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# **The Routledge Handbook of Phonological Theory**

*Edited by S. J. Hannahs and Anna R. K. Bosch*

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- Ségéral, Philippe, and Tobias Scheer 2005. What lenition and fortition tells us about Gallo-Romance *Muta cum Liquida*. *Romance Languages and Linguistic Theory 2003*, edited by Twan Geerts, Ivo van Ginneken and Haike Jacobs, 235–267. Amsterdam: Benjamins.
- Sievers, Eduard 1885. *Grundzüge der Phonetik*. Vol. 3. Auflage Leipzig: Breitkopf and Härtel.
- Sievers, Eduard 1901. *Grundzüge der Phonetik: Zur Einführung in das Studium der Lautlehre der indogermanischen Sprachen*. Vol. 5. Auflage Leipzig: Breitkopf & Härtel.
- Spencer, Andrew 1986. A non-linear analysis of vowel-zero alternations in Polish. *Journal of Linguistics* 22: 249–280. WEB.
- Steriade, Donca 1982. Greek Prosodies and the Nature of Syllabification. Ph.D. dissertation, MIT.
- Steriade, Donca 1999. Alternatives to syllable-based accounts of consonantal phonotactics. *Proceedings of LP '98: Item Order in Language and Speech*, Vol. 1, edited by Osamu Fujimura, Brian D. Joseph and Bohumil Palek, 205–245. Prague: Karolinum Press.
- Szigetvári, Péter 1999. Why CVCV? *The Even Yearbook* 4: 117–152.
- Szigetvári, Péter 2001. Dismantling syllable structure. *Acta Linguistica Hungarica* 48: 155–181.
- Szigetvári, Péter 2007. Branching onsets and syncope in English. *Language Sciences* 29: 408–425.
- Szigetvári, Péter 2008. Two directions for Lenition. *Lenition and Fortition*, edited by Joaquim Brandão de Carvalho, Tobias Scheer and Philippe Ségéral, 561–592. Berlin: Mouton de Gruyter.
- Takahashi, Toyomi 1993. A farewell to constituency. *UCL Working Papers in Linguistics* 5: 375–410.
- Ulfsbjorninn, Shanti 2014. A field theory of stress: The role of empty nuclei in stress systems. Ph.D. thesis. London: SOAS.
- Yoshida, Shohei 1993. Licensing of empty Nuclei: The case of Palestinian vowel harmony. *The Linguistic Review* 10: 127–159. WEB.
- Zdziebko, Sławomir 2012. *Issues in Scottish Vowel Quantity*. Newcastle upon Tyne: Cambridge Scholars Publishing.
- Zdziebko, Sławomir 2015. Licensing of vowel quantity and the Scottish Vowel Length Rule. *Roczniki humanistyczne* 63: 151–176.

# Interfaces in Government Phonology

Tobias Scheer and Eugeniusz Cyran

## 11.1 Interface with morpho-syntax

### 11.1.1 General (and pre-theoretical) settings

#### 11.1.1.1 Distinct computational systems and their communication

Before describing the specific contribution of Government Phonology (GP) to the workings of the interface with morpho-syntax, it is useful to recall a number of general issues that all interface theories need to address. The broadest of these is the modular architecture of grammar that lies at the heart of the generative enterprise since *Aspects* (Chomsky 1965; see Chapter 9.2.1). That is, grammar is made of a number of distinct computational systems, each of which operates over a proprietary vocabulary that is distinct from the ones used by other systems. Taking these vocabulary items that are stored in long-term memory as an input, computational systems build structure (e.g. trees in syntax) following hard-wired instructions (among others, Merge in syntax) in online processing (active memory). The output may then be communicated to other modules for further processing, but the distinct vocabulary sets (called *domain specificity* in cognitive science) blocks direct transmission of information. Hence the output of a donor module needs to be translated into the idiom of the receiving module prior to transmission. This is what we call the interface, or interface operations: making information legible for the recipient.<sup>1</sup>

For the purpose of this chapter, it is enough to agree that morpho-syntax and phonology are distinct computational systems, one operating over lexical items such as number, person, animacy etc., the other working with labiality, occlusion and the like (no overlap). A further point is the fact that in production morpho-syntax feeds phonology in the (functional) sense that it concatenates items retrieved from long-term memory; the product of this gluing-together is linearized and enters phonological computation as a linear string.<sup>2</sup> Phonology itself does not concatenate anything, nor create linearity: it interprets whatever is delivered. Hence morpho-syntactic activity necessarily occurs prior to the workings of phonology (in production).

### 11.1.1.2 Morphological vs. syntactic influence on phonology

Another general setting that holds for the entire interface literature is this: what is studied almost exclusively is the influence of morpho-syntax on phonology, not the reverse. Zwicky & Pullum (1986) have introduced the idea that syntax is phonology-free, i.e. uninfluenced by any phonological information. This principle was challenged namely on the grounds of intonation, stress, rhythm, minimal word constraints and other properties that are located at or above the skeleton in phonological representations. Melody (i.e. items below the skeleton), however, never appears to bear on syntax. The correct generalization thus seems to be melody-free syntax (Scheer 2011: §662, 2016a). In any event, this chapter, following the literature, is only concerned with the influence of morpho-syntax on phonology (not the reverse).

Another question concerns an eventual distinction between morphology and syntax. This is a long-standing debate in itself: traditional generative and non-generative approaches (today autonomous morphology, i.e. the heirs of Lexical Phonology/Morphology) devise two distinct systems, but the trend in generative quarters is to consider that morphology and morphology follow the same workings and hence constitute a single computational system. The latter view is held by Distributed Morphology (e.g. Embick & Noyer 2007) and Nanosyntax (e.g. Starke 2009). Interface theories (which are almost always made by phonologists) clearly reproduce the distinction between syntax and morphology (see Scheer 2011: §423). Roughly, Lexical Phonology is responsible for morphological influence (i.e. by smaller pieces below the word level, with a cyclic/derivational management), while Prosodic Phonology describes how syntax bears on phonology (i.e. larger pieces at and above the word size: postlexical phonology, with a representational management).

Until the late 1990s, the little that was done in GP regarding the interface with morpho-syntax (domain structure) concerned only morphology, and hence had Lexical Phonology as a reference point. This will be explained in some detail below. External sandhi, i.e. the bearing of syntactic divisions on phonology at and above the word level, only entered the scene when the so-called initial CV was introduced (Lowenstamm 1999) and combined with syntactic phase theory (Chomsky 2000; on which more in sections 11.1.2.3 and 11.1.2.4 below).

### 11.1.1.3 Derivational vs. representational management of the interface

The final point to be made in this introduction is Interface Dualism (Scheer 2011: §6). There are two ways for morpho-syntax to influence phonology: derivationally and representationally. The former is a genuinely generative invention that came into being in Chomsky et al. (1956: 75) and was successively known as the transformational cycle, the phonological cycle, cyclic derivation and finally today derivation by phase (in syntactic quarters). It embodies the insight that (phonological and semantic) interpretation applies successively from the most to the least embedded piece of structure.

The other means by which morpho-syntax can bear on phonology is through the insertion of a representational object into the linear string that is submitted to phonological computation. This is the traditional interface management which is practiced (at least) since the 19th century, and in any case is shared by structuralist and generative thinking: carriers of extra-phonological information in phonology have been successively incarnated as juncture phonemes, SPE-type diacritics (# and the like) and the Prosodic Hierarchy ( $\omega$ ,  $\phi$  and so forth), each being the representative of its time, i.e. reflecting general assumptions on the organization of phonological units (phonemes, segments, autosegmental structure).

This is also the division of labour that underlies interface thinking. It was mentioned that Lexical Phonology (which proposes a purely derivational management) is supposed to account for pieces up to the word level, i.e. within the realm of morphology, and explicitly rejects any procedural management of external sandhi (postlexical phonology is supposed to be non-cyclic). Prosodic Phonology, on the other hand, uses only representational devices, i.e. constituents of the Prosodic Hierarchy, whose higher levels (from the Prosodic Word on) describe the influence of pieces that have word size or are bigger (syntax).

In this context, GP was only derivational in the 1990s, rejecting any representational management of the interface (Kaye 1995). This is not unrelated to the aforementioned fact that the reference point for Kaye was Lexical Phonology. Here again, the aforementioned initial CV modifies the picture substantially: it introduces a representational carrier of morpho-syntactic information in phonology (see section 11.1.3.1).

## 11.1.2 Standard GP: domain structure

### 11.1.2.1 Visible and invisible morpheme boundaries

In Standard GP, i.e. up to the late 1990s, there were basically two articles about how GP views the interface with morpho-syntax: Kaye (1992) and Kaye (1995), plus relevant pieces of Prunet's (1986) dissertation (including Prunet 1987). A more complete overview of Kaye's interface theory is discussed in Scheer (2011: §258).

Kaye's basic idea is that a morpheme boundary may either be visible or invisible to phonological computation. In Kaye's vocabulary, the former is called analytic morphology (the phonological string is analyzed into two substrings), while the latter amounts to non-analytic morphology (the phonological string, although morphologically complex, is phonologically unanalyzable). That is, a morphological structure  $[[A]B]$  (where A and B are morphemes) appears as  $[AB]$  in phonology: the fact that B is a separate morpheme goes unnoticed (the boundary is not flagged), and hence the computation of  $[AB]$  is indistinguishable from the computation of a monomorphemic string. For instance, stress in English (which for the sake of exposition we will assume to be simply penultimate) falls on the second but last vowel in monomorphemic items (*párent*) as much as in morphologically complex strings made of a root and a class 1 suffix (*parént-al*). Kaye concludes that class 1 affixes are of the invisible kind: stress assignment operates over  $[parent-al]$  as much as it does over  $[parent]$ .

Class 2 affixes, on the other, hand are visible in phonology: they are flagged and leave a trace. Hence a morphological structure  $[[A]B]$  is computed as such in the phonology. Chunks that are submitted to phonological interpretation and computed in one go (here  $[A]$  and  $[AB]$ ) are called domains in Kaye's vocabulary – they are known as cycles (or levels) and today as phases.

Phonologically visible morpheme boundaries alter regular phonological computation in the following way: properties of the string that are acquired by computation in a given domain cannot be modified by further computation occurring in outer domains (Kaye calls this robustness). Hence when a class 2 suffix such as *-hood* attaches to a root as in  $[[parent]-hood]$ , stress is first assigned to the inner domain, producing *párent*. Stress assignment is then also performed on the outer domain  $[párent-hood]$ , but given robustness the previously acquired location of stress cannot be undone or modified, and the result is *párent-hood*.

With the notion of robustness, Kaye in fact pioneers what today is known as the Phase Impenetrability Condition (PIC) in (syntactic) phase theory (on which more in section 11.1.2.3). Another example of the prohibition to undo what was done in previous domains comes

from French and is exposed both in Kaye (1992: 142ff.) and Kaye (1995: 306ff.). Data and analysis are originally due to Prunet (1986, 1987). French shows a contrast between *mon ami* [mɔ̃n ami] 'my friend' and *bon ami* [bɔn ami] 'good friend': the vowel of the possessive (*mon* 'my') is nasalized, while the vowel of the adjective (*bon* 'good') is not.

Both determiners bear a liaison consonant at their right edge: the *-n* is only present when the following noun begins with a vowel. It is absent before consonants (*mon café* [mɔ̃n kafɛ] 'my coffee', *bon café* [bɔn kafɛ] 'good coffee') and when the words are pronounced in isolation (*mon* [mɔ̃] 'my', *bon* [bɔ̃] 'good'). Note that in these contexts the vowel of both *mon* and *bon* is consistently nasalized. Following standard autosegmental assumptions on French liaison, liaison consonants are lexically floating.

Prunet and Kaye argue that there is good reason to believe that the syntactic relationship of *bon* is closer than the one that *mon* entertains with the following noun. This syntactic difference is then transmitted to the phonology in terms of domain structure. While *mon ami* is the complex [[mon] ami], *bon ami* lacks internal structure: it identifies as [bon ami].

(1) French *mon ami* vs. *bon ami*: input to the phonology

a. <i>mon ami</i>	b. <i>bon ami</i>
O N    O N O N	O N    O N O N
[[ x x ] x x x x ]	[ x x x x x x ]
m o n    a m i	b o n    a m i

Two processes now apply: floating consonants associate to available consonantal positions (the floating nasal here behaves like all other floating consonants), and nasalization of vowels is effected by nasals that occur domain-finally or before a consonant (this is a specific behavior of nasals, but general in the language). The derivation proceeds cyclically: phonology is first done on the inner domain of [[mon] ami]; the result is vowel nasalization, i.e. the association of the floating nasal to the preceding nucleus. On the outer cycle, liaison also associates the nasal to the following ONSET, which is now available. In the end, the nasal consonant thus enjoys a double association: it contributes to the pronunciation of the preceding nucleus and the following ONSET; the result is [mɔ̃n ami]. By contrast, the nasal in [bon ami] will undergo liaison, but fails to nasalize the preceding vowel because *bon* is not a domain by itself – hence the nasal is never domain-final. Therefore the triggering environment for nasalization is never met, and the result is [bɔn ami].

Critical for this analysis is that the association of the nasal to the preceding nucleus that is achieved on the inner domain is not undone when the outer domain is computed. This is due to robustness (Kaye's PIC).

### 11.1.2.2 Parsing cues

Kaye (1989, 1995) follows the perception-oriented logic of Trubetzkoy's *Grenzsignale* (which has a number of modern incarnations; see for example Hume & Johnson 2001; Boersma 1998). The idea is that phonology helps the listener to identify morphemes in the unstructured linear signal: this signal contains information, parsing cues, which flag morpheme boundaries. When the phonological system of the listener runs over the linear string, it is able to tell whether or not a given sequence is well-formed according to its standards: a sequence is ill-formed if it does not conform to what the application of phonological computation would have produced. In other words, speakers know what a morpheme may look

like, and what it cannot look like. Anything that constitutes a phonological anomaly or is not compatible with morpheme structure, then, sends an alarm to the parsing system: it signals the presence of a morpheme boundary.

The cluster [mz], for example, is a possible sequence in English (*it seem-s*, *dream-s* etc.), but does not occur within a morpheme. The same is true for the cluster [stm] that is found in *postman*. In these cases, a monomorphemic parse of the string is thus incompatible with the phonological knowledge of the listener. Hence the parses [[seem] s] and [[post] man] are enforced. Another example is the sequence [ksθs] in the word *sixths*. Since neither [ksθ] nor [sθs] nor [sθ] nor [θs] can be tautomorphemic, the correct structure must be [[[ksθ]θs]s]. In the same way, *darkness* and *enlargement* could not be the result of a computation over a single domain either since [rkn] and [rdʒm] are not good tautomorphemic clusters. This is how the suffixes *-ness* and *-ment* are identified by phonology alone, i.e. without look-up in the lexicon or any morphology intervening.

While the cases of morpheme-detection described are theory-independent, there are also theory-specific parsing cues. For example, Standard GP holds that super-heavy rhymes (a long vowel plus a coda, i.e. a rhyme dominating more than two skeletal slots) are universally ill-formed (a consequence of the Binary Theorem; see Kaye 1990 and section 1.3 of Chapter 10). The consonant of VVC sequences is therefore always an ONSET, even when it is word-final or followed by another consonant. Hence speakers know that the only possible parse of VVCC# sequences contains two empty nuclei, /VV.Cø.Cø#. Word-final consonants are onsets of empty nuclei anyway, and the cluster-internal empty nucleus is the only possible parse given the ban on super-heavy rhymes. In other words, a universal property of syllable structure betrays the existence of empty nuclei in words such as *seem-ed* [siimd], *peep-ed* [piipt], *seep-ed* [siipt] and *fak-ed* [fejkt], whose only possible parses are /[[siimø]dø]/, /[[piipø]dø]/, /[[siipø]dø]/ and /[[fejko]dø]/, respectively. In each case, the long vowel (or heavy diphthong) allows only for an ONSET interpretation of the following consonant, which in turn can only be followed by another ONSET consonant.

### 11.1.2.3 Location in the general landscape: Lexical Phonology, phase theory

Let us now look at the formal characteristics of Kaye's domains. In a given language, Kaye calls the set of phonological instructions that effect phonological computation the  $\phi$ -function. The internal workings of the  $\phi$ -function are described in section 1.4.2 of Chapter 9 (no extrinsic ordering or ranking of instructions). An important property of the  $\phi$ -function for the present purpose is that there is only one. Almost all phonological theories implement a number of different phonologies, i.e. distinct computational systems that apply phonological instructions in different ways. Mini-phonologies in a given language may be chunk-specific (i.e. specific to a particular size of the input string: general vs. word-level phonology in SPE, stem-level vs. word-level vs. postlexical phonology in Lexical Phonology and Stratal OT) or morpheme-specific (i.e. specific to a particular class of morphemes: indexed constraints, cophonologies). According to Kaye, phonology is one: there is only one  $\phi$ -function per language.<sup>3</sup>

Technically speaking, the  $\phi$ -function:

has one argument, a phonological string, and returns the application of the phonology to this argument, also a phonological string. The expression  $\phi(X)$  means, "apply phonology to the string X".  $\phi(X)$  returns the phonological string which results from the application of phonology to its argument.

(Kaye 1995: 302)

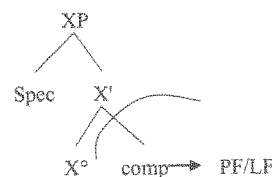
Kaye builds on interactionism, the central insight of Lexical Phonology. That is, morphological (concatenation) and phonological (interpretation) activity is intertwined: first you do phonology on an item, then you concatenate another piece, then you do phonology again on the result of concatenation, and so forth. In Kaye's system, morphological activity is represented by the concat function (which today would be called Merge):  $\phi(\text{concat}(X,Y))$  means that phonology is done on the result of a morphologically complex string, but that this morphological complexity is invisible to the phonology (were  $[XY]$  monomorphemic, the result would be identical). Analytic (or cyclic) domain structure is created when concat and phonological interpretation are interleaved: given two morphemes X and Y, either may be subjected to  $\phi$  before concatenation takes place. This situation corresponds to the expressions  $\phi(\text{concat}(\phi(X),Y))$  and  $\phi(\text{concat}(X,\phi(Y)))$ . In the former case, phonology operates over morpheme X, the result is concatenated with morpheme Y and phonology again applies to the output. The latter configuration is the symmetric counterpart.<sup>4</sup>

In SPE and GB syntax of the 1980s, all concatenation was completed before phonological and semantic interpretation started. Derivation by phase (Chomsky 2000 and following) abandons this scenario and adopts interactionism (which was introduced by Lexical Phonology). It also implements selective spell-out, i.e. the idea that not all morpheme breaks define a cycle (as was the case in SPE): only a subset of nodes of the syntactic structure, phase heads, trigger spell-out. Selective spell-out was introduced by Halle & Vergnaud (1987) in phonology (see Scheer 2011: §225 for more detail), and Kaye takes over this mechanism: the morpheme boundary in  $[\text{parent-}al]$  is invisible for phonology because it does not trigger spell-out. By contrast, the boundary in  $[[\text{parent-}]hood]$  is visible, which means that it has triggered spell-out: phonological computation applies to  $[\text{parent}]$  alone. In other words, class 1 affixes are interpretation-neutral, while class 2 affixes trigger interpretation, i.e. project phase heads.

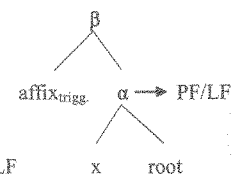
This leads to another prominent property of current syntactic phase theory, which it turns out was anticipated by Kaye: the fact that when spell-out is triggered by a given piece, it is not this piece itself that is sent to interpretation, but its sister (see Scheer 2008a for more detail). In syntactic phase theory, the spell-out of an XP only triggers the interpretation of the complement, i.e. the sister of the head of the XP; the head and Spec, XP – called the phase edge – are spelt out only at the next higher phase (Chomsky 2000: 108). This allows material that is trapped in the spell-out domain to escape the PIC by moving to the edge, and hence to be available for further computation. The mechanism devised by Kaye also spells out the sister of the interpretation-triggering piece: *-hood* creates a domain that is subjected to interpretation, and this domain is its sister (i.e. excluding the head = the suffix itself). The parallel with syntax is depicted under (2) below where in both cases the sister of the lexical category that triggers spell-out ( $X^\circ$ ,  $\text{affix}_{\text{trigg}}$ ) is actually spelt out: the complement and the node that dominates the root ( $\alpha$ ).

(2) The phase edge in syntax and phonology: spell-out your sister

a. Chomsky (2000)



b. Kaye (1995)



Finally, let us look at the Phase Impenetrability Condition (PIC) as entertained in current syntactic phase theory. The PIC is a device which guarantees that previously interpreted strings do not burden further computation – in Chomsky's terms, strings that are returned from interpretation are 'frozen' and 'forgotten' when concatenation resumes. The history of no-look-back devices in generative theory starts with Chomsky's (1973) Conditions on Transformations, and its offspring – until its recent revival in the guise of the PIC – was essentially phonological. No-look-back devices are designed in order to prevent computation to consider 'old' strings. Depending on their precise formulation, however, they have quite different empirical effects, which correspond to the thing that the analyst wants the computation to be unable to do. Like for the phase edge, Kaye's modification-inhibiting robustness is a phonological precedent of Chomsky's PIC, though not the first implementation of this idea: the Free Element Condition (Prince 1985) restricts rules that erect foot structure to strings that do not possess any such structure yet. In other words, phonological computation can build but not destroy existing structure. The construction of syllable structure was restricted in the same way (e.g. van Oostendorp 1994). On the syntactic side, Riemsdijk's (1978: 160) Head Constraint is a precursor of modification-inhibiting no-look-back.<sup>5</sup>

In sum, Kaye's domain structure was clearly ahead of its time: it combines or introduces workings that today lie at the heart of current syntactic theory: interactionism, selective spell-out, the phase edge and the PIC.

11.1.3 A non-diacritic theory of the interface (Direct Interface)

11.1.3.1 The initial CV: TR-only vs. anything-goes languages

Let us now turn to the representational side of the interface. It was mentioned that GP developed interest in this aspect only when Strict CV entered the scene. Lowenstamm (1999) proposed that the phonological exponent of the morphological information 'beginning of the word' is an empty CV unit.<sup>6</sup> Among other things, his goal was to derive the typology of restrictions regarding word-initial clusters: some languages admit only TR clusters (English, Italian etc.), while others allow for any sonority slope (e.g. Moroccan Arabic). Let us call the former TR-only, the latter anything-goes languages (T stands of any obstruent, R for any sonorant). A third pattern is trivial, i.e. languages that do not allow for any word-initial clusters at all. What needs to be explained, then, is the absence of RT-only languages, i.e. cases where RT but not TR clusters may occur word-initially. Or, put differently, the implicational relationship between initial TR and RT clusters raises the question: why is it that a language which has the latter will also have the former, but one that has the former may or may not have the latter?

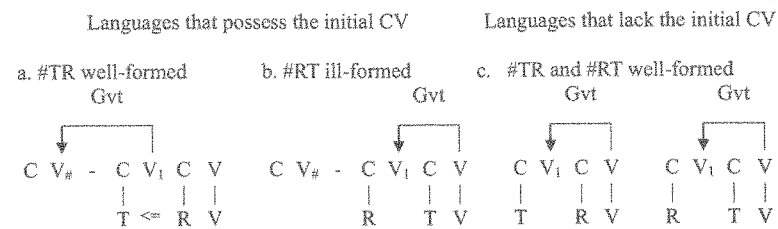
Lowenstamm's analysis is based on the identity of branching onsets (i.e. TR clusters) that was developed by Scheer (1999, 2004: §14): the solidarity of TR is due to a lateral relation among the two consonants that R is the head of (Infrasegmental Government, see section 2.3.4 of Chapter 10). This relation circumscribes the empty nucleus separating the two consonants. It could not relate the two consonants of an RT cluster since all lateral relations are head-final in Strict CV, and the head R could not be government-licensed by an empty nucleus. Table (3) shows how the initial CV ( $CV_\mu$ ) supplemented with the Strict CV analysis of branching onsets ('<=>' represents the solidarity-creating lateral relation) derives the typological situation described.

(3b) is ill-formed because two empty nuclei occur in a row where the second ( $V_1$ ) is unable to dispense government because it is itself governed. By contrast, under (3a)  $V_1$

does not need to be governed by the following full vowel because it is enclosed within the solidarity domain of the TR cluster. Therefore it is a sound governor and may govern the empty nucleus of the initial CV. Hence the presence of the initial CV is responsible for the TR-only restriction: it adds a burden (an empty nucleus) that needs to be taken care of. Its absence in anything-goes languages takes away this burden, and accordingly there is only ever one empty nucleus that needs to be managed: the one enclosed within the initial cluster. As shown under (3c), this nucleus will always be able to be governed by the following full vowel, and hence the sonority slope of the surrounding consonants plays no role: any sonority sequence will do.

While for Lowenstamm (1999) the initial CV was always present but somehow switched off or made invisible in anything-goes languages, Scheer (2000: 274ff., 2004: §404) introduces the idea that its distribution is parameterized: languages decide whether or not to flag the left edge of the word just as they decide whether or not to spell out this or that syntactic property (person, case etc.) with a phonological marker of its own. The decision is parametric and hard-wired in the spell-out mechanism. But once it is taken, it is interpreted by the phonology, whose own workings produce the asymmetric picture at hand.

### (3) Restrictions on initial clusters in CVCV



#### 11.1.3.2 Non-arbitrary effects of the left edge of the word: three for the price of one

There are (at least) two other phenomena that are pervasively observed at the left edge of words and allow languages to pick one of two options. In some languages, first vowels of words cannot alternate with zero (while vowels elsewhere in the word can). In other languages first vowels do not show any peculiar behavior with respect to other vowels. But there is no language where non-initial vowels are unable to alternate with zero while initial vowels are. Relevant evidence is discussed in Ségéral & Scheer (2008) and Scheer (2004: §90). In strict CV, the reason why first vowels cannot alternate with zero is the presence of the initial CV: the relevant configuration is shown under (3b), only that the governed nucleus accommodates a vowel-zero alternation. Zero surfaces under government, which creates an ill-formed sequence of two empty nuclei. Therefore first vowels of words resist vowel-zero alternations in languages that mark the left edge of words with the initial CV. In absence of the initial CV, however, nothing withstands first vowels of words to alternate with zero.

The second phenomenon concerns word-initial consonants. In some languages, word-initial consonants are especially strong (and then pattern with post-coda consonants), while in others they show weak intervocalic behavior. But there is no language where they are especially weak. In terms of the Coda Mirror, a theory of lenition and fortition (see Chapter 10.2.3.1 and Chapter 10.2.3.2; Ségéral & Scheer 2008 for a summary), the strength of word-initial consonants is a consequence of the presence of an empty nucleus to their left:

the government of the following vowel is absorbed by the initial CV, which means that the consonant itself is licensed (i.e. backed up) but ungoverned (i.e. unspoiled), that is, experiences maximally comfortable conditions whose expression is segmental strength. In the absence of the initial CV, however, the vowel following initial consonants has no governing duties and therefore governs its own ONSET – which is the description of regular intervocalic consonants (see Chapter 10.2.3.2).<sup>7</sup>

For each of the three phenomena discussed (restrictions on initial clusters, alternation of first vowels with zero and the strength of initial consonants), the cross-linguistic variation observed is due to the presence or absence of the initial CV. Since the presence of the initial CV is the result of a parametric choice, the prediction is made that any language which displays one of the three consequences of the initial CV (TR-only, first vowel unable to alternate with zero, initial consonant strong) will also instantiate the two others. And conversely, languages that display one of the three correlates of the absence of the initial CV (anything-goes, first vowel able to alternate with zero, initial consonant weak) are predicted to be also set to implement the two others.

This prediction is tested on a number of languages in Ségéral & Scheer (2008) and Scheer (2014a), showing its empirical substance. Whatever the ultimate result, though, the fact that a number of very specific phenomena occur at the left edge of words shows that the effect of this position is anything but arbitrary: it is not the case that, say, in some language word-initial consonants are especially strong, while in others they are especially weak; or that some languages restrict initial clusters to TR, while others allow only for RT. Rather, languages may or may not grant a specific status to the word-initial site. If they do not, word-initial consonants behave just as if they were word-internal. If on the other hand something peculiar happens at left edges of words, it is always the same phenomena that are observed. The following section explains why this invalidates diacritic carriers of morpho-syntactic information (such as # or ω).

#### 11.1.3.3 Diacritics do not qualify

Since the 19th century, reference to morpho-syntactic information was always made by a diacritic, whose identity was determined by the basic phonological units of the time: juncture phonemes in structuralism when phonology was a string of phonemes, # which was held to be a [-segment] segment in SPE when the basic phonological units were feature matrices, and finally autosegmental domains such as the Prosodic Word ω or the Prosodic Phrase φ since the early 1980s when all areas of phonology were autosegmentalized.

By being a non-diacritic, the initial CV breaks with this tradition: syllabic constituents, an ONSET and a nucleus, are not arbitrarily chosen and interchangeable symbols whose function reduces to the representation of morpho-syntactic information. If a # or an ω is replaced by an & and phonological processes then are said to occur in the vicinity of a banana, rather than of a # or an ω, the workings of the interface as we know it will remain unchanged. By contrast, a CV unit cannot be replaced by an & because it has a phonological identity which is independent from its eventual function of carrying morpho-syntactic information: an ONSET is an ONSET, not a banana; a nucleus is a nucleus, not a banana.

A number of arguments can be made against diacritic carriers of morpho-syntactic information (see Pak 2008: 60ff.; Samuels 2009: 284ff.; Scheer 2008b, 2012b: §93; 2014a: 316ff.). The most obvious of them is certainly the fact that diacritics are intrinsically unable to make predictions. Phonology does not react on the simple presence of a # or an ω – such items can only bear on phonology if the analyst has devised some instruction in phonological



computation (a rule or a constraint) that is sensitive to them. Therefore hash marks, omegas and the like are passive ‘sleepers’: they merely sit in phonological representations without producing any effect by themselves.<sup>8</sup> For example, will a hash mark or a Prosodic Word favor or disfavor consonant clusters in their vicinity? There is no answer to this question because they can trigger (or inhibit) any phonological process and its reverse. By contrast, if phonologically meaningful items carry morpho-syntactic information, phonological computation will react on their bare presence. This is what Scheer (2012b: §154) calls the *Direct Effect*. A number of examples have been discussed above: the presence of the initial CV adds an empty nucleus to the string, a fact that has consequences: restrictions on initial clusters, inability of the first nucleus of the word to alternate with zero, strength of the initial consonant. These effects could not be the reverse: they depend on the phonological identity of the item inserted. Also, they are *automatic* and do not depend on any specific instruction: inserting #s and ω’s is for free (no consequences need to be feared), inserting an empty CV unit is not: there is no way for an empty CV unit to land in the phonological string without being interpreted.

In conclusion, then, diacritics are disqualified by the non-arbitrary nature of the effects produced by morpho-syntactic information. Since the bare presence of diacritics does not have any effect and makes no prediction, representing boundary information by diacritics is claiming that anything and its reverse can be triggered by them. We know for sure that this falls foul of the empirical record.

Finally, another important difference between the insertion of syllabic space and regular units of the Prosodic Hierarchy is the linear character of the former. Syllabic space inserted (as much as structuralist juncture phonemes and SPE-type hash marks) becomes itself a piece of the linear string: it has a left and a right neighbor. An ω does not: units of the Prosodic Hierarchy define (autosegmental) domains, i.e. delineate a piece of the linear string to which phonological processes then make reference (domains of phonological computation). Modern phase theory (on which see section 11.1.4) does the same labour derivationally: it feeds phonological computation piecemeal with chunks that correspond to spell-out domains. It may therefore be asked whether grammatical theory can afford accommodating two distinct chunk-defining devices that do the same thing, one derivationally, the other representationally. Modular PIC, to be introduced in section 11.1.4.1, says no: there is only one chunk-defining device in grammar: spell-out (which defines computational domains in phonology).

#### 11.1.3.4 Carriers of morpho-syntactic information reduce to syllabic space

Let us now zoom out to the global picture in order to see which units qualify for carrying morpho-syntactic information in phonology, and what their properties are. We have seen that diacritics do not qualify – hence the Prosodic Hierarchy has to go.<sup>9</sup> On the other hand, melodic primes, i.e. everything that is located below the skeleton (binary features, elements etc.), do not carry morpho-syntactic information either. While this fact does not appear to follow from anything, it is a paramount and consensual empirical generalization: the literature has not recorded any phenomena where melody would carry boundary information, nor has any theory devised melodic items as carriers of morpho-syntactic information: only items at and above the skeleton play this role. In GP, Bendjaballah (2012: 6) and Bendjaballah & Haiden (2013) have made this observation a central piece of their work. The observation itself is discussed in Scheer (2011: §660, 2012b: §124).

By elimination of those representational units that do not qualify for carrying boundary information, one concludes that *the output of translation of morpho-syntactic information*

*reduces to syllabic space*. Note that this statement (as much as the list of items that do not qualify) is entirely theory-neutral. Depending on the theory favored, syllabic space may mean skeletal slots, moras, onsets, rhymes etc. In Strict CV, the minimal syllabic unit is CV.

The elimination of diacritics from the interface and the restriction of carriers to syllabic space are central pieces of Direct Interface theory (Scheer 2012b), which is called direct because there are no diacritic categories (#s, ω’s etc.) mediating between morpho-syntactic information and phonological objects.

#### 11.1.3.5 The initial and other CVs

Let us now look at some consequences of this setup. If the only object that is ever inserted into the phonological string in order to carry boundary information is syllabic space, it should be able to be the exponent of all kinds of morpho-syntactic values, not just of the beginning of the word.

This is indeed what the GP literature has found. Following up on Guerssel & Lowenstamm (1990), a line of research aims to identify the internal structure of templates (see Lowenstamm 2003). The idea is that templates of the Semitic kind are not just an amorphous set of consonantal and vocalic positions; rather, they have an internal structure. That is, morphological operations take place only on designated portions of the template.

Work along these lines includes Bendjaballah (1999); Bendjaballah & Haiden (2003); Lahrouchi (2001); Ségéral (2000); and Arbaoui (2010). Examples of boundary information that is found to be carried by CV units are the negative in Kabyle Berber (Bendjaballah 2001), a verbal marker in Chleuh Berber (Lahrouchi 2001) and little *v*, AspP and AgrP in Arbaoui’s (2010) decomposition of Guerssel & Lowenstamm’s (1990) Classical Arabic verbal template. Special mention needs to be made of the fact that work by Bendjaballah & Haiden (2003) has wandered outside of the Semitic or Afro-Asiatic family, showing that (much like Prosodic Morphology in the 1980s and 1990s) languages with predominantly concatenative morphology such as German may also possess portions of the syllabic makeup – CV units in their analysis – which are the exponents of specific morpho-syntactic information (such as tense in the ablauting system).

Cases of CV units other than the initial CV which carry morpho-syntactic information and are not related to (Afro-Asiatic) templates include the following. Charette (2003) and Luo (2013) hold that the right edge of words is marked by a CV unit in Turkish and Chinese, respectively. Pagliano (2003) argues that the exponent of a suffix class in French is a CV unit, which produces intrusive *t* as in *numéro-t-er* ‘to number’ and *bleu-t-er* ‘to make something blue’, as opposed to *bleu-âtre* ‘bluish (pej.)’: the infinitive *-er* comes with a CV unit, while the pejorative *-âtre* does not. In Italian, Passino (2008) argues that the non-nativeness of roots is marked by a CV unit: consonant-final roots, which do not occur in native vocabulary, geminate the root-final consonant in derivation (e.g. *tag* appears as *tagg-are* ‘to mark’). Passino (2011) also analyzes a classical topic of Italian phonology, s-voicing, by recurring to the spell-out of an empty CV unit: in Northern varieties, intervocalic *s* is voiced before suffixes (*/cas-ina/* → *kaziina* ‘house, dim.’) and before prefix boundaries (*/dis-abile/* → *dizaabile* ‘disabled’), but not after prefix boundaries (*/a-simmetrico/* → *asimmetrico* ‘asymmetric’). On her account, voicing is blocked when *s* is able to (covertly) geminate on an empty CV unit spelt out by the prefix boundary. Further, according to Passino (2014a: 20f.), so-called a-insertion in Italo-Romance dialects of the upper South amount to the marking of specific morpho-syntactic contexts by an empty CV unit (compare the final vowel of the word *kænə* in *lu kænə narə* ‘the black dog’ with *li kænə mi* ‘my dogs’).

### 11.1.4 Phase theory and Distributed Morphology

GP devices such as Element Theory on the one hand and results from phonologically oriented work on the interface regarding the initial CV on the other have been carried into the discussion of morphological and syntactic theory. Section 11.1.4.1 reports on which way the initial CV interacts with phase theory, while section 11.1.4.2 shows how work in Distributed Morphology (DM) of Jean Lowenstamm and his students uses Element Theory in the decomposition of morphological exponence.

#### 11.1.4.1 What the initial CV is initial of

The study of external sandhi has shown that there are TR-only languages where the initial CV must be absent when cross-word phonology is computed. Belarusian (Scheer 2009b, 2012a: §285) and Corsican (Scheer 2009a, 2012a: §270) are cases in point. In the latter language, intervocalic stops lenite in external sandhi, i.e. when they occur in word-initial position before a vowel and the preceding word is vowel-final: voiceless stops voice (*um páne – u báne* ‘a/the bread’), while voiced stops spirantize (*un dnte – dui dnti* ‘a tooth, two teeth’). The data mentioned also show that no lenition is observed when the preceding word ends in a consonant. This is unsurprising since the post-consonantal position is strong. In sum, the phonology across words behaves exactly as if it applied within words, i.e. as if the word boundary were not there. The presence of the initial CV would obliterate the alternations shown: word-initial consonants would always occur after an empty nucleus and hence be strong (in terms of the Coda Mirror) no matter what. Interestingly, though, consonants are also strong when occurring in a position where nothing can precede, i.e. utterance-initially and when quoted in isolation.

There are thus (at least) two patterns on record: in some languages, the initial CV is word-initial (no external sandhi), while in others it is utterance-initial. What the initial CV is initial of is thus variable: sometimes the word, at other times larger chunks (that exclude the word). That is, what languages mark with extrasyllabic space is initiality, i.e. the beginning of a given unit, whereby this unit may correspond to variable morpho-syntactic chunks.

If phase theory as currently entertained in syntax (Chomsky 2000 and following) is taken seriously, i.e. if it is believed to be the mechanism that organizes spell-out between morpho-syntax and phonology, morpho-syntactic structure can only impact phonology if it is spelt out. If on top of that we know that what is marked is initiality, the conclusion is that *what the initial CV is initial of is phases* (Scheer 2009a, 2012a: §307). Based on complementizer doubling and a-insertion after complementizers in Abruzzese (Italo-Romance), D’Alessandro & Scheer (2013) argue that more precisely what may be marked with a CV unit is the left edge of either the spell-out domain of a phase head (i.e. the complement of  $X^{\circ}$ ) or the phase head itself ( $X^{\circ}$ ).

This perspective prompts an issue for phase theory itself: phonological diagnostics for phasehood do not necessarily match syntactic diagnostics. In fact they rarely do, but they should if it were true that, as Chomsky (2000 and following) holds, phases are an active memory saving mechanism, and phonological computation needs to save active memory as much as syntactic computation. If it is true that in Corsican the CP is marked with an initial CV (because consonants are strong utterance-initially) but no smaller unit dominated by CP is (because, recall, that words cannot be preceded by an initial CV), it would be outlandish to conclude that Corsican as a whole has only one phase head. This phonological diagnostic does no justice to the syntactic workings: there is successive cyclic movement in Corsican. This and other standard syntactic diagnostics suggest that vP and maybe other functional categories are phase heads as well. They do not leave any trace in the phonology, though.

English offers established evidence that illustrates this mutual independence of phonological and syntactic footprints of phases. In American varieties, *t*-flapping is reported to operate across *all* word boundaries regardless of the syntactic relationship between the words (provided the *t* is word-final and intervocalic; see e.g. Nespor & Vogel 1986: 46f., 224ff.). Jensen (2000: 208) specifically mentions a case where flapping applies across a vP boundary: *a very dangerous wild ca[r] escaped from the zoo*. On the other hand, there is firmly established syntactic evidence for the vP being a phase head especially regarding successive cyclic movement (e.g. Uriagereka 2011: 256). The vP in English is thus a case where a phase head leaves a footprint in syntax, but not in phonology. The reverse is also found: the assignment of word stress in English is strictly bound by the word, but the word is not a relevant unit in syntax, certainly nothing that would be described as a phase head for syntactic reasons.

D’Alessandro & Scheer (2015) show that all four logically possible configurations are found: a given phase head may leave a footprint both in syntax and in phonology, in neither module, or in one but not in the other. The result is *Modular PIC*: unlike in current phase theory, spell-out and the PIC are dissociated. There is a phase skeleton that defines phasehood for each language, i.e. at which points in the derivation spell-out occurs. An individual decision is then made for each access point whether a footprint will be left in syntax, and whether a trace of spell-out will be visible in phonology. In the latter case, footprints can be of two kinds, representational or derivational, and again all combinations are possible: spell-out domains, i.e. linear(ized) strings that reach phonology as an input, may or may not be associated with a PIC, and they may or may not be marked by an initial CV. Recall Kaye’s example from section 11.1.2.1: in terms of Modular PIC, both nodes projected by class 1 and class 2 affixes trigger spell-out, but only the latter is associated to a PIC, i.e. freezes its sister. The conduit that organizes communication between morpho-syntax and phonology, spell-out, is thus the unifying spine of both representational and derivational management of the interface: the PIC and the initial CV may be associated to it.

In sum, Modular PIC is an attempt to bring phonological evidence to bear in order to develop phase theory into a general theory of the interface. The motor is previously unexploited phonological evidence: the pervasive mismatch of phonological and syntactic diagnostics for phasehood enforces more variable workings. Conversely, if phase theory is taken to be correct, a deeply rooted phonological mantra that transcends individual theories must be wrong: since Kiparsky (1982), postlexical phonology (i.e. phonology that applies across words) is supposed to be non-cyclic. According to phase theory, however, spell-out sends all kinds of strings that are larger than word size to phonological interpretation. It is implausible that a computational system, phonology, be entirely insensitive to its input conditions, i.e. never acknowledges the fact that packages arrive piecemeal.

#### 11.1.4.2 Distributed Morphology and phonological exponence

Distributed Morphology (DM) does not feature much work related to phonology, and the items that include a phonological analysis often use minimal SPE-type vocabulary (e.g. Marvin 2002). Work by Lowenstamm (2008, 2011, among others) and his students (Rucart 2006; Arbaoui 2010; Lampitelli 2011; Faust 2013) does DM with stronger assumptions on the phonological side, and these are set in GP. Namely melodic representation in form of elements is concerned, since issues relevant to the organization of morphological structure involve exponence. At the heart of this strand is morphemic, rather than boundary, information. Lowenstamm (2011), for example, provides phonological arguments for the analysis of person, number and gender in Moroccan Arabic.

In order to illustrate element-based decomposition of morphemes, let us look at Lampitelli's (2011, 2013) analysis of Bosnian case markers (see also Passino 2014b; Lampitelli 2010 on markers of nominal inflection in Italian). Bosnian case markers are made of a vowel, which may be followed by a consonant and another vowel. Case markers express gender (roots belong to different declension groups according to their gender), number (singular and plural case markers are distinct) and case (six: nominative, accusative, genitive, dative, locative and instrumental). As is typical for Indo-European languages, all three values are expressed by one single morpheme, a vowel in this case, which at first glance appears to be indivisible: there is no piece of, say, the plural *-i* of masculine nominatives that corresponds to gender, number or case.

Lampitelli argues that this may be a wrong impression, though. Vowels decompose into elements, and these according to his analysis are the exponents of the three values to be realized. Case marking vowels, then, are compositional: they simply combine the elemental exponents of number, gender and case. The entire system is too intricate to be presented here, but let us look at a few prototypical cases. The unmarked values, which have a zero exponent, are (unsurprisingly) nominative, masculine and singular. Hence nouns with these values lack any case ending: *učenik* 'pupil'. The exponent of plural is an |I|, which produces the nominative plural *učenic-i*. The exponence of gender is as follows: masculine is zero, as was mentioned, feminine is |A| and neuter realizes |U|. Recall that gender produces three distinct declension classes. A feminine in nominative singular thus realizes two zeros (nominative, singular) and an |A|, which produces *kuć-a* 'house'. In its plural form, the plural marker |I| is added, to yield *kuć-e* where *-e* combines |A| and |I|. Neuter nouns display *-o* in nominative singular where *-u* is expected: *sel-o* 'village'. Since *-o* combines |A| and |U|, there is a supernumerary |A| whose origin needs to be accounted for. Lampitelli observes that there is syncretism between nominative and accusative in neuter nouns: *sel-o* is both nominative and accusative sg. Now accusative is marked by |A|, as shown by (animate) masculines: *učenik-a* (acc. sg.). Hence, Lampitelli argues, the case marker that is realized in the nominative of neuter singulars is in fact the accusative marker |A|, syncretically extended to the nominative.

While exponence in terms of specific elements and compositionality thereof produces correct results for a number of cells, the mechanism does not cover the entire paradigm. For those cells that resist, Lampitelli resorts to allomorphy rules such as  $\text{Element} \rightarrow \text{zero} / \_\_ \text{A}_{[\text{GEN}]}$  which erases all elements in presence of the genitive marker |A|. This accounts for the genitive plural of all three genders, which is uniformly *-a* (masc. *učenik-a*, fem. *kuć-a*, neut. *sel-a*): the rule erases the plural |I| in all three genders, as well as the neuter |U| in neuters. In genitive singular forms, nothing needs to be erased in masculines, which realize two zeros (gender and number) and the genitive |A| (*učenik-a*). The genitive singular of neuters, however, realizes the neuter |U| as well, and the expected output is |A|+|U|=|o|. Here again the allomorphy rule eliminates the neuter |U|, producing the attested *sel-a*.

More allomorphy rules are needed to account for the entire paradigm and additional (shallowly populated) declension groups. But the direction should be clear: following the general atomizing (i.e. anti-lexicalist) orientation of DM, a phonologically informed theory of exponence is able to shift labour from vocabulary insertion to the proper workings of phonology (and allomorphy), thereby achieving a one-to-one exponence, rather than the regular many-to-one exponence. That is, on the regular DM account, indecomposable case markers compete for realizing a portion of the tree that defines gender, number and case (many morphological features mapped onto one single exponent). The phonologically informed alternative assures that each morphological feature (or feature value) has its

own phonological exponent. In sum, then, what is usually taken to be synthetic morphology may under such an account in fact be just as analytic as what agglutinating languages display overtly.

## 11.2 Interface with phonetics

### 11.2.1 Phonetic interpretation in Standard GP

The general and long-standing assumption concerning the interaction between phonology and phonetics in Standard GP is that phonological representations are directly mapped to phonetics. This rather enigmatic statement has gained new flesh recently, though the general outlook has remained. What has changed is that phonetic interpretation and inter-modular communication between phonology and phonetics has received more attention in recent publications in which the traditional phonetic interpretation of GP has been placed in a broader cognitive science environment. The recent developments are also consistent with evolutions outside GP (e.g. Hale & Reiss 2000, 2008; Hamann & Boersma 2009; Bermúdez-Otero & Börjars 2006), which build on phonology-phonetics mismatches and conclude that the relationship between the two domains is arbitrary. What has not changed within GP is that there are no computational steps within the phonological module towards a more concrete phonetic form. Rather, phonetic interpretation, or spell-out, is post-phonological and is done through lexical access (Scheer 2014b: 255).

How is it possible that phonological representations are interpreted phonetically without the mediation of computation that brings phonological representations to the level of systematic phonetic representation, which we know from SPE? The answer lies in the basic tenets of Element Theory (Kaye et al. 1985; Harris 1990, 1994, 1996; Harris & Lindsey 1995), which is part and parcel of Standard GP, and which is, with minor modifications, continued in recent incarnations of GP (cf. Chapter 9). Phonological elements and their combinations enjoy autonomous interpretability, that is, they are pronounceable without the need of further specification.<sup>10</sup> This means that phonological representations are fully interpretable regardless of the stage of phonological derivation we are in. In this sense, phonological derivation is not constructing representations that are any closer to phonetic representations. Therefore, there is in fact no need for a systematic phonetic representation (Harris & Lindsey 1995; Harris 2006, 2009). Harris (1994: 95) eloquently argues that the conception that phonological derivation turns more abstract phonological representations into concrete phonetic representations 'assembling phonetic forms for production or reception' places phonology outside the domain of generative grammar because then phonological knowledge would not be independent of performance. He argues that a truly generative role of phonology would be to turn phonological representations of some form into other well-formed phonological representations. More arguments along these lines can be found in Kaye (2005). But how do phonological categories relate to phonetic form?

Drawing on the Jakobsonian insight that grammar should be neutral between the speaker and the listener, Harris & Lindsey (1995) and Harris (1996) claim that phonological categories (elements) are first mapped onto acoustic signal, while perception and articulations are parasitic on this mapping. Harris (1996: 314) provides rough definitions of the universal set of phonological elements as gross acoustic patterns, which are idealized acoustic signatures. Similar views are expressed in Kaye (2005: 285), who maintains that phonological grounding is based acoustically rather than articulatorily, a view which is now also prevailing among phoneticians (e.g. Hamann 2011; Kingston 2007). Within GP, this point about

the acoustic basis of phonological categories has recently been strengthened in Backley (2011) and Backley & Nasukawa (2009).

The above discussion may suggest that the universal set of elements have universally assigned phonetic (albeit only acoustic) substance. This is indeed the present-day 'official' position within Element Theory: universal association between phonological items (elements) and acoustic values, that is, *dip*, *rump* and *mass* for [I, U, A] respectively (Harris 1996). On the one hand, this facilitates talking about autonomous interpretation of representations. On the other hand, however, it takes us into a world of one-to-one universal relationship between phonetic (cues) and phonological (elements) categories. Below we will look at a substantial shift away from this position in recent studies which favor a view that the relationship between phonological and phonetic categories is in fact arbitrary, and established in language acquisition.<sup>11</sup> One of the consequences of this view is that the set of categories (elements) cannot be universal and innate. What humans have at birth is the ability to categorize physical input from the sensory system into cognitive units.

Despite the fact that not much has been said directly about the nature of phonetic interpretation within the GP tradition, individual proposals concerning concrete analyses provide a rather clear picture, which is expressed most emphatically in Kaye's (2005) *Phonological Epistemological Principle*, and which says that the only source of phonological knowledge is phonological behavior. From this it follows that the phonological representation cannot be successfully read off from the phonetic form, even if only acoustic cues are taken into account. Static phonetic properties may and do provide for initial hypotheses, which however can only be refuted or confirmed by phonological processing, which is the final judge. From the phonological practice, it also transpires that the rigid relation between phonological representation and phonetic exponence, whether acoustic or otherwise, needs to be relaxed as well.

For example, since the role of phonology, among other things, is to provide categorical phonological distinctions and the role of phonetic interpretation is to express these properties in concrete phonetic terms, one might be tempted to assume that two different phonological representations should never yield identical phonetic effects. One example that this view is wrong is provided in Gussmann's (2007: 56–61) analysis of *e*'s in Polish, which strictly follows Kaye's Epistemological Principle. In his analysis of palatalization, Gussmann observes two behavioral patterns in which *e*'s are involved in native vocabulary and concludes that despite identical pronunciation as [ɛ] there are in fact two different representations of this phonetic object. One of them is [j]-headed [A.ɹ]. It palatalizes onsets, e.g. *rakiem* [racɛm] 'cancer, instr.', and is found word-initially after [j], e.g., *jest* [jɛst] 'is'. The second 'e' is headless [A.I.] and does not palatalize onsets, e.g. *plotem* [pwɔtɛm] 'fence, instr.'. Thus, there are two representations of the front mid vowel which are realized in the same fashion, and it looks like phonetic interpretation has not fulfilled its obligation to express these phonological distinctions.

There is another way of looking at this problem, however. If phonetic interpretation, that is, the post-phonological spell-out, is a set of decisions independent of phonology proper, such mismatches are neither surprising nor problematic. Two disparate representations established on the basis of phonological behavior may receive the same interpretation, especially that they all involve a combination of the same two elements [j] and [A]. This, however, means that if there are any universal acoustic patterns associated with elements, they may be overridden by language-specific decisions. Note that from the perspective of language acquisition, when a child is confronted with data involving the same phonetic object behaving in two different ways, there is no choice but to give two different representations to that phonetic object.

Thus, the postulation of phonological categories depends in equal measure on the attempt to encode observable phonetic distinctions as phonological ones, as well as encoding phonetic non-distinctiveness with dual phonological behavior as two phonological categories. The guiding principle, however, is that one should observe phonological behavior. Some other examples of mismatches between phonetic categories and expected phonological categories will be mentioned below, and will be claimed to be due to arbitrary spell-out.

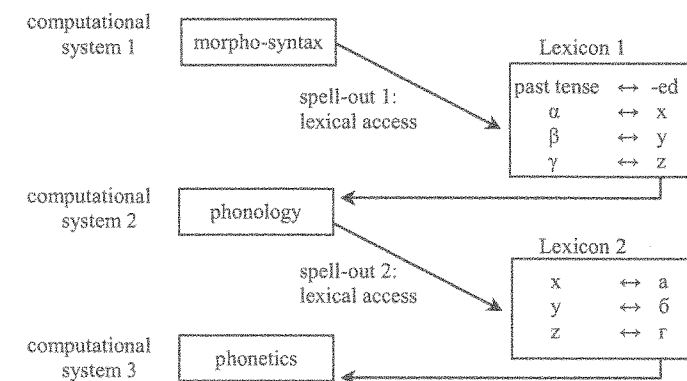
### 11.2.2 Two perspectives, one result: arbitrary spell-out

Below we show two distinct perspectives on the nature of the interaction between phonology and phonetics. One is global and theory-driven, while the other is data-driven but only possible under certain theoretical assumptions. They both converge on the same final conclusion: the relationship between phonological and phonetic categories is arbitrary.

#### 11.2.2.1 Translation and arbitrariness

Working from a global modular architecture of grammar, Scheer (2014b) presents what the nature of the phonology–phonetics interface should be within GP (see also Chapter 9, section 9.1.2.1). One of the vocally articulated theoretical positions in this paper is that the spell-out must be viewed as arbitrary. The global modular architecture of grammar involving phonology is reproduced below (Scheer 2014b: 256).

#### (4) Fragment of grammar involving phonology



As encoded in the scheme, it is assumed that phonetics is a separate computational module that uses its own symbols and has a domain-specific battery of operations.<sup>12</sup> With this assumption in hand, the relationship of phonology with the lower end of grammar, that is, phonetics, must be of the same nature as with the upper end, that is, morpho-syntax (Scheer 2011). The communication between modules can take place only as translation (spell-out) because the vocabulary of two different modules are not mutually understandable, a point to which we return below. The spell-out is done through lexical access. It is a list-type conversion, very much like a dictionary list which is not subject to manipulation by any computation. This, in turn, suggests arbitrariness of the spell-out relations because lexical properties, or effects of translation, are as unpredictable as anything in a dictionary.

Scheer (2014b) notes a potential discrepancy between the nature of 'spell-out 1' above and 'spell-out 2'. While everybody agrees that morpho-syntax uses a distinct language from

phonology and that this translation must be arbitrary – note the translation ‘past tense’ ↔ ‘-ed’ in English: there is no reason why the exponent is ‘-ed’ rather than, say, ‘-a’ or ‘-t’ – the distinction between the vocabulary used by phonology and phonetics, at least in terms of features, seems to be less obvious, and in fact more difficult to conceive of. For example, the phonological feature [labial] is sure to be interpreted as labial articulation with a corresponding specific acoustic signature. Thus, the domain of phonology–phonetics interaction is slightly more difficult to approach because of the similarity between the two modules. What is needed is a clear view with solid diagnostic criteria describing what the two modules are and what they can do.

One common misconception about the phonetic interpretation of phonological structure is that a production-oriented perspective seems to be implicitly assumed. This is inherent not only in the question: how are phonological representations interpreted phonetically, but also in the very terms ‘spell-out’, ‘translation’, or ‘interpretation’. All these assume a directionality. This view enforces the use of similar if not identical vocabulary to talk about the two modules in question. Recall the association of elements to acoustic patterns in Harris (1996), mentioned above. This perspective forces us to say that phonological labiality translates into phonetic labiality or roundness. To see that this perspective is misleading it is sufficient to observe that such parallels are missing in the upper end of the grammar and one should also ask the question *why?* The past tense exponent ‘-ed’ in English and ‘-ł’ in Polish are what they are for one single reason (excluding the historical development): these exponents have been lexicalized in acquisition. The spell-out connection has been established in acquisition, and is simply accessed each time a particular morpho-syntactic feature requires translation.<sup>13</sup>

Taking this into the phonology–phonetics domain now, the same mechanism can and should be expected and assumed. Since the phonological representation is established in language acquisition on the basis of phonetic input, including static patterns and distinctions between phonetic categories, as well as alternations, it is obvious that the feature [labial] or element |U| merely express the fact that this phonological category, whatever its real identity, has an established connection to labiality and its acoustic correlates. Thus, the similarity of the vocabulary used in phonology and phonetics may stem only from the fact that we do not know how to call the phonological category which is translated as labiality, so we use shorthand labels such as [labial], or |U|. Note that once we accept that phonetic interpretation, or spell-out is a case of access or activation of the relations already established in acquisition, the problem of autonomous interpretability of elements, and more broadly, of interpretation of truly phonological representation, vanishes. All we need to focus on more is the nature of the relations and criteria for deciding what is a truly phonological process, what is a phonetic phenomenon and what are the principles of interpretation. In other words, how the phonological representations are established. The story of Polish ‘e’ is one example of this. To illustrate this point further we may use another example, that of Russian ‘v’.

### 11.2.2.2 Arbitrariness and the nature of mismatches

The behavior of Russian ‘v’ has been discussed in the literature on many occasions (e.g. Andersen 1969; Hayes 1984; Mołczanow 2008). The problem with this segment is that it sounds like an obstruent and behaves like a sonorant in some contexts and like an obstruent in others. The typical line of analysis is that it is an underlying sonorant which is turned into an obstruent by derivation. The problematic nature of this speech sound, it seems, is due to the assumption criticized above, that there is a one-to-one correspondence between the phonetic cues and phonological representation. Under the view that phonological representation

is primarily governed by phonological behavior (Kaye 2005), the Russian ‘v’ is no more problematic than the Polish ‘e’.

The small percentage of cases where we observe a mismatch between phonological and phonetic categories is usually due to the procedural rather than static considerations. In other words, observable phonological processes, such as alternations, determine the actual phonological representation of seemingly straightforward phonetic objects. Surely there is nothing in principle that should preclude lexicalization of the input [v] as a phonological object involving the categories for labiality |U|, friction |h| and voicing |L|, to use a Standard GP application of Element Theory, unless some evidence, process or alternation tells us otherwise. The Russian ‘v’ is a classic example of this.<sup>14</sup> It is best represented by |U| or |U| only. The friction as well as voicing are non-phonological. What is more, as argued in Cyran (2014b), obstruentization is not only unnecessary but also impossible as a synchronic phonological process. The need to call Russian ‘v’ a voiced labio-dental fricative (an obstruent) stems only from the assumption that all the phonetically distinctive properties must find a reflection in the phonological representation. The error of this thinking lies in the fact that it ignores the Phonological Epistemological Principle of Kaye (2005).

Let us now return to the question posed in Scheer (2014b), namely, why should there be so much one-to-one correspondence between phonological and phonetic categories if the relationship is arbitrary (see also Hamann 2011, 2014). We are able to say that partly this one-to-one correspondence is a linguist’s illusion. Firstly, if we reanalyze all familiar melodic phenomena using the Phonological Epistemological Principle and Element Theory, we might conclude that the ratio is not so overwhelmingly in favor of one-to-one relationship. And secondly, given the arbitrary spell-out the phonological categories need not correspond to phonetic labels at all. In the extreme case the phonological elements could be numbers, shapes or colors. Current Element Theory has not gone that far. However, it seems to do enough to remove phonological categories from phonetic ones. Recall that Harris defines elements in terms of gross acoustic patterns. In this sense, we could say that phonological elements are idealizations of the acoustic cues they have been related to in acquisition.

Scheer (2014b) gives yet another explanation for the general one-to-one correspondence as well as the observed mismatches. In his view, this overall picture follows from diachronic development in which phonetic faithfulness is present only in the case of fresh lexicalizations of phonological processes, and it may wane by aging and rule telescoping.

### 11.2.2.3 Modular constraints on translation

In this section we focus on constraints on translation which follow from the modular organization of grammar shown in (4) above (Scheer 2014b: 258–260). Thus the general constraints established on the basis of the interface between phonology and morpho-syntax will be enumerated and applied to the translation of phonological output into phonetic alphabet.

One of the properties is that spell-out through lexical access must take a form of *list-type conversion*. This means that phonological categories are lexically associated with particular phonetic categories and stored in the long-term memory. This does not preclude diachronic change, however. We should probably add a speculation that there is no size limitation as to how much phonological structure is associated to a given phonetic exponent. This point may look a little unconstrained and probably requires some more explicitness. However, there is ample evidence from existing studies within GP in which chunks larger than one segment are subject to a phonetic interpretation suggesting that we are dealing with a single segment or simplex representation. Scheer (2014b: 263) calls this phenomenon virtual length, which

is a case in which phonological length that is typically interpreted in phonetics as duration may sometimes be spelt out differently. One example of this situation is the English angma. The velar nasal [ŋ] has been shown to be a phonological cluster /ng/ (e.g. Gussmann 1998). Numerous studies within GP also show that in some languages phonological length of vowels is not distinctive phonetically. For example, in Apulian dialects of Italian (Bucci 2013a, 2013b) phonological length of vowels translates as non-reduction, while short vowels are reduced to schwa. Finally, there are studies which demonstrate that consonantal length is interpreted as shortness of the preceding vowel (Caratini 2009; Cyran 1996; Ségéral & Scheer 2001).

Another property of inter-modular translation is its necessarily *non-computational* nature. The very fact that we are dealing with two distinct modules precludes a computational translation from one system to the other. In our view, contrary to the dominating outlook in the phonological tradition since SPE to this day, it is impossible to imagine how some computational system would turn morpho-syntactic features into phonological categories, or a phonological system into phonetic categories for that matter.

*Arbitrariness* is a consequence of inter-modular translation that we have already mentioned above. What needs to be added here is the perspective from which we need to look at it. The arbitrariness that we observe at the interface between morpho-syntax and phonology mentioned above is never a problem for acquisition or spell-out. The arbitrary relation between the phonological form and the meaning in German *Hund* and Polish *pies* for 'dog' is simply established in acquisition. Thus, we need to bear in mind that the actual synchronic state of the grammar at any level, including the phonology-phonetics interface, came into being from an opposite direction to production. The original decision in the construction/internalization of grammar was to connect exponents located in the input to particular features of grammar at higher levels. Thus, there is never a problem with externalization of a previously internalized grammar. Spell-out does not decide on anything; it is merely an activation of an existing, previously formed connection. In this sense, arbitrariness is also fully compatible with Kaye's Phonological Epistemological Principle. The connections need not be one-to-one.

A final property that follows from the general behavior of translation is *exceptionlessness of conversion*. Lexical relations are never mistaken or prone to error. Just like at the upper interface: there is 100% regularity of the match between past tense and '-ed'. Here we observe a convergence of this property as diagnostic of spell-out, that is, phonetic interpretation of phonological representation, as well as of truly phonological processes. Note that, like in Natural Generative Phonology (e.g. Hooper 1976), GP also claims that processes which have exceptions must not be viewed as phonological. The obvious question then is how to tell the difference between 100% regular phonological processes and 100% regular spell-out effects, which will also amount to alternations in some cases. The dilemma is not trivial and requires further study. We need to know how to distinguish the two types of phenomena, as well as to know for what reasons. It may turn out that this ambiguity is not unwelcome.

To illustrate the ambiguity described above we may briefly look at the alternation [v~w] in Belarusian (Scheer 2012b: 223–231).<sup>15</sup> Within a word, the distribution of the two allophones is clear and can be described in traditional terms as [v] occurring in the ONSET, that is, pre-vocalically, and [w] in the 'coda' position, that is, pre-consonantly and word-finally, which in GP terms translates as: in front of an empty nucleus (cf. Chapter 10.2.3.3). Thus, in *korov-a* 'cow, nom.sg.' and *vad-a* 'water' we get [v], while in *korow-ka* 'cow, dim.nom.sg.' and *korow* 'cow, gen.pl.' the glide [w] is found. To a great extent, given the

conflation of regular spell-out and regular phonology, the descriptive problem with this allophony resembles that of English aspiration, namely, two distinct analyses can be offered. If the alternation is phonological, some phonological computation must be assumed to derive it. One simplified analysis will be shown presently. If, on the other hand, the alternation is purely interpretational (a case of post-phonological spell-out), then no derivation of /v/→/w/, or /w/→/v/ should be assumed. Rather, we would be dealing with a spell-out of the same representation as two distinct phonetic objects in the relevant contexts, say, |U|↔[w]/\_ø, and |U|↔[v]/\_V. That such an interpretational shift must have occurred in most Slavic languages is argued for in e.g. Cyran (2014b), who additionally eschews |U|→|U| as a possible phonological process of strengthening. On the other hand, loss of headedness under weak licensing |U|→|U| is licit. Below we compare the two stories: phonological and interpretational.

In the phonological analysis, we follow Scheer's assumption that the underlying representation is /v/, that is, headed-|U|. In (5a) below, we observe the derivation of the weak [w], which, to simplify things a little, may be said to occur under weak licensing of the following empty nucleus and takes the form of loss of headedness. The pre-vocalic context in (5b) provides sufficient licensing for the headedness of |U|, therefore the result of computation is the same as the lexical representation. (5c), on the other hand, shows the same alternation viewed as a case of spell-out. This time, since there is no phonological computation, it does not matter if the underlying segment is |U| or |U|. We go for the headless one. It should be noted that the point that is made here is entirely independent of the phonological theory used. Whether we use the Element Theory in GP, or a different model, the phonological/computational analysis will involve a syllable-based change of phonological identity of /v/ to /w/ in the coda (or in front of an empty nucleus in GP), while in the spell-out analysis, the same phonological object undergoes context-sensitive spell-out, not a change of identity. Below in (5) we provide phonological representations of whole words, but the focus is on the element |U|. Note that the role of context in the phonological analysis (5a,b) is instrumental in computation, but irrelevant for spell-out in that it takes a list-type translation: |U| ↔ [v], |U| ↔ [w]. On the other hand, in the spell-out analysis (5c), the context plays a role in distinguishing the two phonetic outcomes of the same phonological object: |U| ↔ [w]/\_ø, |U| ↔ [v]/elsewhere.

(5) Phonological representation and computation		Spell-out	
a.	/koro <u>U</u> ø/ → /koroUø/	↔ [korow]	U  ↔ [w]
	/koro <u>U</u> øka/ → /koroUøka/	↔ [korowka]	U  ↔ [w]
b.	/koro <u>U</u> a/ → /koroUa/	↔ [korova]	U  ↔ [v]
c.	/koroUø/	↔ [korow]	U  ↔ [w]/_ø
	/koroUøka/	↔ [korowka]	U  ↔ [w]/_ø
	/koroUa/	↔ [korova]	U  ↔ [v]/elsewhere

There is no *a priori* reason why the computational analysis should be superior to the interpretational one. In fact, it is argued in Cyran (2014b) that (5c) must have been the initial stage of the strengthening shifts involving the Common Slavic \*w. It was interpretational at first, and then phonologized.<sup>16</sup> (5a,b) are cases of phonologization of that shift, turning it into a computational phenomenon and allowing for further shifts including a lexicalization of the sonorant-like [v], that is, |U|, as the full-blown obstruent /v/, that is, |U.h.L| in some modern Slavic languages, e.g. Polish. For the shift from (5c) to (5a,b) to occur, a phonological condition must be fulfilled. Namely, the distribution of strong (headed) and weak (headless) objects must correlate with prosodically defined strong and weak positions, to ensure that the distribution of headedness is phonologically/computationally non-arbitrary.

To conclude, the ambiguity between 100% regular spell-out and 100% regular phonology is in fact a welcome situation because it describes the conditions for diachronic change to occur: it is a phonologization of shifts that originate in spell-out.

So far, we have looked at the global modularity-based argument for post-phonological spell-out, and have added some empirical flesh to it as well as shown some consequences. Below, we look at how very much the same conclusions have been reached from a data-based end, which, however, could not be possible if a particular strict version of Element Theory was not assumed.

#### 11.2.2.4 Laryngeal relativism

Apart from the global perspective of modularity and cognitive science presented in Scheer (2014b), one may argue for the arbitrariness of the phonology-phonetics spell-out from a theory-specific point of view, coupled with empirical solutions (Cyran 2011, 2014a). What is rather impossible and futile, as will transpire below, is approaching the spell-out problem from a purely empirical, data-based or 'phonetic-facts-based' position.

Laryngeal phonology is one of the few areas in the field where similar representational views seem to be held across frameworks. The main one is privativity of laryngeal categories. In recent years, laryngeal realism (Iverson & Salmons 1995; Honeybone 2005; Harris 2009) seems to have gained wide acceptance. It assumes, for example, that languages with a two-way laryngeal contrast divide into two different systems with different categories involved in the privative marking. The so-called 'voicing' languages (e.g. Slavic and Romance) oppose fully voiced stops with voiceless unaspirated ones, while 'aspiration' languages (typically Germanic) contrast voiceless aspirated stops with the voiceless unaspirated or passively voiced ones. The three phonetic categories – that is, fully voiced, voiceless unaspirated and voiceless aspirated – form a well-known continuum along the VOT dimension (Lisker & Abramson 1964). The guiding principle in laryngeal realism is that phonological categories correspond to the members which constitute a VOT displacement from the neutral, that is, voiceless unaspirated. Thus, for example, Polish voiced obstruents must be defined by the presence of the element |L|, which corresponds to traditional [+voice]. We will symbolize such voiced obstruents as C<sup>L</sup>. On the other hand, the voiceless unaspirated series are neutral (unmarked), that is, C<sup>°</sup>. In contrast, English fortis series are C<sup>H</sup>, where the element |H| roughly corresponds to [spread glottis], and are opposed to C<sup>°</sup>. Within GP, laryngeal realism is widely recognized in Harris (1994, 2009); Honeybone (2005); and Gussmann (2007).

In the light of our discussion above, it is immediately obvious that laryngeal realism, although it constitutes a welcome advancement in the theory of subsegmental representation, is not exactly compatible with the expected arbitrariness, which is one of the offshoots of post-phonological spell-out stemming from an independent modular status of phonology and phonetics introduced above. The one-to-one relationship between the phonetic cue 'negative VOT' and the representation of that cue as element |L| is anything but arbitrary in nature. The assumption that, when met with a two-way contrast [b-p] in acquisition, the child will automatically assign a marked status to the voiced obstruent, rather than to the voiceless one, is also incompatible with Kaye's Phonological Epistemological Principle. What if the phonological behavior of the objects in question suggests a reversed marking? One such situation is discussed below.

Laryngeal realism seems to fail when confronted with a number of phenomena. One case in point is Polish, in which thus understood laryngeal realism allows us to understand only one of the two main dialect groups, and leaves us helpless with respect to the celebrated

phenomenon of Cracow-Poznań (CP) sandhi voicing. In order to fully appreciate the arguments below, we need to be clear about a basic theoretical assumption of Element Theory which we wish to strictly adhere to, namely, privativity. This means that two-way contrasts are represented by the presence versus absence of one phonological category (element). And more importantly, the absence of contrast means that there is no marking. The latter situation refers to sonorants, that is, vowels and sonorant consonants, which are neutral from the point of view of laryngeal specification (V<sup>p</sup>, S<sup>°</sup>), and their voicing is spontaneous.

The main voicing phenomena in Polish, to simplify things a little, are final obstruent devoicing (FOD) and voicing assimilations (VA) between obstruents. Both processes involve phonological computation in the form of delaryngealization (element deletion) before an empty nucleus, and spreading. Phonetic interpretation also seems to play an important role in the phenomena. Given the assumption of laryngeal realism, the voiced obstruents in Polish have |L|, and the phenomena can be described in the following way. The alternation *waga/wag* [vaga ~ vak] 'scale, nom.sg./gen.pl.' with FOD involves loss of |L| before an empty nucleus: /vag<sup>L</sup>a/ ~ /vag<sup>L</sup>ø/ → /vag<sup>°</sup>ø/ ↔ [vak]. Recall that the laryngeally neutral obstruent must be spelt out as [k]. One of the regressive assimilations also involves a similar mechanism. Namely, in the alternation *kawa/kawka* [kava ~ kafka] 'coffee, nom.sg./dim.', the only phonological operation involved is also delaryngealization of /v<sup>L</sup>/: /kav<sup>L</sup>a/ ~ /kav<sup>L</sup>øk<sup>°</sup>a/ → /kav<sup>°</sup>øk<sup>°</sup>a/ ↔ [kafka]. Note that this assimilation is not due to spreading because the following obstruent is neutral as well and has nothing to spread. Thus, the phonological computation is limited to delinking of |L|, while the actual assimilation is merely interpretative, that is, a case of spell-out. Spreading is present in the alternation *prosić/prośba* [prošit̪ ~ prozba] 'to ask/a request' in that |L| spreads from /b<sup>L</sup>/ leftwards: /proš<sup>°</sup>it̪ø/ ~ /proš<sup>°</sup>øb<sup>L</sup>a/ → /proš<sup>L</sup>øb<sup>L</sup>a/ ↔ [prozba].

The phenomena of FOD and VA, as well as the existence of the voiced/voiceless distinction, are uniform in all dialects of Polish. The differences come out in the so-called pre-sonorant CP sandhi voicing, which is not observed in Warsaw Polish (WP).

(6)		WP	CP	
a.	<i>grup otwartych</i> 'open groups'	p-ɔ	b-ɔ	_V <sup>p</sup>
	<i>grób otwarty</i> 'open grave'	p-ɔ	b-ɔ	
b.	<i>grup matek</i> 'groups of mothers'	p-m	b-m	_S <sup>°</sup>
	<i>grób matek</i> 'grave of mothers'	p-m	b-m	
c.	<i>grup dorosłych</i> 'groups of adults'	b-d	b-d	_C <sup>L</sup>
	<i>grób dorosłych</i> 'grave of adult'	b-d	b-d	
d.	<i>grup takich</i> 'such groups'	p-t	p-t	_C <sup>°</sup>
	<i>grób takich</i> 'grave of such'	p-t	p-t	

We can immediately eliminate (6c,d) from our discussion as the results are the same in both dialects. Within laryngeal realism, (6c) is a case of |L|-spreading from the following C<sup>L</sup>, while (6d) is due to |L|-deletion. Let us note that just as in all the other examples in (6), we are dealing with a neutralization of the laryngeal distinction in word-final context, in that the lexical distinction is lost.

(6a,b) appear to be fully predicted as far as WP is concerned. Given that |L| is neutralized in the word-final context, and the following sonorants do not possess a spreadable laryngeal element |L|, it is expected that the final obstruents will be uniformly voiceless. This, however, is not what happens in CP. Both types of obstruents, that is, lexically voiced and lexically voiceless, are voiced in front of vowels and sonorant consonants.

It is clear that we are not dealing with mere retention of [L] in these forms, because that would concern only the lexically voiced obstruents. The alternative solution, then, must be that voicing comes from the following sonorants. This is problematic for laryngeal realism because we suddenly have to admit that sonorants may be marked with [L], but only in CP. Needless to say, this is not even an option within the strict version of Element Theory (Harris 1994).

An alternative solution was proposed in Cyran (2011, 2014a), which retains strict privativity and non-marking of sonorants and applies the Phonological Epistemological Principle in contravention of the principles of laryngeal realism. Under this new proposal, given the two-way contrast [b-p], the choice of which series is to be marked depends on the phonological behavior alone. This leads us to an inverted laryngeal marking in CP, one in which the full voicing is a spell-out of an unmarked object, while the voiceless object has [H] as in typical 'aspiration' languages, except that with no aspiration.

Let us first see how this reversed system handles the familiar processes of FOD and VA. It appears that the interpretative system must be quite different from that of WP, while the phonology, except for the inverted marking, remains identical. FOD in the alternation *waga/wag* no longer involves delaryngealization. It is simply a case of absence of passive voicing which is observed in /vag<sup>o</sup>a/ ↔ [vaga] in phonetically non-voiced environment: /vag<sup>o</sup>ø/ ↔ [vak]. Thus, the new situation here is that FOD is phonological in WP, but interpretational (spell-out), and thus in a sense phonetic, in CP. Assimilations are surprisingly non-problematic in this inverted system. The alternation *prosić/prośba* involves regular delaryngealization in front of an empty nucleus: /prɔɛ<sup>H</sup>øb<sup>o</sup>a/ → /prɔɛ<sup>o</sup>øb<sup>o</sup>a/ ↔ [prɔzba], cf. /prɔɛ<sup>H</sup>itɛø/ ↔ [prɔɛitɛ]. This is a case of phonetic/interpretational assimilation (passive voicing). Finally, the alternation *kawa/kawka* is a case of absence of passive voicing in front of a phonetically voiceless obstruent, which is marked to be so: /kav<sup>o</sup>a/ ↔ [kava] ~ /kav<sup>o</sup>øk<sup>H</sup>a/ ↔ [kafka]. It is possible to talk about [H]-spreading here, but it is not even necessary. The neutral obstruent requires a following voiced context in order to be pronounced voiced in this dialect.

We saw in the sandhi data that the word-final context neutralizes the laryngeal distinction. This means that in WP the element [L] is lost, while in CP it is [H]. Both dialects end up with a neutral C<sup>o</sup> in that context. However, these are systemically different animals. In WP, C<sup>o</sup> may be voiced only if [L] is spread from the following word, as we see in (6c). In CP, on the other hand, all that is required now is a phonetically voiced segment in the following word and the neutral C<sup>o</sup> should be spelt out as voiced through passive voicing, which it does in (6a–c). It is important to realize that this analysis does not require any rule of CP sandhi voicing. The phonetic interpretation of C<sup>o</sup> in sandhi is exactly the same as word-internally, that is, C<sup>o</sup>V = C<sup>o</sup>#V, C<sup>o</sup>S = C<sup>o</sup>#S, C<sup>o</sup>C<sup>o</sup>V = C<sup>o</sup>#C<sup>o</sup>V, and C<sup>o</sup>C<sup>H</sup>V = C<sup>o</sup>#C<sup>H</sup>V.

Thus, it is possible to provide an analysis of CP sandhi voicing without compromising strict privativity and non-marking of sonorants. There is also no need for rule ordering (Rubach 1996). The phonological computation (delaryngealization and spreading) naturally precedes spell-out. All that we did was apply all principles of GP and Element Theory strictly, including the Phonological Epistemological Principle. But, as a consequence, we need to break with laryngeal realism. The phonological marking of laryngeal contrasts is not given directly in the signal. The signal provides information that we need a category to distinguish two series, as well as plenty of information concerning the behavior of these two series. It is the latter type of information that determines the type of marking, which happens to be reversed in the two dialects of Polish.

As with the two alternative analyses of [v~w] in Belarusian, discussed above, we observe similar consequences of the presence of post-phonological spell-out. One of them is the ambiguous nature of phonetic facts. Voicing can be phonological, with an active phonological category which will participate in phonological processing such as deletion and spreading, but it may also be a result of a particular systemic spell-out, in which case it is more phonetic in nature, and phonetics-dependent. FOD is phonological in WP and interpretational in CP. Assimilations can be due to spreading, but also due to interpretation. Thus, all these phenomena must be treated with caution, and representational conclusions must not be drawn on the basis of phonetic properties alone. Such is laryngeal relativism.<sup>17</sup>

### 11.2.3 Further issues and perspectives

This section is to some extent speculative. One of the main aims for future research within the program sketched above, in which phonology and phonetics are separate modules and communicate through arbitrary translation, is first to delineate the two linguistic modules and define their disparate characteristic behavior, as well as determine the principles of translation, if there are others than the ones discussed in section 11.1.2.2 above. This is not an easy task. One reason for this difficulty lies in the fact that the delineation should be radical if it is going to bring any results.<sup>18</sup> Otherwise, the boundary between phonology and phonetics will continue to be unclear. For example, the assumption of substance-free phonology, for which the presented model of Element Theory seems to be cut out, does not seem to loom on the horizon even though this should be the very first step in order to move on. GP in general is also best suited to explore such a path.

The phonological module as practiced in current versions of GP is much smaller than generally assumed in other models (cf. Chapter 9, section 1.3). It simply involves mostly syllabic representation with privative elements and very restricted computation limited to the arrangement of government and licensing and a small number of melodic operations such as decomposition (e.g. lenition, that is, delinking of elements) and composition which must involve spreading of a property from a local source, e.g. [L]-spreading in voicing assimilation, or resonance element spreading in vowel harmony. The only phonetic presence in this theory is the acoustic definition of phonological elements, and possibly, the very division of the skeleton into Cs and Vs.

The definition of phonetics as a computational module is not simple either. A number of universal principles which can be harnessed to explain linguistic sound systems by providing, for example, the rationale for particular phonetic categories used as spell-out targets in phonology–phonetics translation, may be claimed not to be phonetic, but rather belonging to more general cognitive strategies parallel to other non-linguistic ones. The quantal theory of Stevens (1972) or the dispersion theory (Liljencrants & Lindblom 1972; Schwartz et al. 2007) are interesting proposals within phonetic theory, but are they really talking about phonetics-specific properties of the human brain? Inference in perceptual studies might be viewed as a good candidate to pass for computation in the phonetic module (Reiss 2007), but is it really only phonetic? The same principles hold in visual perception. The 'phonetic' nature of voicing is in fact physics (aerodynamics). Thus, our views on phonetics as a linguistic module must also crystalize. It is possible that the grammar–non-grammar boundary runs between phonology and phonetics. This does not undermine the scheme in (4) showing inter-modular communication. It just tells us that the translation between phonology and phonetics is still more complex than we envisage today.



### 11.3 Further reading

Kaye, Jonathan 1995. Derivations and interfaces. *Frontiers of Phonology*, edited by Jacques Durand & Francis Katamba, 289–332. London & New York: Longman. (Also in *SOAS Working Papers in Linguistics and Phonetics* 3, 1993, 90–126.)

Introduces the concepts of domain structure (akin to cycles) and analytic vs. non-analytic morphology (akin to class 1 vs. class 2 affixes in English). Morphological boundaries are either visible (analytic) or invisible (non-analytic) to phonological computation. The article introduces what will later be known as Phase Impenetrability (robustness) and the Phase Edge (the sister of a phase-relevant node is spelt out, rather than the node itself).

Scheer, Tobias 2014. The initial CV: Herald of a non-diacritic interface theory. *The Form of Structure, the Structure of Form: Essays in Honor of Jean Lowenstamm*, edited by Sabrina Bendjaballah, Noam Faust, Mohamed Lahrouchi & Nicola Lampitelli, 315–330. Amsterdam: Benjamins.

Lowenstamm (1999) has introduced the idea that morpho-syntactic information may incarnate into a truly phonological object that exists anyway (a CV unit), rather than into a diacritic (#, ω). This article explains from hindsight how the initial CV has paved the way of a non-diacritic interface theory.

Scheer, Tobias 2012. *Direct Interface and One-Channel Translation: A Non-Diacritic Theory of the Morphosyntax-Phonology Interface: Vol.2 of A Lateral Theory of Phonology*. Berlin: de Gruyter.

The book introduces and motivates a non-diacritic theory of the interface, i.e. where phonological carriers of morpho-syntactic information are true phonological objects that are also used beyond interface issues. This theory is theory-neutral, i.e. may be implemented into any individual phonological theory. Its incarnation using the representational vocabulary of Strict CV is described.

Lampitelli, Nicola 2013. The basic elements of inflection: Morphophonology of Bosnian nouns. *Formal Approaches to Slavic Linguistics 20: The Second MIT Meeting 2011*, edited by Alexander Podobryaev, 154–170. Ann Arbor: Michigan Slavic Publications.

Exposes and illustrates the idea that morphological units may spell out as subsegmental phonological items (elements), rather than as full vowels, consonants or combinations thereof. Hence in Bosnian, the nominative plural of the feminine declension is [-ε] and decomposes into A (feminine), I (plural) and zero (nominative).

Harris, John 1996. Phonological output is redundancy-free and fully interpretable. *Current Trends in Phonology. Model and Methods*, edited by Jacques Durand & Bernard Laks, 305–332. Salford, Manchester: ESRI.

Presents a clear picture of phonetic interpretation in GP and argues against the view that phonological derivation produces representations which are closer to the systematic phonetic level.

Harris, John 2009. Why final obstruent devoicing is weakening. *Strength Relations in Phonology*, edited by Kuniya Nasukawa & Phillip Backley, 9–45. Berlin and New York: Mouton de Gruyter.

The paper is a good example of a dominant philosophy concerning the relationship between phonology and phonetics in GP, placing emphasis on extracting phonological information from the signal.

Scheer, Tobias 2014. Spell-out, post-phonological. *Crossing Phonetics-Phonology Lines*, edited by Eugeniusz Cyran & Jolanta Szpyra-Kozłowska, 255–275. Newcastle upon Tyne: Cambridge Scholars Publishing.

This programmatic paper places the phonology–phonetics interaction in a broad context of all inter-modular communication in language, arguing, for example, for arbitrariness of spell-out.

Cyran, Eugeniusz 2014. *Between Phonology and Phonetics: Polish Voicing*. Berlin: Mouton de Gruyter. This is a book-length study of voicing phenomena in Polish from the perspective of the phonology–phonetics interaction. It argues for an arbitrary relation between these two domains.

### Notes

- 1 Scheer (2011: §26, 2016b) provides discussion of the general environment, including approaches that lie beyond the modular frame.
- 2 See Nasukawa (2011, 2016) for an approach called Precedence-Free Phonology where linearity does not pre-exist phonological computation (upon production) but follows from dependency relations among the units of phonological hierarchical structure.
- 3 Though, following SPE, with an implicit recognition of a specific treatment of the word level (see Scheer 2011: §338).
- 4 See Scheer (2011: §271) for more discussion regarding the combination of concat and φ, Gussmann (2002: 45ff.) for a general introduction to domain structure.
- 5 A more detailed review of no-look-back devices that the literature has accumulated since 1973 is available in Scheer (2011: §287).
- 6 Scheer (2014a) provides an overview of the offspring of this idea, also including a more detailed discussion of the material covered below.
- 7 Kula & Marten (2009) discuss the strength of word-initial consonants in languages that lack word-initial clusters.
- 8 The history of diacritics in Prosodic Phonology is documented in Scheer (2011: §365): in the early 1980s linear diacritics (SPE-type #'s) were replaced by autosegmental diacritics (ω etc.).
- 9 To be precise: the higher levels of the Prosodic Hierarchy from the Prosodic Word ω on have to go. Feet, syllables and moras are different because they are bottom-up constructions, i.e. the projection of basic units. By contrast, the Prosodic Word etc. is the projection of nothing (see Scheer 2012b: §138).
- 10 Apart from elements and their combinations, phonological structure can also be directly interpreted, except for empty positions. For example, association of a resonance element to two skeletal positions (long vowel) may produce a tenser variety than the same element linked to just one position (cf. English [ɪ] vs. [i:]). Coda-onset governing relations of the Standard GP type have also been assumed to be interpreted as 'stopness' leading to the elimination of the occlusion element [ʔ] (Jensen 1994). In more recent proposals under the banner of GP 2.0, the former element |A| is expressed phonologically as a subsegmental tree structure akin to syntactic ones (Pöchtrager & Kaye 2013). The latter proposal is very much in the spirit of standard Element Theory in that a universal one-to-one connection between representation and phonetic interpretation is assumed, an idea that we attempt to dismantle in this chapter.
- 11 Although the emergent nature of elements within GP is not an accepted view, it will be shown that arbitrariness of spell-out leads directly to this conclusion. This does not mean that elements cannot be defined in terms of universal acoustic patterns. All that it means is that the relation is not innate (e.g. Mielke 2008). The supposed universality is due to phonetic and functional factors such as the characteristics of the vocal tract and perception.
- 12 The claim that phonology and phonetics are separate modules will not be argued for here. It follows from the phonological model assumed here, that is, GP, which is sharply distinguished from phonetics. It is also an open question what counts as phonetics and what phonetic computation might look like and if it is indeed necessary to conceive of such a module. The absence of computation in phonetics would appear to weaken the global picture in which each module is characterized, among other things, also by possessing its own domain-specific battery of computational operations.
- 13 For this reason, the symbol '↔' to refer to spell-out, which is used in Scheer (2014b), touches the heart of the matter. The translation relation is bi- if not non-directional. It is static in a fully developed grammar, and facilitates parsing in perception as well as articulation in production. Note that at the acquisition stage, it is in fact the reverse direction from the one assumed in the production-oriented perspective: the phonological representation is established on the basis of phonetic input (phonology ← phonetics).
- 14 For a general Slavic perspective on the labial glide strengthening within GP, see e.g. Cyran & Nilsson (1998) and Cyran (2014b).
- 15 In fact the alternations involve [u~w~v] and are much more complicated than presented here. For example, the discussion in Scheer (2012b) aims to capture the phonological behavior of these allophones with respect to word boundaries. We will limit ourselves to the word-internal situation. This, however, has no consequence on the argument in question.
- 16 The reason why strengthening [w]>[v] could not be phonological at the initial stage follows from a strict application of Element Theory, which limits potential phonological processes to

decomposition (element loss) and composition (addition of elements and properties like headedness) as a result of spreading. Thus, obstruentization as a synchronic process is also ruled out because there is no local source of spreading of headedness. Obstruentization may only occur as a phonologization of a spell-out pattern.

- 17 See van der Hulst (2014) for an analysis of Dutch in the spirit of laryngeal relativism. His conclusion is not only that Dutch (a 'voicing' language by laryngeal realism standards) is an [H]-system like CP, but he also proposes that all two-way systems are [H]-marked, thus taking laryngeal relativism to the extreme, and killing it at the same time: if the representation is rigid, we are back to laryngeal realism, except reversed.
- 18 See, for example, the proposal of van der Hulst (1995) and his later attempts to provide structural configurations as phonological categories corresponding to phonetic substance. This structural view of melody, which finds an echo in the recent work of Pöchtrager & Kaye (2013), requires only one step towards 'substance-free' phonology, that is, assume arbitrary spell-out rather than one-to-one relations between particular structures and their phonetic interpretation.

## References

- Andersen, Hening 1969. The phonological status of the Russian labial fricatives. *Journal of Linguistics* 5: 121–127.
- Arbaoui, Nora 2010. Les dix formes de l'arabe classique à l'interface syntaxe/phonologie. Ph.D. thesis, Université Paris 7.
- Backley, Phillip 2011. *An Introduction to Element Theory*. Edinburgh: Edinburgh University Press.
- Backley, Phillip & Kuniya Nasukawa 2009. Representing Labials and Velars: A single 'dark' element. *Phonological Studies* 12: 3–10.
- Bendjaballah, Sabrina 1999. Trois figures de la structure interne des gabarits. Ph.D. dissertation, Université Paris 7.
- Bendjaballah, Sabrina 2001. The negative preterite in Kabyle Berber. *Folia Linguistica* 34: 185–223.
- Bendjaballah, Sabrina 2012. La grammaire des gabarits. Habilitation à Diriger des Recherches, Université Paris 7.
- Bendjaballah, Sabrina & Martin Haiden 2003. Templatic architecture. *Recherches Linguistiques de Vincennes* 32: 157–168.
- Bendjaballah, Sabrina & Martin Haiden 2013. The representational anomalies of floating markers: Light prepositions in Taqbaylit of Chemini. *Challenges to Linearization*, edited by Theresa Biberauer & Ian Roberts, 331–376. Berlin: de Gruyter.
- Bermúdez-Otero, Ricardo & Kersti Böjars 2006. Markedness in phonology and in syntax: The problem of grounding. *Linguistic Knowledge: Perspectives from Phonology and from Syntax*, edited by Patrick Honeybone & Ricardo Bermúdez-Otero, *Lingua* 116(5) (special issue): 710–756.
- Boersma, Paul 1998. *Functional Phonology. Formalizing the Interactions between Articulatory and Perceptual Drives*. The Hague: Holland Academic Graphics.
- Bucci, Jonathan 2013a. Raddoppiamento Fonosintattico indotto par l'accent et reduction vocalique en Italie: perspectives phonologique et dialectologique. Ph.D. dissertation, Université de Nice, Sophia Antipolis.
- Bucci, Jonathan 2013b. Voyelles longues virtuelles et reduction vocalique en coratin. *Canadian Journal of Linguistics* 58(3): 397–414.
- Caratini, Emilie 2009. Vocalic and consonantal quantity in German: Synchronic and diachronic perspectives. Ph.D. dissertation, Nice University and Leipzig University.
- Charette, Monik 2003. Empty and pseudo-empty categories. *Living on the Edge: 28 Papers in Honour of Jonathan Kaye*, edited by Stefan Ploch, 465–479. Berlin and New York: Mouton de Gruyter.
- Chomsky, Noam 1965. *Aspects of the Theory of Syntax*. Cambridge, MA: MIT Press.
- Chomsky, Noam 1973. Conditions on transformations. *A Festschrift for Morris Halle*, edited by Stephen Anderson & Paul Kiparsky, 232–286. New York: Holt, Rinehart & Winston.
- Chomsky, Noam 2000. Minimalist inquiries: The framework: Step by step. *Essays on Minimalist Syntax in Honor of Howard Lasnik*, edited by Roger Martin, David Michaels & Juan Uriagereka, 89–155. Cambridge, MA: MIT Press.
- Chomsky, Noam, Morris Halle & Fred Lukoff 1956. On accent and juncture in English. *For Roman Jakobson: Essays on the Occasion of His Sixtieth Birthday*, edited by Morris Halle, Horace Lunt, Hugh McLean & Cornelis van Schooneveld, 65–80. The Hague: Mouton.
- Cyran, Eugeniusz 1996. Licensing properties of nuclei and principle ranking in Irish. *The Linguistic Review* 13: 1–31.
- Cyran, Eugeniusz 2011. Laryngeal realism and laryngeal relativism: Two voicing systems in Polish? *Studies in Polish Linguistics* 6: 45–80.
- Cyran, Eugeniusz 2014a. *Between Phonology and Phonetics: Polish Voicing*. Berlin: Mouton de Gruyter.
- Cyran, Eugeniusz 2014b. The phonology and phonetics of obstruentization. *Crossing Phonetics-Phonology Lines*, edited by Eugeniusz Cyran & Jolanta Szpyra-Kozłowska, 31–46. Newcastle upon Tyne: Cambridge Scholars Publishing.
- Cyran, Eugeniusz & Morgan Nilsson 1998. The Slavic [w > v] shift: A case for phonological strength. *Structure and Interpretation: Studies in Phonology*, edited by Eugeniusz Cyran, 89–100. Lublin: Foliu.
- D'Alessandro, Roberta & Tobias Scheer 2013. Phase head marking. *Linguistic Analysis* 38: 305–330.
- D'Alessandro, Roberta & Tobias Scheer 2015. Modular PIC. *Linguistic Inquiry* 46: 593–624.
- Embick, David & Rolf Noyer 2007. Distributed morphology and the syntax-morphology interface. *The Oxford Handbook of Linguistic Interfaces*, edited by Gillian Ramchand & Charles Reiss, 289–324. Oxford: Oxford University Press.
- Faust, Noam 2013. Decomposing the feminine suffixes of modern Hebrew. *Morphology* 23: 409–440.
- Guerssel, Mohand & Jean Lowenstamm 1990. The derivational morphology of the classical Arabic Verb. Ms., UQAM and University Paris 7.
- Gussmann, Edmund 1998. Domains, relations and the English angma. *Structure and Interpretation. Studies in Phonology*, edited by Eugeniusz Cyran, 101–126. Lublin: Foliu.
- Gussmann, Edmund 2002. *Phonology: Analysis and Theory*. Cambridge: Cambridge University Press.
- Gussmann, Edmund 2007. *The Phonology of Polish*. Oxford: Oxford University Press.
- Hale, Mark & Charles Reiss 2000. Substance abuse and dysfunctionality: Current trends in phonology. *Linguistic Inquiry* 31: 157–169.
- Hale, Mark & Charles Reiss 2008. *The Phonological Enterprise*. Oxford: Oxford University Press.
- Halle, Morris & Jean-Roger Vergnaud 1987. *An Essay on Stress*. Cambridge, MA: MIT Press.
- Hamann, Silke 2011. The phonetics-phonology interface. *The Continuum Companion to Phonology*, edited by Nancy Kula, Bert Botma & Kuniya Nasukawa, 202–224. London: Continuum.
- Hamann, Silke 2014. Phonetics-phonology mismatches. Paper presented at Old World Conference in Phonology, Leiden 22–25 January.
- Hamann, Silke & Paul Boersma (eds.) 2009. *Phonology in Perception*. Berlin: Mouton de Gruyter.
- Harris, John 1990. Segmental complexity and phonological government. *Phonology* 7(2): 255–300.
- Harris, John 1994. *English Sound Structure*. Oxford: Blackwell.
- Harris, John 1996. Phonological output is redundancy-free and fully interpretable. *Current trends in Phonology. Model and Methods*, edited by Jacques Durand & Bernard Laks, 305–332. Salford, Manchester: ESRI.
- Harris, John 2006. The phonology of being understood: Further arguments against sonority. *Lingua* 116(10): 1483–1494.
- Harris, John 2009. Why final obstruent devoicing is weakening. *Strength Relations in Phonology*, edited by Kuniya Nasukawa & Phillip Backley, 9–45. Berlin and New York: Mouton de Gruyter.
- Harris, John & Geoff Lindsey 1995. The elements of phonological representation. *Frontiers of Phonology. Atoms, Structures Derivations*, edited by Jacques Durand & Francis Katamba, 34–79. Harlow, Essex: Longman.
- Hayes, Bruce 1984. The phonetics and phonology of Russian voicing assimilation. *Language Sound Structure*, edited by Mark Aronoff & Richard T. Oehrle, 318–328. Cambridge, MA: MIT Press.
- Honeybone, Patric 2005. Diachronic evidence in segmental phonology: The case of laryngeal specifications. *The Internal Organization of Phonological Segments*, edited by Marc van Oostendorp & Jeroen van de Weijer, 319–354. Berlin: Mouton de Gruyter.

- Hooper, Joan 1976. *An Introduction to Natural Generative Phonology*. New York: Academic Press.
- Hulst, Harry van der 1995. Radical CV phonology: The categorical gesture. *Frontiers of Phonology. Atoms, Structures, Derivations*, edited by Jacques Durand & Francis Katamba, 80–116. Harlow, Essex: Longman.
- Hulst, Harry van der 2014. The laryngeal class in RcvP and voice phenomena in Dutch. *Above and Beyond the Segments: Experimental Linguistics and Phonetics*, edited by Johanneke Caspers, Yiya Chen, Willemijn Heeren, Jos Pacilly, Niels O. Schiller & Ellen van Zanten, 323–349. Amsterdam: John Benjamins Publishing Company.
- Hume, Elizabeth & Keith Johnson (eds.) 2001. *The Role of Speech Perception in Phonology*. New York: Academic Press.
- Iverson, Gregory & Joseph C. Salmons 1995. Aspiration and laryngeal representation in Germanic. *Phonology* 12: 369–396.
- Jensen, John 2000. Against ambisyllabicity. *Phonology* 17: 187–235.
- Jensen, Sean 1994. Is ? an element? Towards a non-segmental phonology. *SOAS Working Papers in Linguistics and Phonetics* 4: 71–78.
- Kaye, Jonathan 1989. *Phonology. A Cognitive View*. Hillsdale: Erlbaum. WEB.
- Kaye, Jonathan 1990. 'Coda' licensing. *Phonology* 7: 301–330. WEB.
- Kaye, Jonathan 1992. On the interaction of theories of Lexical Phonology and theories of phonological phenomena. *Phonologica 1988*, edited by Uli Dressler, Hans Luschützky, Oskar Pfeiffer & John Rennison, 141–155. Cambridge: Cambridge University Press. WEB.
- Kaye, Jonathan 1995. Derivations and interfaces. *Frontiers of Phonology*, edited by Jacques Durand & Francis Katamba, 289–332. London & New York: Longman. Also in *SOAS Working Papers in Linguistics and Phonetics* 3, 1993, 90–126. WEB.
- Kaye, Jonathan 2005. GP, I'll have to put your flat feet on the ground. *Organizing Grammar. Studies in Honor of Henk van Riemsdijk*, edited by Hans Broekhuis, Norbert Corver, Riny Huybregts, Ursula Kleinhenz & Jan Koster, 283–288. Berlin: Mouton de Gruyter.
- 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.
- Kingston, John 2007. The phonetics-phonology interface. *The Cambridge Handbook of Phonology*, edited by Paul De Lacy, 435–456. Cambridge: Cambridge University Press.
- Kiparsky, Paul 1982. From cyclic phonology to lexical phonology. *The Structure of Phonological Representations I*, edited by Harry van der Hulst & Norval Smith, 131–175. Dordrecht: Foris. WEB.
- Kula, Nancy & Lutz Marten 2009. Defining initial strength in clusterless languages in Strict CV. *Strength Relations in Phonology*, edited by Kuniya Nasukawa & Phillip Backley, 251–284. Berlin: de Gruyter.
- Lahrouchi, Mohamed 2001. Aspects morpho-phonologiques de la dérivation verbale en berbère (parler chleuh d'Agadir). Ph.D. dissertation, Université Paris 7.
- Lampitelli, Nicola 2010. Nounness, gender, class and syntactic structures in Italian nouns. *Romance Languages and Linguistic Theory 2008*. Selected papers from 'Going Romance' Groningen 2008, edited by Reineke Bok-Bennema, Brigitte Kampers-Manhe & Bart Hollebrandse, 195–214. Amsterdam: Benjamins.
- Lampitelli, Nicola 2011. Forme phonologique, exposants morphologiques et structures nominales: étude comparée de l'italien, du serbo-croate et du somali. Ph.D. dissertation, Université de Paris 7.
- Lampitelli, Nicola 2013. The basic elements of inflection: Morphophonology of Bosnian nouns. *Formal Approaches to Slavic Linguistics 20: The Second MIT Meeting 2011*, edited by Alexander Podobryaev, 154–170. Ann Arbor: Michigan Slavic Publications.
- Liljencrants, Johan & Bjorn Lindblom 1972. Numerical simulation of vowel quality systems: The role of perceptual contrast. *Language* 48(4): 839–862.
- Lisker, Leigh & Arthur Abramson 1964. A cross-language study of voicing in initial stops: Acoustical measurements. *Word* 20: 384–422.
- Lowenstamm, Jean 1999. The beginning of the word. *Phonologica 1996*, edited by John Rennison & Klaus Kühnhammer, 153–166. La Hague: Holland Academic Graphics. WEB.
- Lowenstamm, Jean 2003. *Grammaire et gabarits*. St.-Denis: Recherches Linguistiques de Vincennes 32.
- Lowenstamm, Jean 2008. On little n, √, and types of nouns. *Sounds of Silence: Empty Elements in Syntax and Phonology*, edited by Jutta Hartmann, Veronika Hegedüs & Henk van Riemsdijk, 105–143. Amsterdam: Elsevier.
- Lowenstamm, Jean 2011. The phonological pattern of phi-features in the perfective paradigm of Moroccan Arabic. *Brill's Annual of Afroasiatic Languages and Linguistics* 3: 140–201.
- Luo, Xiaoliang 2013. Vers une phonologie gabaritique du chinois. Analyse des interactions entre syllabe, ton et processus morphologiques. Ph.D. thesis, Université d'Orléans.
- Marvin, Tatjana 2002. Topics in the stress and syntax of words. Ph.D. dissertation, MIT.
- Mielke, Jeff 2008. *The Emergence of Distinctive Features*. Oxford: Oxford University Press.
- Molczanow, Janina 2008. *The Phonology of Glides in Russian*. München: Lincom Europa.
- Nasukawa, Kuniya 2011. Representing phonology without precedence relations. *English Linguistics* 28: 278–300.
- Nasukawa, Kuniya 2016. A precedence-free approach to (de-)palatalisation in Japanese. *Glossa* 1: article 9, DOI: <http://doi.org/10.5334/gjgl.26>.
- Nespor, Marina & Irene Vogel 1986. *Prosodic Phonology*. Dordrecht: Foris.
- Oostendorp, Marc van 1994. Affixation and integrity of syllable structure in Dutch. *Linguistics in the Netherlands 1994*, edited by Reineke Bok-Bennema & Crit Cremers, 151–162. Amsterdam: Benjamins.
- Pagliano, Claudine 2003. L'épenthèse consonantique en français. Ce que la syntaxe, la sémantique et la morphologie peuvent faire à la phonologie. Ph.D. dissertation, Université de Nice.
- Pak, Majorie 2008. The postsyntactic derivation and its phonological reflexes. Ph.D. dissertation, University of Pennsylvania.
- Passino, Diana 2008. *Aspects of Consonantal Lengthening in Italian*. Padova: Unipress.
- Passino, Diana 2011. Phonological traces of morphosyntactic phases: The phonology/syntax interface in the varieties of Italian: I luoghi della traduzione. *Atti del XLIII Congresso Internazionale della Società di Linguistica Italiana*, edited by Giovanna Massariello & Serena dal Maso, 849–864. Rome: Bulzoni.
- Passino, Diana 2014a. Dialectes italo-romans et théorie phonologique: un rapport d'enrichissement mutuel. Habilitation Thesis, Université de Nice Sophia Antipolis.
- Passino, Diana 2014b. An element-based analysis of Italian nominal inflection. *Selected Proceedings of Décembrettes 6, Morphology in Bordeaux*, edited by Fabio Montermini, Gilles Boyé & Jesse Tseng, 63–75. Somerville, MA: Cascadilla.
- Pöchtrager, Markus & Jonathan Kaye 2013. GP 2.0. *SOAS Working Papers in Linguistics* 16: 51–64.
- Prince, Alan 1985. Improving tree theory. *Proceedings of the 11th Annual Meeting of the Berkeley Linguistics Society*, edited by Mary Niepokuj, Mary VanClay, Vassiliki Nikiforidou & Deborah Feder, 471–490. Berkeley: University of California, Berkeley.
- Prunet, Jean-François 1986. Spreading and locality domains in phonology. Ph.D. dissertation, McGill University at Montreal. Published in 1992 by Garland Press.
- Prunet, Jean-François 1987. Liaison and nasalization in French. *Studies in Romance Languages*, edited by Carol Neidle & Rafael Nuñez Cedeño, 225–235. Dordrecht: Foris.
- Reiss, Charles 2007. Modularity in the 'sound' domain: Implications for the purview of universal grammar. *The Oxford Handbook of Linguistic Interfaces*, edited by Gillian Ramchand & Charles Reiss, 53–79. Oxford: Oxford University Press.
- Riemsdijk, Henk van 1978. *A Case Study in Syntactic Markedness*. Lisse: Peter de Ridder.
- Rubach, Jerzy 1996. Nonsyllabic analysis of voice assimilation in Polish. *Linguistic Inquiry* 27: 69–110.
- Rucart, Pierre 2006. Morphologie gabaritique et interface phonosyntaxique. Aspects de la morphologie verbale en afar. Ph.D. dissertation, Université Paris 7.
- Samuels, Bridget 2009. The structure of phonological theory. Ph.D. dissertation, Harvard University.
- Scheer, Tobias 1999. A theory of consonantal interaction. *Folia Linguistica* 32: 201–237. WEB.
- Scheer, Tobias 2000. De la Localité, de la Morphologie et de la Phonologie en Phonologie. Habilitation thesis, Université de Nice. WEB.

- Scheer, Tobias 2004. *A Lateral Theory of Phonology: Vol.1: What Is CVCV, and Why Should It Be?* Berlin: Mouton de Gruyter.
- Scheer, Tobias 2008a. Spell out your sister! *Proceedings of the 27th West Coast Conference on Formal Linguistics*, edited by Natasha Abner & Jason Bishop, 379–387. Somerville: Cascadilla. WEB.
- Scheer, Tobias 2008b. Why the prosodic hierarchy is a diacritic and why the interface must be direct. *Sounds of Silence: Empty Elements in Syntax and Phonology*, edited by Jutta Hartmann, Veronika Hegedüs & Henk van Riemsdijk, 145–192. Amsterdam: Elsevier. WEB.
- Scheer, Tobias 2009a. External sandhi: What the initial CV is initial of. *Studi e Saggi Linguistici* 47: 43–82. WEB.
- Scheer, Tobias 2009b. Representational and procedural sandhi killers: Diagnostics, distribution, behaviour. *Czech in Formal Grammar*, edited by Mojmir Dočekal & Markéta Ziková, 155–174. München: Lincom. WEB.
- Scheer, Tobias 2011. *A Guide to Morphosyntax-Phonology Interface Theories. How Extra-Phonological Information Is Treated in Phonology since Trubetzkoy's Grenzsignale*. Berlin: Mouton de Gruyter.
- Scheer, Tobias 2012a. At the right edge of words (again). *Festschrift for Glyne Piggott: McGill Working Papers in Linguistics* 22: 1–29.
- Scheer, Tobias 2012b. *Direct Interface and One-Channel Translation: A Non-Diacritic Theory of the Morphosyntax-Phonology Interface: Vol.2 of a Lateral Theory of phonology*. Berlin: de Gruyter.
- Scheer, Tobias 2014a. The initial CV: Herald of a non-diacritic interface theory. *The Form of Structure, the Structure of Form: Essays in Honor of Jean Lowenstamm*, edited by Sabrina Bendjaballah, Noam Faust, Mohamed Lahrouchi & Nicola Lampitelli, 315–330. Amsterdam: Benjamins.
- Scheer, Tobias 2014b. Spell-out, post-phonological. *Crossing Phonetics-Phonology Lines*, edited by Eugeniusz Cyran & Jolanta Szypra-Kozłowska, 255–275. Newcastle upon Tyne: Cambridge Scholars Publishing.
- Scheer, Tobias 2016a. Melody-free syntax and phonologically conditioned allomorphy. *Morphology* 26: 341–378.
- Scheer, Tobias 2016b. Juncture and Boundary. *Oxford Bibliographies Online* publication at [www.oxfordbibliographies.com/view/document/obo-9780199772810/obo-9780199772810-0074.xml](http://www.oxfordbibliographies.com/view/document/obo-9780199772810/obo-9780199772810-0074.xml).
- Schwartz, Jean-Luc, Luis-Jean Boë & Christian Abry 2007. Linking dispersion-focalization theory and the maximum utilization of the available distinctive features principle in a perception-action-control theory. *Experimental Approaches to Phonology*, edited by Maria-Josep Solé, Patrice Beddor & Manjari Ohala, 104–124. Oxford: Oxford University Press.
- Ségéral, Philippe 2000. Théorie de l'apophonie et organisation des schèmes en sémitique. *Research in Afroasiatic Grammar*, edited by Jacqueline Lecarme, Jean Lowenstamm & Ur Shlonsky, 263–299. Amsterdam & Philadelphia: Benjamins. WEB.
- Ségéral, Philippe & Tobias Scheer 2001. Abstractness in phonology: The case of virtual geminates. *Constraints and Preferences*, edited by Katarzyna Dziubalska-Kolaczyk, 311–337. Berlin and New York: Mouton de Gruyter.
- Ségéral, Philippe & Tobias Scheer 2008. The Coda Mirror, stress and positional parameters. *Lenition and Fortition*, edited by Joaquim Brandão de Carvalho, Tobias Scheer & Philippe Ségéral, 483–518. Berlin: Mouton de Gruyter. WEB.
- Starke, Michal 2009. Nanosyntax: A short primer to a new approach to language. *Nordlyd* 36: 1–6.
- Stevens, Kenneth 1972. The quantal nature of speech: Evidence from articulatory-acoustic data. *Human Communication: A Unified View*, edited by Peter B. Denes & Edward E. David Jr., 51–66. New York: McGraw Hill.
- Uriagereka, Juan 2011. Derivational cycles. *The Oxford Handbook of Minimalism*, edited by Cedric Boeckx, 239–259. Oxford: Oxford University Press.
- Zwicky, Arnold & Geoffrey Pullum 1986. The principle of phonology-free syntax: Introductory remarks. *Ohio State University Working Papers in Linguistics* 32: 63–91.

## Dependency Phonology

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### 12.1 Introduction

Whenever two minimal units enter into a relation, they form a construction and, typically, the relation between units in a construction will not be equal; it is asymmetrical. This is, in short, the heart of the wisdom that Dependency Phonology (DP), or Dependency Grammar more broadly, has contributed to linguistic theory. In contrast with a constituency-based approach, there are no constituents, no 'consist of' relations, in the dependency approach. In language, asymmetrical relations are found everywhere where two units combine: in stress languages, two syllables are joined into a 'foot', where one will be stressed and the other unstressed. In morphology, two nouns can form a compound with one being semantically dominant as well as, typically, determining the word class. In syntax, one word in a phrase will function as the syntactic 'head'. Even in single segments such as affricates there is an asymmetric relation between the phonetic parts of the segment. The status and implementation of this head-dependency relation (HDR) in both segmental and suprasegmental structure is the defining feature of the DP framework, which we will discuss in this contribution.

The organization of this chapter is as follows. Section 12.2 discusses the basic principles of the DP approach. Section 12.3 reviews some proposals for revision or further extensions of the DP model that have been made in the literature.<sup>1</sup> While these revisions mostly focus on the structure of segments, section 12.4 discusses suprasegmental structure, starting with the notion of syllable structure and then moving on to the distinction between word and utterance structure. Section 12.5 deals with the manner in which DP allows the expression of phonological alternations. Section 12.6 compares DP to other phonological models, and section 12.7 offers a brief conclusion.<sup>2</sup>

As a preamble, a note on the term 'dependency'. This term has been used in a variety of ways, as also noted by Ewen (1995). In Feature Geometry proposals (Clements 1985; Sagey 1986), the term can refer to the hierarchical relation between a mother node and its daughter(s), i.e. as the inverse of dominance: no headedness in the DP sense is assumed; this is the sense in which McCarthy (1988) (and others) have used the term. Mester (1986, 1988) allows different features, residing on different tiers, to be dependent on each other, such that spreading one 'drags along' the other. A related concept is 'government' (the inverse of dependency), as in Government Phonology (Kaye et al. 1985, 1990) (see Chapters 9–11 in this book, as well as section 12.6 below).