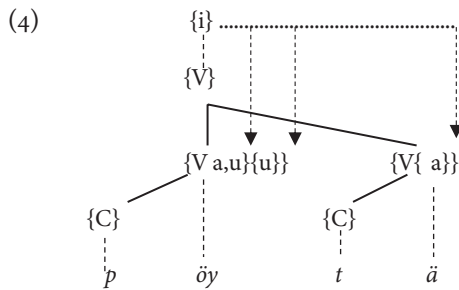
⁹ We here indicate ‘glosses’ that reflect an acoustic/auditory perspective, but we also include corresponding articulatory labels.

counterparts in the vowel system, as a full specification of the vowel system of Finnish clearly shows:

- (3) The fully specified Finnish vowel system
- | | | |
|-----------|-------------|-----------|
| {i} /i/ | {i,u} /y/ | {u} /u/ |
| {i;a} /e/ | {i,u,a} /ø/ | {u,a} /o/ |
| {a;i} /æ/ | {a} /a/ | |

C29P10 This system contains three pairs of harmonic vowels: high-rounded front/back /y/ ~ /u/, mid-rounded **high/back** /ø/ ~ /o/, and low front/back /æ/ ~ /a/. As shown, the front vowels /i/ and /e/ lack a back-harmonic counterpart. We refer to these vowels as *neutral* precisely because they reveal the neutralization of a palatal contrast.¹⁰ Contrastivity requires a *minimal representation* which is much sparser than (3). For a detailed motivation of a more minimal specification of the Finnish vowel system, we must refer to Anderson and Durand (1988) and Anderson (2011c: 166–218), but we mention here that because a subset of the vowels, namely {i,u}, {i,u,a}, and {a;i}, are products of harmony, the element {i} can be extracted from at least these segmental representations, being called ‘extrasegmental.’

C29P11 Anderson takes to domain of vowel a harmony to be *accentual* in nature—that is, left-headed, representing the initial word stress location in Finnish. In the dependency graph in (4) (which omits details), the capital C’s and V’s encode the ‘major class’ properties of the syllabic units:



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C29P13 As shown, harmony is achieved in terms of a percolation device; see Chapter 27, this volume, for comparable approaches in other multi-linear approaches to phonology.

C29P14 The neutral vowels /i/ and /e/ which act transparently can occur with both front and back vowels and do not interrupt the ‘spreading’ of the {i} element. The neutral vowels possess the {i} element as a segmental property in all circumstances. Nevertheless, the extrasegmental component ensures surface contrast between /e/ and /æ/, the former vowel having a ‘higher proportion’ of {i} than the latter, in combining inherent (though redundant) {i} and extrasegmental {i}. The two vowels thus end up as respectively /e/ {i;a} versus /æ/ {a;i}.

¹⁰ Many phonologists, including Anderson, use the term *neutral* as equivalent to ‘transparent,’ while for us transparency denotes only one kind of behavior of neutral vowels, the other kind being opacity.

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29.3 VOWEL HARMONY IN RADICAL CV PHONOLOGY

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In this section, we briefly review a second dependency-based model of VH, which is fully presented and extensively, empirically supported in van der Hulst (2018). This model takes from DP the basic principles of unarity and the head–dependency relation as a fundamental organization principle, while differing in its set of primitives, proposing that there are only two phonological primitives, C and V, following the model of Radical cv Phonology (van der Hulst 2020), which displays a relentless pursuit of structural analogy *within* the phonological plane. The two elements have different phonetic correlates depending on the ‘place node’ they occur in. For example, C and V in the place node play the role of [I] and [U] in standard unary approaches. In what follows, we will in fact use the ‘familiar’ element labels that correspond to the use of C and V in this model. In the van der Hulst (2018) model, a pivotal role is given to the mechanism of *licensing* which operates on ‘variable elements.’¹¹ The idea of licensing is, in general terms, shared by many approaches in Government Phonology (GP; and several other approaches as well; see Chapter 28, this volume).¹² However, the *source* of the licensed element remains somewhat unclear in these GP proposals. RCVP views harmony as the licensing of an element, *which is lexically specified in the target vowel as ‘variable’,* by another locally *non-variable* instance of that same element. Below, a variable element is represented as ‘(ε),’ with ‘ε’ standing for the harmonic element and the parentheses indicating variability. An element is variable if its realization depends on being licensed by a preceding or following non-variable occurrence of the same element. This is called *lateral licensing*. RCVP postulates that in the case of VH licensing is *strictly local* with respect to the *nuclear tier*, which means that no vowel can be ‘skipped.’¹³ It is important to emphasize that licensing is a dependency relation namely between a licenser (the head) and a licensee (the dependent). The variable element is left uninterpreted (or ‘disappears’) if not licensed. Variable elements are posited for vowels that alternate due to harmony. In addition, usage of variable elements is extended as an account of *neutral transparent* vowels that display ‘dual behavior’ in occurring with vowels from both harmonic classes. That this is in fact a necessary extension will be shown when we discuss how transparent vowels are handled in RCVP. Variable elements thus represent the *neutralization* of the contrast between presence and absence of an element in a certain context (syntagmatic neutralization) or in all contexts (paradigmatic or absolute neutralization). In a binary feature system, absence of contrast would typically be expressed by saying that the harmonic feature is under-specified, but in the RCVP model it is expressed in terms of a variable element ‘(ε),’ which means ‘ε or nothing.’¹⁴

¹¹ Van der Hulst (2021) offers an outline of the RCVP approach to VH, while putting forward a way of representing the property ATR which differs from the proposal in van der Hulst (2018).

¹² See Harris (1994a); Charette and Göksel (1994, 1996); Ritter (1995, 1999). The term ‘licensing’ is in fact widely used in phonology, often with very similar ‘intentions’; see Walker (2011) for a broad treatment.

¹³ There are exceptions to this which van der Hulst (2018) captures with the notion *bridge locality*. These are cases where locality is defined with respect to another element tier; see below.

¹⁴ It must be kept in mind that the so-called *zero option* that is used in binary feature theory also refers to a disjunction, namely ‘+ or –’. This means that the variable approach is an instance of the approach

C29P20 This proposal does not undermine the unary nature of the elements. Contrast *in the vowel system* is only expressed through the presence or absence of an element. The variable notation encodes the fact that certain vowels *as part of specific morphemes* have a dual character in displaying an alternation between the presence and absence of the element. The notation ‘(ε)’ simply means that for the relevant vowel it is undecided *in the lexicon* whether it will surface with or without the element in question. Van der Hulst argues that unless we distinguish between (6b) and (6c), we cannot make a representational difference between alternating vowels and vowels that are disharmonic in that they fail to alternate, as in *disharmonic roots* and *non-alternating affix vowels*.

C29P21 *Locality* is a central theme in the discussion of VH (if not of all linguistic relations). While virtually all accounts of VH appeal to some notion of locality, frameworks differ in important details in defining this relationship or in dealing with apparent violations of locality. RCVP adheres to a *strict* interpretation of locality (modulo the invisibility of consonants), which avoids mechanisms such as *discontinuous ‘association’* or feature/element insertion to account for apparent violations. This implies that locality does *not* mean ‘establishing a relation between two entities that are as close as possible’ (as proposed in Nevins 2010; see Chapter 22, this volume), but rather (and more conventionally) between elements that are adjacent with reference to a specific *projection* (in the sense of Vergnaud 1977), usually the nuclear tier (*nuclear locality*). To account for some cases of unexpected transparency, the RCVP model admits so-called *bridge locality*, in which case the locality requirement for licensing is satisfied on an element tier that differs from the harmonic tier (such cases are a subclass of ‘parasitic harmony,’ as first described in Steriade 1981).

C29P22 Van der Hulst (2018) pursues a proposal made in van der Hulst and Smith (1986), namely that when neutral vowels occur in a harmony system, their behavior as either transparent or opaque is predictable:¹⁷

(7) Transparency and opacity

- a. A vowel that is *compatible* with the harmonic element is *transparent*
- b. A vowel that is *incompatible* with the harmonic element is *opaque*

C29P23 (7a) is exemplified by the neutral vowels /i/ and /e/ in Finnish, which, being compatible with the harmonic element [I], act transparently. As shown in (8a), we *must* say that the neutral /i/ and /e/ are specified with a variable (I)-element, because left-to-right lateral licensing must be local (and thus cannot skip a vowel); nor can such neutral vowels be specified with an invariant [I]-element, because this would predict that such vowels will license variable elements that follow them, which they cannot, as shown in (8b):

(8) Finnish

- a. I{U}{UA} -dA -ks{AV¹⁸} -n{} -k{UA} [lyödäksenicö] ‘for me to hit’
I I » (I) » (I) » (I) » (I)
- b. I{U}{UA} -dA -ks{AV} -n{} -k{UA} [luodäkseniko] ‘for me to create’
(I) (I) (I) (I)

¹⁷ Krämer (2003) raises valid objections to the van der Hulst and Smith (1986) theory, which the current formalization preempts.

¹⁸ The element ‘V’ represent the property ‘high.’ The architecture of RCVP ‘enforces’ such an element as the polar opposite of the element [A].

C29P24 The representation in (8a) conflates the successive steps in licensing. The first variable (I) in the suffix *-dA* is licensed by the final |I| of the stem and thus ‘becomes’ invariable |I|, such that it can then license the following variable |I| in the next suffix, and so on.

C29P25 We must note that the proposed treatment of transparent vowels requires that lateral licensing *can* apply in a *non-derived environment*. We can see this when a transparent neutral vowel is preceded in the root by a front vowel. A following alternating suffix will then be front, which means that the transparent front vowel must be licensed first. This is illustrated here with some examples from Hungarian (Uralic):

- (9) a. $r\{A\}d\{r\} - n\{A\}k$ radír-nak ‘eraser-DAT’
 (I) (I)
- b. $\{U\}v\{A\}g - n\{A\}k$ üveg- nek ‘glass-DAT’
 I » (I) » (I)

C29P26 The variable (I) of the neutral vowel /i/ in (9a) remains unlicensed, which explains why the suffix vowel is back. Nevertheless, this vowel will be phonetically realized as [i] because there is no lexical contrast for palatality for non-low, non-round vowels.¹⁹ However, the transparent vowel in (9b) licenses frontness in the suffix vowel, which means that its variable element must first be licensed by the |I|-element in the first syllable.

C29P27 We can conclude that licensing is prohibited in a non-derived environment *only* if its effect would be to neutralize a lexical contrast. This allows the licensing of the variable (I) of the second root vowel of (9b), because by definition a contrast between front and back has been lexically neutralized for this vowel; it has no back-harmonic counterpart.

C29P28 Turning to the case in (9b), the claim is that neutral vowels that surface as negative vowels are predicted to act opaquely. We have seen this prediction confirmed in the case of the Turkish plural suffix (see (5d)). Van der Hulst (2018: Chapter 8) provides further confirmation of this prediction in the case of the ATR system, in which the low vowel /a/ misses a harmonic ATR counterpart.

C29P29 The predictions in (7) have not gone unchallenged. There are cases of both unexpected opacity and unexpected transparency (some of which were already identified in van der Hulst 1988). Unexpected opacity is not a problem for locality. Neutral vowels that are compatible with the spreading element can be lexically specified with the element as invariable, instead of variable. Kiparsky and Pajusalu (2003) report Finno-Ugric languages in which the neutral vowels, unlike in Finnish, behave as opaque. Lack of space prevents the discussion of these cases.

C29P30 Unexpected transparency is, of course, more worrisome. A familiar case at hand occurs in Halh Mongolian, which has labial harmony among non-high vowels in which the intervening high vowel /i/ seems to be transparent, while the vowel /u/ is opaque (see Chapter 60, this volume). This is the opposite of what would be expected, given (7). The solution that is proposed in van der Hulst (2018) is to allow locality to be defined, not with respect to the usual projection of nuclei that applies in most cases of VH, but with respect to another element tier, in this case the tier on which element |A| resides. Van der Hulst (2018)

¹⁹ We refer to van der Hulst (2018) for a principled explanation as to why absolute neutralization can only deliver front vowels.

refers to this as *bridge locality*. For reasons of space, we must refer to this work for details, but also see van der Hulst (2021: Section 1.2.6).

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29.4 CONCLUSION

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In this chapter, we have looked at the handling of VH within DP and RCVP. The presentations of these two approaches reveal some shared characteristics, in particular regarding the unarity of primitives and the use of head-dependent relations. The approaches differ, in that in DP the harmonic element is represented extrasegmentally, which requires a ‘distribution mechanism’ to assign it to segments, whereas in RCVP harmonic elements are located in the segmental representations of vowels that license the harmonic agreement in other vowels. An important strand of reflection in Anderson’s work is the emphasis on non-contrastivity and minimal specification and structural analogy, which has been cross-examined at length in Anderson (2011c and much earlier work). In the RCVP approach, VH is accounted for as lateral licensing of variable occurrences of elements, and special attention has been paid to the question of whether the behavior of neutral vowels as either transparent or opaque can be predicted based on the structure of the vowel systems.

C29S5

ACKNOWLEDGMENTS

C29P32

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