17. A note on recursion in phonology[1]

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1. Introduction

Recursion is widely postulated or questioned as a property of human language, in particular of syntactic and morphological expressions, i.e. as a property of Martinet's first articulation (Martinet 1960). What about the second articulation? It is quite common to read that phonology is *not* recursive. To illustrate this point it is often mentioned that, for example, we do not find 'syllables inside syllables'; cf. Pinker and Jackendoff (2005: 10):

> "Recursion consists of embedding a constituent in a constituent of the same type, for example a relative clause inside a relative clause (...). This does not exist in phonological structure: a syllable, for instance, cannot be embedded in another syllable."

On the other hand, Ladd (1986, 1996) argues that higher-level prosodic structure allows (limited) recursion, while Hunyadi (this volume) argues that intonational structure displays recursion, even center-embedding. Several other authors have discussed the notion of recursion in phonology, both with reference to syllables and feet (i.e. lower prosodic structure) and prosodic words, phonological or intonational phrases (i.e. higher prosodic structure). In this chapter I offer a general discussion of the notion recursion in phonology.

As stated in van der Hulst (this volume), recursion is possible when combinations of units that can be included in larger combinations are of the same complexity. Thus in syntax, XPs can occur inside XPs and this then allows for the kind of recursion that Pinker and Jackendoff refer to: we can find a phrase of a certain categorical type (e.g. a NP) inside a phrase of the same type.[2] A common characterization of phonotactic

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2. In syntax, this type of direct recursion is perhaps limited to adjunction structures. In morphology, however, we readily find, for example, nouns that are directly dominated by the category noun, as in [[child]hood].

structure is that it adheres to the 'Strict Layer Hypothesis' (Selkirk 1980, 1984, 1986, 1995; Nespor and Vogel 1986) which precludes a phrase from containing a phrase of the same complexity. The kind of structure that the Strict Layer Hypothesis allows can be characterized by the following rule schema (see van der Hulst, this volume):[3]

(1) Phrase^{n+1} ⇒ Phrase^n + Phrase^n

Given this rule format, prosodic structure can not be recursive, which confirms the point that hierarchical structure as such does not entail recursion. However, the ban on recursivity has not been taken to be absolute. The phonological literature contains proposals for recursive feet, recursive phonological words, recursive phonological phrase and recursive intonational phrases. We also, although less common, find proposals to allow intrasyllabic recursion, which allow syllables inside syllables, or, at even lower levels of organization, onsets within onsets, or rhymes within rhymes. In the next two sections I will briefly discuss proposals of this sort, starting in section 2, with the lower prosodic units (i.e. syllables and feet). Section 3 will be devoted to the higher prosodic units.

In what follows I will assume that phonotactics is just as much a combinatorial system as morphotactics and that combinations involve both basic units and units that themselves are combinations. My general conclusion will be that there is no reason to expect that phonology is not recursive. Rather, adopting the notion of Structural Analogy (Anderson 1992; van der Hulst 2005b) which suggests that both articulations (i.e. *morphotactics and phonotactics*) appeal to the same kinds of structural relations, we would *not* expect recursion to discriminate between the two. Rather, then, I will promote the idea that recursion is part of our human cognitive capacities, both phonotactics and morphotactics make use of it, albeit it to different degrees.

It is important to keep in mind that morphemes, the basic units of morphotactics, are meaningful units, whereas phonemes, the basic units of phonotactics (loosely 'phonology'), are not[4]. The 'other side' of phonemes

3. I refer to Itô and Mester (2009) for a detailed discussed of the formal aspects of the prosodic hierarchy as it was originally understood. They also discuss subsequent views within Optimality Theory and their own proposals which I discuss in section 3.1.
4. I use the term 'phonotactic structure' to cover syllabic, and metrical/prosodic structure.

is not 'semantic substance' as it is for morphemes, but rather 'phonetic substance'. Thus the basic units in both articulations differ *substantially*.
There is therefore no reason to expect that phonotactics will display the same degree of recursive structure as morphotactics for the simple reason that the kinds of structures that are employed in both modules do not exist in a vacuum, but rather are formed to iconically (i.e. isomorphically) accommodate whatever it is that these structures stand for. This view point reflects the idea that both tactic planes are 'grounded in their substance' (Anderson 1997). If we assume that certain aspects of semantic substance are inherently recursive (such as *second degree intentionality*[5]), we expect morphotactics to try and mimic this as much as possible. Of course, principles, if any, that are inherent to morphotactics may impose limits on the degree of isomorphy that morphotactic structures can attain. Additionally, it is conceivable that these structures, at the same time, also try to accommodate something other than strictly semantic substance, such as *information structure* (i.e. the organization of given and new information, etc.). If, on the other hand, phonetic substance is not inherently recursive there is no need for phonotactics to produce recursive structures in an attempt to be isomorphic. As I would like to claim, phonetic substance indeed does not appear to be recursive. Rather it would seem that phonetic substance, being the result of motoric actions, is essentially 'sequential, iterative and rhythmic'[6], which seems be mimicked by phonotactic structures that display strict layering. Why then would phonotactics nonetheless display recursion? I suggest that there are two reasons. Firstly, if strict layering is guided by binarity (as I will assume here, although the matter, of course, warrants more discussion) we need a procedure for incorporating (i.e. adjoining) 'stray units' when the string to be organized consists of an odd number of units; this produces degree-1 recursion; cf. below. Secondly, at higher levels of organization, phonotactic structure tries to match (be isomorphic to) morphotactic structure (and therefore indirectly semantic structure). This stimulates recursion wherever the morphotactic structure is recursive. In this case, however, recursion of phonotactic structure is counterbalanced by the fact that the phonetic

5. Second degree intentionality involves intentions that are *about* intentions.
6. These terms would obviously have to be more precise to explain the correlation between phonetic stuff and 'fat structures'. For the moment, I will not try to do that and appeal to a more intuitive and informal understanding of this point.

grounding stimulates adherence to the strict layering which, in turn, may give rise to recursion resulting from adjunction.

I will demonstrate the first source of recursion by referring to the fact that rhythmic structures (as exemplified in music and language, and other areas) impose a binary or ternary structure on sequential events such that an even number of events is grouped in binary units (cf. 2a), whereas an uneven number of events would have to deal with one stranded unit, (2b):

(2) a. (x x) (x x) (x x)
    b. (x x) (x x) x
    c. (x x) ((x x) x)
    d. (x x) ((x x) x) x

I suggest that the most likely manner for a stranded unit to be adjoined to an adjacent binary structure is as in (1c), which, then, creates a recursive structure. However, even though recursion is thus possible (and perhaps the only way to go), we would not expect to find multiple recursion, as in (2d), because an even number of units can be more rhythmically parsed as in (2a). One would only expect to find (2d) if some other external force than rhythm demands it. I will argue below that, in phonotactics, this other force could be the 'desire' for phonotactic structure to be isomorphic to morphotactic structure, but I will also show that, while rhythm may give rise to isomorphy 'a little', rhythm is strong enough to prevent phonotactic structure to be fully isomorphic to morphotactic structure, which is the reason for why phonotactic structures are usually flatter than morphotactic structures. Thus, summarizing, I will argue that phonotactics *does* produce recursive structures to (a) incorporate stranded units and (b) achieve isomorphy to morphotactic and thus semantic structure. With reference to the latter, what would perhaps be optimal recursion in phonology (from the view point of achieving maximal isomorphy) is counterbalanced (i.e. flattened) by the inherent sequential, rhythm and iterative drive of the phonetic substance.

Anticipating the discussion in section 3, I add here an important distinction, made explicit in Wagner (2005), which is that the question of recursion in phonotactic structure must be distinguished from the effect of phonological rules applying cyclically to (potentially recursive) syntactic structures. If, for example, a cyclic phonological rule lengthens the rightmost vowel in a *syntactic* phrase, it is easy to see that this cannot be an argument in favor of recursive phonological grouping-structure, or, for that matter, phonological grouping-structure of any kind, unless the argument could be made that the 'phrases' that the rule refers to are phonolog-

ical ('prosodic') rather than syntactic. Even if, let us say, a phrasal accentuation rule applies cyclically to increasingly larger syntactic phrases, this, again, does not mean that these rules create recursive phonological structures *unless* one would argue that the notion phrasal accent is formalized in terms of a phonological grouping structure. The latter point of view would be taken within standard metrical theory (Liberman and Prince 1977, and maintained in Ladd 2008). However, if phrasal accentuation rules simply assign 'an accent' (i.e. grid mark), there is no sense in which the result is a recursive structure.[7]

2. Syllables (and feet)

With the preceding remarks in mind, let us start with a discussion of *syllable structure* which is the lowest level of organization, imposing a grouping on the linear string of phonemes. I will assume that phonemes indeed group into syllables, although this is not generally accepted. For example, in all varieties of Government Phonology (see Scheer 2004 for an overview), the syllable is *not* recognized as a phonotactic constituent. Instead, phonemes are grouped into onsets and rhymes (some of which are empty-headed; cf. below), which in the standard variety of Government Phonology (Kaye, Lowenstamm and Vergnaud 1990), depending on the language, are allowed to branch once, so that each contains maximally two phonemes. In this view, syllabic constituents combine only basic units (i.e. phonemes) which, then, rules out recursion because recursion can only exist if combinations can be included into larger combinations (cf. section 1). In a more widespread view, the one adopted here, syllables *are* recognized as constituents, which entails grouping of units that themselves can be combinations. In this view recursion is possible, at least in principle, and, as we will see, it does, contrary to popular belief, occur.[8] The issue involves the analysis of so-called codas.

7. Schreuder, Gilbers and Quené (2009) argue in favor of phonological recursion on precisely these grounds, but it would seem that they only show that accent assignment in phrases can be cyclic.

8. As is well-known, Chomsky and Halle (1968) did not postulate syllables. In the approach taken by Blevins (2003) arguments in favor of the syllable, based on their alleged necessity for the statement of phonotactic restrictions and allophonic effects are questioned. I will assume here without further discussion that phonotactic arguments remain valid; cf. van der Hulst and Ritter (1999).

It is generally stated that syllables are projections from vowels. Since the consonantal skeleton of lexical items can be said to be the primary expression of the lexical meaning of these items (especially in templatic languages like the Arabic languages), while vowels are less crucial in this respect and indeed often the expression of inflectional categories, we can think of the latter as 'functional' units and the former as 'lexical' units, and as such, heads that take consonants as complements. Hence a CVCVCV word can be parsed into three syllables:[9]

(3)

$$\begin{array}{ccc}
V_{syl} & V_{syl} & V_{syl} \\
\bigwedge & \bigwedge & \bigwedge \\
C\;\;V & C\;\;V & C\;\;V^{10}
\end{array}$$
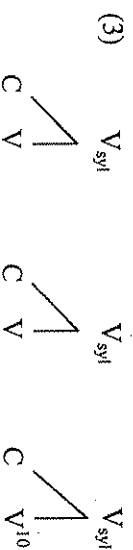
This way of looking at vowels and consonants, whatever its merit, is congruent with the traditional idea that vowels are syllable heads because they are the most sonorous phonemes. Thus, syllable heads are sonority 'maxima' (optimally vowels, perhaps more generally sonorants), while their consonantal dependents are sonority minima (optimally obstruents, more generally consonants). Sonorant consonants fall within the inter-section of sonorants and consonants and can thus be either heads or dependents. I take the labels 'C' and 'V' (in 3) to be *category labels* of phonemes (analogous to labels such as Noun and Verb for morphemes). Feature structures that capture the 'content' of phonemes can belong to the category V or to the category C in which case we refer to them as 'vowels' and 'consonants', respectively. In addition to C and V we can postulate subcategories such as 'C$_s$V' for 'sonorant consonants'.[11] The term 'syllable' is just an informal label for a *complex* unit that belongs to the category V; likewise, the term 'nucleus' can be used for a basic (non-
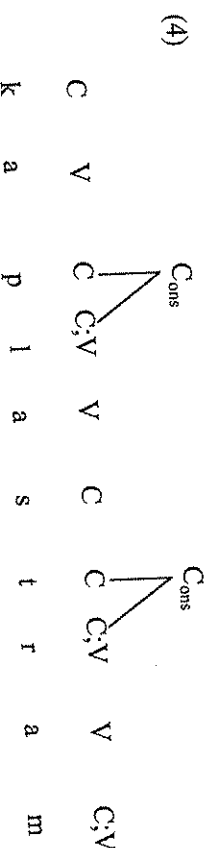
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9. Henceforth I will add subscript labels such as 'syll(able)' that correspond to traditional labels. These subscripts have no formal status in the proposal discussed here, but they help the reader to relate the structures used here to more informal traditional ones.

10. In van der Hulst (2005a) I present an extensive discussion of such phoneme categories which traditional feature systems capture in terms of 'major class features'.

11. These intermediate categories can be characterized in terms of dependency structures as proposed in Anderson and Ewen (1987); cf. van der Hulst (2005a) for an elaboration of these ideas.

complex) V and the term 'onset' can be used as an informal label for units that belong to the category C.[12]

When a string of phonemes is more complex than a regular CV alternation, we need more than one round of grouping before all phonemes have been organized into syllables. We can think of the way in which a string of phonemes can be analyzed in terms of syllables and subsyllabic units in the following manner. First we locate the 'lexical units' (onsets). As 'complements' to a head (cf. 3) we expect onsets to be potential projections themselves and in languages that allow so-called *branching onsets* that is what they are. It is tempting to think of onsets (at least in languages that allow branching onsets) as units defined in terms of rising sonority, just like syllables as a whole, which, in fact, would allow us to see the syllable as a recursive unit in that onsets would be 'syllables inside syllables'. Although I think that this perspective has some merit, it seems to entail that in such complex onsets, the more sonorous consonant is the head. However, because onsets are sonority minima, the *least* sonorous consonant (optimally an obstruent) counts as the typical member of the complex onset. For this reason it makes more sense to regard the least sonorous phoneme as the head as is proposed in Anderson (1986) and in Kaye, Lowenstamm and Vergnaud (1990):[13]

(4)

$$\begin{array}{ccccccccc}
C & V & C_{ons} & V & C & C_{ons} & V & C_{ons} \\
 & & \bigwedge & & & \bigwedge & & \bigwedge \\
 & & C\;\;C_sV & & & C\;\;C_sV & & C_sV \\
k & a & p\;\;\;l & a & s & t\;\;\;r & a & m
\end{array}$$

If we now assume that all Cs that are not followed by a sonorant form onsets on their own, the next step after (4) is to combine onsets with their functional heads to their right, the V units.

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12. Whether obstruents can be syllable heads, like vowels can be onsets (as 'glides'), is controversial. This point, however, is not absolutely crucial to the following discussion.

13. Here and below, the strings of phonemes do not present actual words in any specific language.
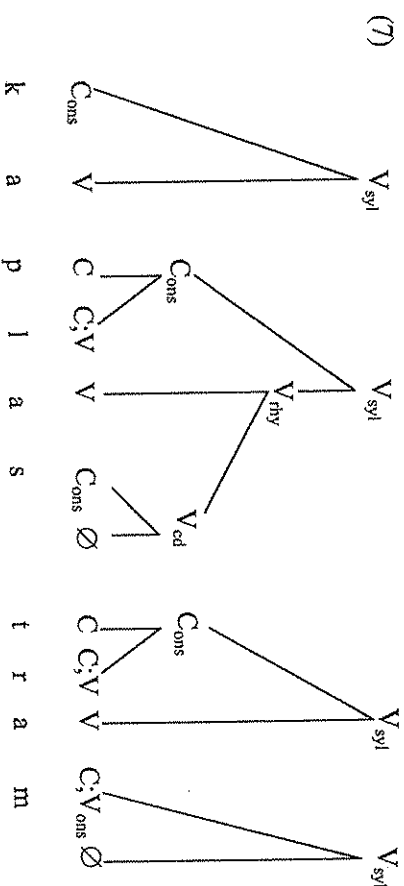
(5)

V_syl   V_syl

C_ons   V   C   C;V   V   C   C;V   V   C;V

k   a   p   l   a   s   t   r   a   m
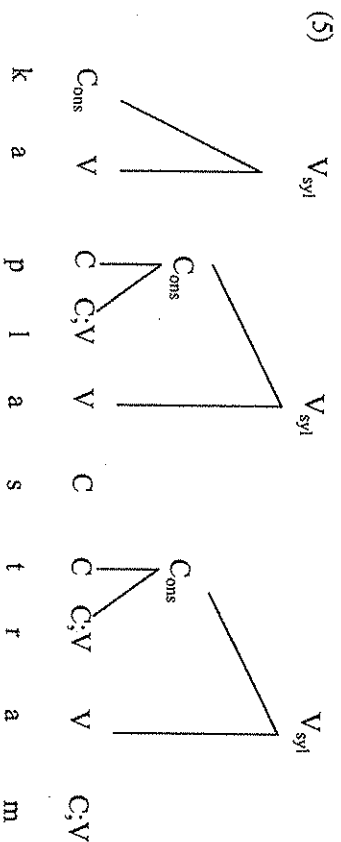
Here we face the question what to do with stray 'onsets', i.e. C's or C;V's that are not *followed* by a V; such 'onsets' are usually called 'codas'. In approaches such as Government Phonology (Kaye, Lowenstamm and Vergnaud 1990), some of these stray 'onsets' are taken to be followed by an empty V (a V unit that has no vowel content associated to it), while others are analyzed as proper codas, i.e. as direct dependents of the V to their left (if certain conditions are met). Let us say, however, that these alleged codas are, in fact, *always* onsets followed by an empty 'nucleus' (cf. Lowenstamm 1996, Scheer 2004). The next question is then how such 'syllables' are integrated into the phonotactic parse. There are two options. In (6a) the vowel takes a *following* 'coda' as the direct dependent and the preceding onset as an indirect dependent. This creates the familiar 'onset – rhyme' division. The other possibility would deliver (6b) which would correspond to a moraic theory of syllable structure which also has certain arguments going for it (cf. Hyman 1985):

(6)   a.   b.

V_syl   V_syl

C_ons   V_rhy   C_onset   V_mora

C_v   V   V_cd   C_v   V   V_mora

C   Ø   C   Ø
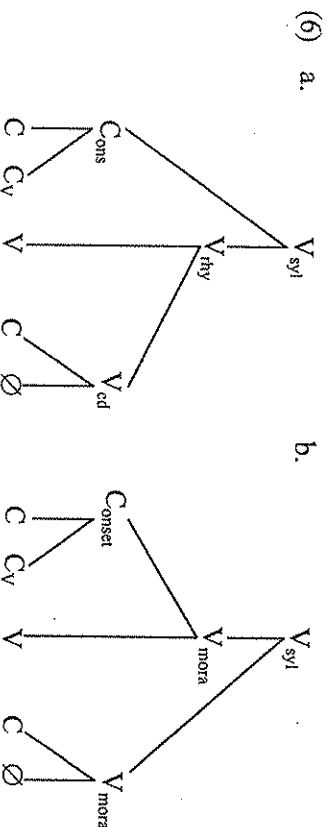
I will assume here that the onset – rhyme structure is the correct one because (a) phonotactic combinatorial constraints refer more often to the vowel and the following 'coda' than to the vowel and the preceding onset

and (b) the poetic convention of rhyming and as well as slips of the tongue and language games also more often presuppose this structure rather than its rival in (6b). This then would lead to the syllabic grouping in (7) for the string in (5):

(7)

V_syl   V_syl   V_syl

C_ons   V   C   C;V   V   C_ons   Ø   C   C;V   V   C;V_ons   Ø
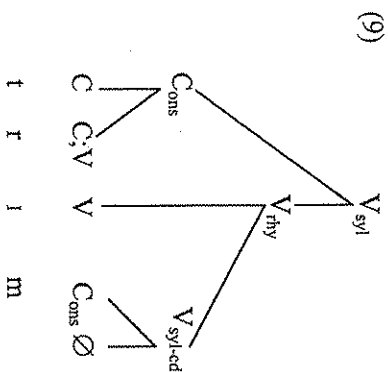
k   a   p   l   a   s   t   r   a   m

The representation of 'codas' as degenerate syllables is not unique to the proposal made here, and indeed is common in varieties of Government Phonology. However, to place this unit as subordinate to the preceding vowel ('nucleus') is not found in these approaches, nor in any other proposal that I am aware of. But that does not mean that the proposal at hand is not a possible contender. It is precisely this possibility that invokes the kind of recursion that is generally held impossible: a syllable inside a syllable.

Syllables are commonly taken to involve a kind of constituent structure that is quite analogous to the syntactic structure of sentences, or perhaps phrases:

(8)   a.   b.

Syllable   XP

Onset   Rhyme   Spec   X'

Nucleus   Coda   X   Complement
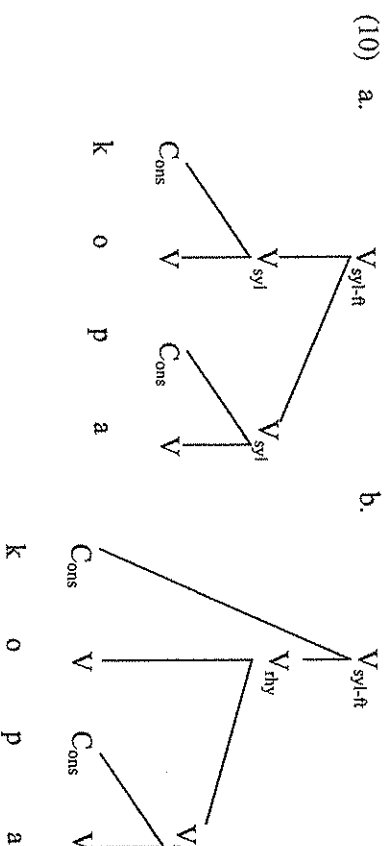   (YP)
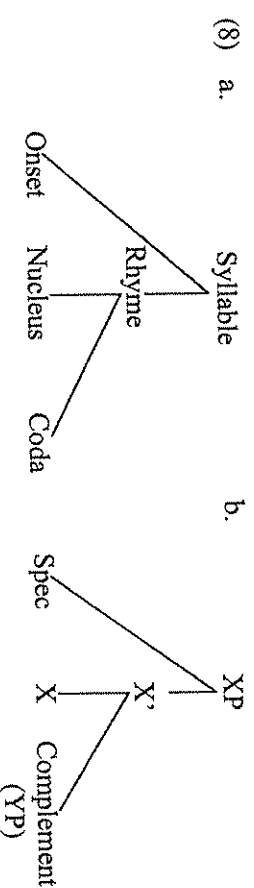
This analogy, indeed, invites the question why 'complements' within the syllable are not syllables, just like complements within syntactic phrases are themselves phrases? It would seem that the apparent lack of recursion within the syllable is an artifact of using the labels that we traditionally

use. If the 'right' labels are used we see that codas are syllables (albeit, so far, with an empty rhyme), and thus that 'codas' *are* 'syllables inside syllables'. We can exemplify all this by focusing on the complex syllable *trim* in (9) in which I have informally labeled the 'coda' as 'syl-cd':
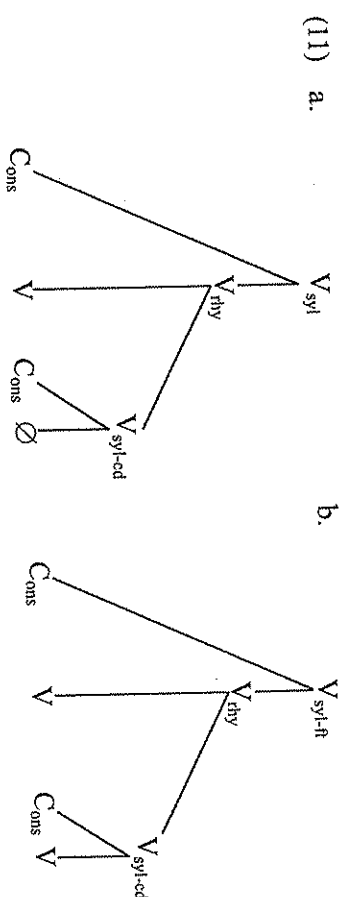
(9)

$$V_{syl} \quad [\, C_{ons} \;\; V_{rhy} \,[\, V \;\; V_{syl\text{-}cd} \,[\, C_{ons} \;\; \varnothing \,]\,]\,]$$
$$C \quad C;V \quad V \quad C_{ons}$$
$$t \quad r \quad i \quad m$$

This account of syllables structure raises a further question.[14] Why do syllables inside syllables (i.e. codas) need to be empty-headed? Why can't we have the syllable /pa/ inside the syllable /ko/? A sequence /kopa/ would 'normally' be regarded as a branching foot, as in (10a). However, I submit that (10b) is, again, a possible contender: one syllable with a syllable inside it:
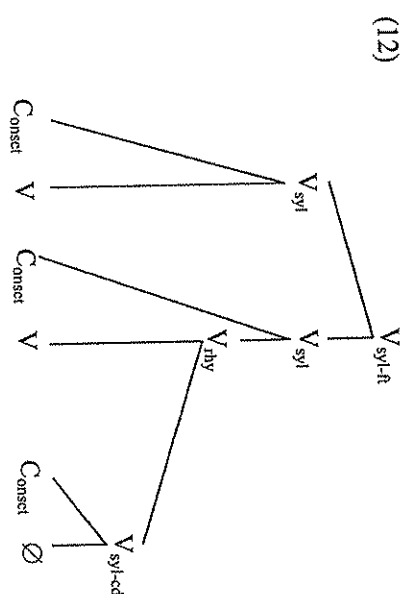
(10) a.

$$V_{syl\text{-}ft} \, [\, V_{syl}\,[\,C_{ons}\;\;V\,] \quad V_{syl}\,[\,C_{ons}\;\;V\,]\,]$$
$$k \quad o \quad p \quad a$$

b.

$$V_{syl\text{-}ft}\,[\,V_{rhy}\,[\,C_{ons}\;\;V \quad V_{syl}\,[\,C_{ons}\;\;V\,]\,]\,]$$
$$k \quad o \quad p \quad a$$

14. Other phonologists have proposed structures for the syllable that involve recursion: Smith (1999), García-Bellido (2005), Pöchtrager (2006). For the sake of brevity I refrain from making a comparison to these other proposals, some aspects of which overlap with the present proposal.

In this proposal 'feet' are syllables that happen to *contain* another syllable. Why would we prefer (10a) over (10b)? (10b) would seem to be extremely adequate given the often observed equivalence between a closed syllable and a branching foot (cf. McCarthy and Prince 1986). In the proposal made here, these two objects are *structurally identical* (cf. 6a and 10b), here both repeated for convenience:

(11) a.

$$V_{syl}\,[\,C_{ons}\;\;V_{rhy}\,[\,V\;\;V_{syl\text{-}cd}\,[\,C_{ons}\;\;\varnothing\,]\,]\,]$$

b.

$$V_{syl\text{-}ft}\,[\,C_{ons}\;\;V_{rhy}\,[\,V\;\;V_{syl\text{-}cd}\,[\,C_{ons}\;\;V\,]\,]\,]$$

Again we can invoke poetic rhyming in support of (11b). In 'feminine rhyme' (*hocus — pocus*), the initial consonant of the foot falls outside the rhyming unit which indeed is a unit in (10b), but not in (10a).

The structures in (11) are so-called trochaic 'feet'. Iambic 'feet' could have the following structure, with one light syllable *pre-adjoined* to a heavy syllable:[15]

(12)

$$V_{syl\text{-}ft}\,[\,C_{onsct}\;\;V \quad V_{syl}\,[\,C_{onsct}\;\;V_{rhy}\,[\,V\;\;V_{syl\text{-}cd}\,[\,C_{onsct}\;\;\varnothing\,]\,]\,]\,]$$

15. In case of so-called 'minor syllables' as in Kammu the head of these adjoined syllables is empty (cf. van der Hulst and Ritter 1998). Below I argue that this structure can be used for triconsonantal 'onsets' in English too.

That trochaic 'feet' and iambic 'feet' quite different 'entities' has been argued for a variety of reasons (Hayes 1986, van der Hulst 2000; van de Vijver 1995). The present proposal provides a basis for a differentiation. Adjunction, of course, also creates recursion.

Returning to trochaic patterns, let us now ask whether syllables that are contained in syllables can contain syllables, i.e. recursion of the second degree? In other words can the string in (13) be parsed as one syllable?

(13)

$V_{syl\text{-}ft}$ C_{onset} V_{rhy} $V_{syl\text{-}ft}$ C_{onset} V_{rhy} V_{syl} C_{onset} V

w i n e p e
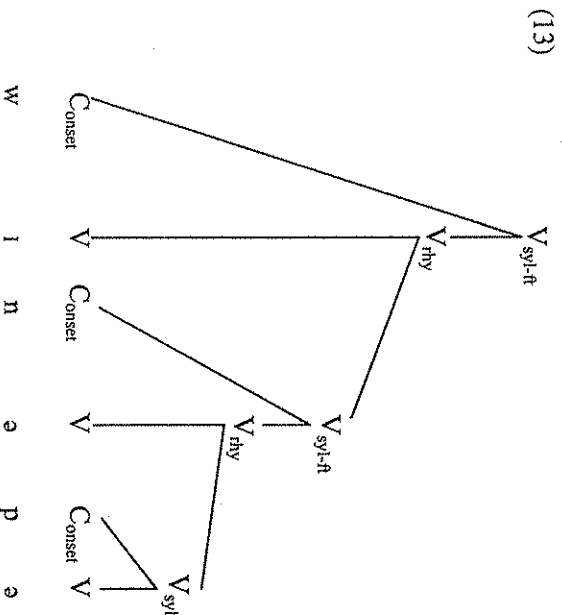
I suggest that (13) is possible and, in fact, represents what elsewhere has been called 'a ternary foot' (sometimes called 'superfoot'), which is a perfectly legitimate object in, for example, English (*winnepe-saukee*, *hippopotamus*).[16] It is interesting that the initial consonant of the such structures is indeed external to the whole sequence as is evidenced by the poetic *dactylic* rhyming convention: *[h]ickeldy* – *[p]ickeldy*. The structure in (13) captures the special position of the initial onset (which can or must be different), as opposed to the other more deeply embedded onsets (which must be identical).

It is generally the case, in syntax, that recursive structures can either result from complement structures or from adjunction. Again, there is no

16. Below I propose that this structure can also be used to accommodate complex 'codas'.

a priori reason to reject the same two options in phonology. In fact, our proposed structure for trochaic and iambic 'feet' differ in precisely this way. The trochaic structure is recursive because the complement (i.e. dependent) of a head is identical to the maximal projection of the head. This is the kind of recursion that is illustrated in (8) and in (9), (10b), (11b) and (13). The dependent, which causes recursion, is *subjoined* to the head. The recursive structure in (12), on the other hand, results from adjunction. Here recursion is caused by the fact that the head contains an instance of itself after an element has been adjoined. This is what is commonly called 'Chomsky-adjunction'. Recursion following from adjunction has been proposed more generally and almost always underlies the claim that a specific phonological unit is recursive. Indeed, work in metrical theory has used ternary feet in which the right-most 'extra' CV unit at the end is seen as being adjoined to the foot formed by the first two syllables, rather than being *incorporated* as the deepest unit:

(14) V (~ superfoot)

V
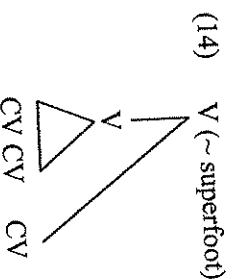
CV CV CV

This is also the structure that Dresher and Lahiri (1991) proposed for the 'Germanic foot', with the first CVCV unit being called the 'subfoot'. If adjunction creates a legitimate (and also recursive) structure (as it does for iambic 'feet'), the structure in (12) is, perhaps, a possible structure, possibly necessarily arising when extrametrical syllables, which are independent syllables, not contained in any other syllable, are incorporated into the phonotactic structure. I will leave undecided here whether both types of structures (i.e., 12 and 14) are independently needed for ternary feet. Perhaps the structure in (14) has been used in cases where that in (13), unavailable in current models, would be more appropriate. I will make another suggestion bearing on this distinction in the concluding section.

Let us now ask whether there are limits on recursion in phonology: Can a sequence of four CV units be parsed as in (15), as a quaternary 'foot'?

(15)

$V_{syl\text{-}ft}$ V_{rhy} $V_{syl\text{-}ft}$ V_{rhy} $V_{syl\text{-}ft}$ V_{rhy} V_{syl}

d e l e g a t e
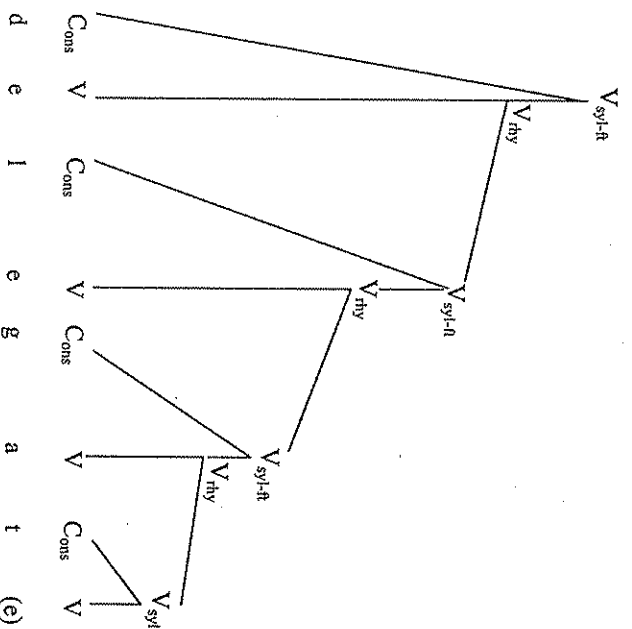
Although formally perfectly correct (if recursion is available), it would seem that (15) creates a dis-rhythmic structure: SWWW, i.e., a lapse that can be avoided by adding an extra beat which would not create a clash. Indeed, a string of four CV units is more likely to be parsed as a sequence of *two* feet (SWSW), which together form a phonological word which is either left-headed or right-headed. Here I display the former option, which expresses the initial primary accent:

(16)

$V_{Pr\text{-}W}$ $V_{syl\text{-}ft}$ V_{rhy} V_{syl} $V_{syl\text{-}ft}$ V_{rhy} V_{syl}

d e l e g a t e
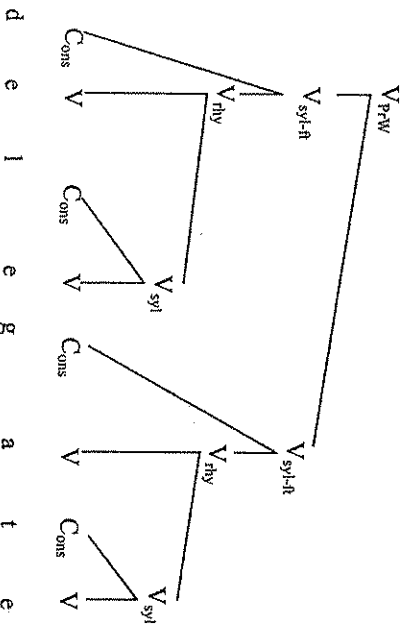
(16) is 'flatter' than (15) and this, I suggest (merely making implicit what most phonologists would take for granted) is a consequence of the rhythmic nature of the 'phonetic substance' that phonotactic structure represents, which seems to be better expressed by an iterative rather than by a recursive structure. *Beyond the 'magic number' 3, recursion gives in to rhythm* (cf. the discussion surrounding 1 in section 1). In other words, I suggest that recursion is perfectly possible in phonology if it does not make the phonotactic structure dis-rhythmic. From a rhythmic point of view '4' is just too much (hence we see 'flattening'), '1' is too little (hence we see subjunction or adjunction), which makes '2' and '3' rhythmically wellformed, i.e. binary and ternary rhythm, respectively.

Syllables have been said to display an even greater complexity than considered so far. In English, onsets can contain three consonants (/spr/) and rhymes can be of even greater complexity (/mk/).[17] The extra consonants (/s-/ and /-m/) would constitute degenerate syllables by the above algorithm, and I will assume that they can be structurally represented as in (17):[18]

(17)

$V_{syll\text{-}ft}$ V_{syl} V_{rhy} $V_{syll\text{-}ft}$ V_{rhy} V_{syl}

s p r i n k

----
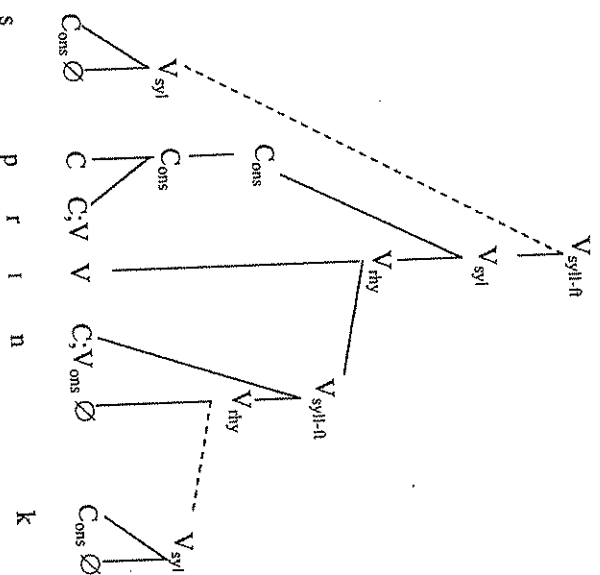
17. This ignores so-called coronal appendices /s/, /st/; *warm-st* 'warmest' which I will analyze as clitics; cf. van der Hulst (2005b).
18. Kuryłowicz (1952) proposes such bare onsets for Slavic initial clusters, although he does not unite this bare onset with the following syllable. A similar

The /s/ is adjoined as a 'degenerate syllable', making use of the iambic structure proposed in (12). The /k/, on the other hand, makes use of the subjunctive structure that was introduced (13).[19] Subjunction brings the rhyme to the maximum structure of three 'nuclei', while adjunction brings the onset to the maximum structure of three consonants. The recursive options stretch the limit of rhythm from 2 to 3, a limit that has been reached in English. We thus predict that languages could not be more complex than this because beyond '3' we have enough material to group into 2's. This prediction faces challenges, as we know, some of which are discussed in van der Hulst and Ritter (1999).

The discussion in this section challenges the idea (or prejudice) that phonology is not recursive at the 'level' of the syllable. What we have argued is that the notion 'foot', at least the trochaic and dactylic foot, emerges naturally from allowing 'syllables inside syllables', whereas other forms of recursion (involving iambic feet as well as trisegmental onsets) can be modeled in terms of adjunction. What needs further study is 'how recursive' the domain of the syllable/foot can be and whether indeed rhythmic principles impose absolute limits, or rather make degree 3 and beyond unlikely, although not impossible.
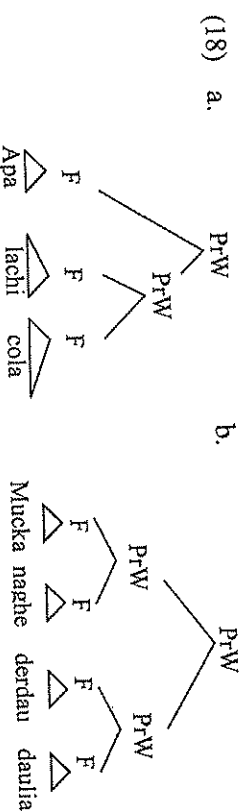
3. Higher prosodic levels

In this section I will discuss some proposals for recursive structure at the level of prosodic words and prosodic phrases. I refer to Fox (2000, chapter 6) for a good overview of different proposals for prosodic organization, including work that was inspired by Selkirk (1978), which culminated in the seminal Nespor and Vogel (1986). The review that Fox offers makes it clear that the question of recursion in prosodic is not a recent one. He refers to earlier work (e.g. by the linguists Kenneth Pike and Paul Tench) who distinguish between basic units in the hierarchy and 'expansions': "the expansion is a group of units whose role is the same as that of the

analysis could be used for minor syllables in Khmer languages; cf. van der Hulst and Ritter (1999). As mentioned, in Government Phonology such bare onsets are taken to be followed by an empty-headed rhyme. Kaye (1992) proposes an onsetless empty headed rhyme with /s/ as the coda. This unit could still be adjoined as in (17), although this is not what Kaye assumes. There are other proposals on /s/ which involve seeing S + obstruent as a complex segment. This proposal would entail a much deeper adjunction of /s/, in fact below the C terminal of the onset head (cf. van de Weijer (1996).

19. These possibilities were pointed out to me by Marcel den Dikken.

basic unit which constitutes its head" (Fox 2000: 351). In this view, a complex onset is an expansion of a single consonant forming an onset, just like unaccented syllables form an expansion to the accented syllables (making a foot). The spirit of these proposals clearly is that prosodic categories display recursion. We must note, however, that the recursion that follows from "expanding" the head corresponds to what is here called 'recursion following from *adjunction*'. Indeed, in section 2 we have seen that recursion can take two forms (cf. also van der Hulst, this volume). The category of the complex units can be identical to the head (adjunction) or to the dependent, i.e. complement of the head which is the kind of recursion that results, in morphotactic structure, from complement phrases having the same category as the phrase that they are contained in. We have called this 'recursion following from *subjunction*'. In section 2 I have suggested that the latter kind of recursion can be attributed to syllable/foot structure if codas and weak syllables are represented as dependents of the preceding syllable nucleus. Subjunctive recursion is what, in morphotactics, is referred to as the prototypical case of recursion ('a unit of type A within a unit of type A'), while adjunctive recursion is usually not mentioned as such. However, in (14) I displayed a recursive foot which involves adjunctive recursion in contrast with (13) which displays subjunctive recursion. As we will see in this section *all* recursion at higher prosodic levels is of the adjunctive kind, even when it claims to be isomorphic to subjunctive morphotactic structure. In section 4 I briefly consider the possibility of subjunctive recursion at levels of organization above the syllable/foot.

3.1. The prosodic word

Leaving the syllable and foot level behind us now, let us turn to the Phonological or Prosodic Word and higher levels, adopting, for convenience, the label F(oot) as it is commonly used. If prosodic structure is driven by rhythm which calls for flat binary grouping, we expect that Prosodic Words contain 2, at most 3 feet and that longer morphosyntactic words will correspond to more than one prosodic word:

(18) a.

```
        PrW
       /   \
     PrW    F
    /   \    \
   F     F    \
  Apa  lachi  cola
```

b.

```
            PrW
          /     \
       PrW       PrW
      /   \     /   \
     F     F   F     F
   Mucka naphe derdau daulia
```
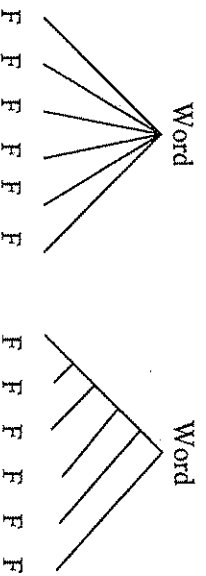
Whereas the English word *apalachicola* can be one PrW containing three feet, a word consisting of four feet would have to be parsed as two prosodic words; cf. also Hesloot (1993, 1995) who explicitly argues on similar grounds that prosodic words are not 'endless'. Note that the structures in (18), on the assumption that the highest node is PrW, *both* display recursion, although with a difference. I will return to the structure in (18) below. First, let us take a closer look at the structure in (18a). Structures of this kind (albeit without the lower PrW label) were proposed in metrical theory (Liberman and Prince 1977). As shown in van der Hulst (this volume) the view embodied in this kind of structure seems to be that the phonological structure of PrWords can be characterized by an *inductive definition*:

(19) Phonological words (recursive definition)
    a. PrWord ⇒ foot   (base case)
    b. PrWord ⇒ PrWord + Foot   (inductive step)

According to (19) a foot is a (minimal) prosodic word and every structure that results from adjoining a foot to a prosodic word is also a prosodic word. In later versions of metrical theory, however, PrWords have been characterized in terms of an iterative structure so that indeed (20a) and (20b) both occur in the metrical literature:

(20) a. Iterative definition   b. Inductive definition

```
      Word                          Word
   / / | \ \                      /      \
  F F  F  F F                   F         Word
                                        /      \
                                      F         Word
                                               /    \
                                             F       F
```

The 'flat' representation in (20a) has also been proposed (e.g., in Halle and Vergnaud 1987) in the guise of so-called 'bracketed grids'. The question is which representation accounts best for the properties of phonological words. (20b), for example, can be said to express different degrees of prominence of feet, about which (20a) has nothing to say. In other words, just like semantic properties may be more adequately expressed in recursive morphotactic structures, phonetic properties may be more adequately expressed in recursive phonotactic structures. However, an unbounded recursive structure does rather poorly as a predictor of rhythm, since there is

no structural basis for the fact that a long sequence of feet will display rhythmic alternation (SWSWSW etc.) and a structure as that in (20b) is therefore likely to be broken up as in (23):
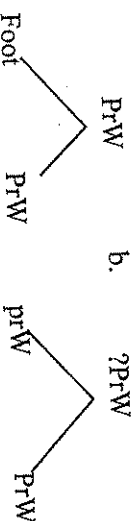
(21)

```
            PrW
          /      \
        PrW       PrW
       /   \     /    \
      F     PrW PrW    PrW
      F   F  F  F  F   F  F  F
```
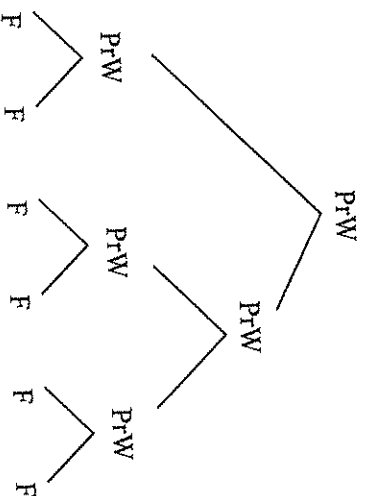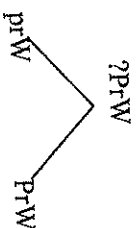
In analyses of languages with long words, Halle and Vergnaud (1987) in fact postulate binary grouping of feet in, what they call, cola (sing. colon). However, if recursion is available there is in fact no need for postulating new phonological categories each time we need more structure than the strict layering model allows. The question should rather be whether the larger unit that is added displays the same kinds of properties as the smaller unit that it contains. In this regard, as we will see below, serious claims have been made that combinations of PrWs do indeed form a specific prosodic category, rather than simply being recursive PrWs. If correct, this would cast doubt on the structure in (18b), here repeated as (22b).

Let us now return to the structures in (18) which suggested that recursion in phonology can take two different forms (both *not* being of the subjunctive type):
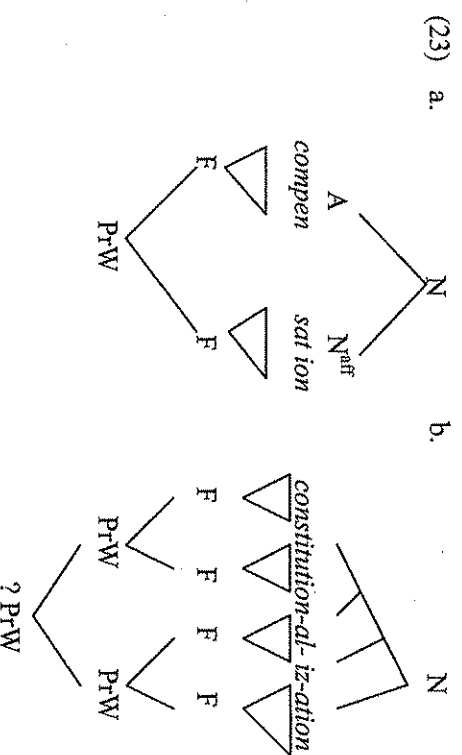
(22) a.   b.

```
        PrW                    PrW
       /    \                /      \
     PrW    PrW           PrW       ?PrW
     |                              /    \
   Foot                          PrW     PrW
```

(Recall that the 'foot', as per section 2, is a kind of syllable.) In a strict layering model, both structures are considered ill-formed. In (18) I tentatively suggested both structures as possibilities for monomorphemic words, although the likelihood of finding a quadric-podal morpheme might be rather slim. We could call (22a) an *unbalanced recursive prosodic*
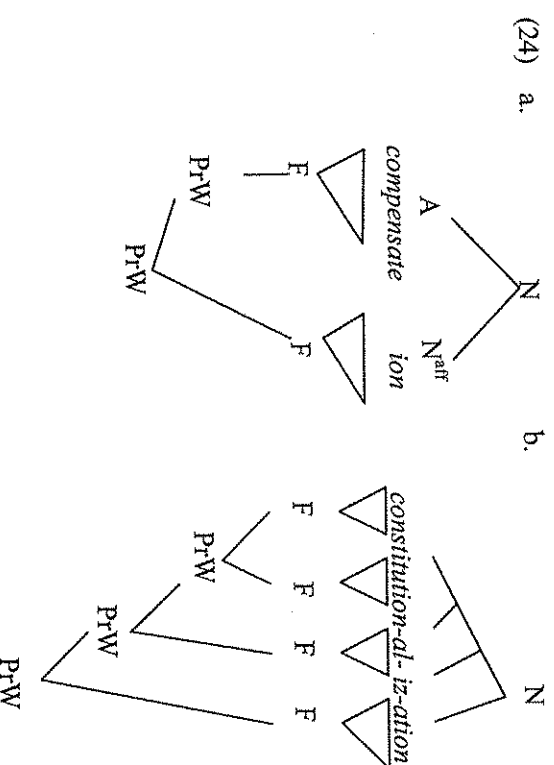
structure, whereas (22b), then, would be a *balanced recursive prosodic structure*. The former arises from adjunction which creates ternary structures as in (18a), whereas the latter result from the need to express rhythm in terms of a layered structure. In both cases, the detailed structure is inherently phonological because the words, by hypothesis, lack any kind of morphotactic structure. In a sense, these structures involve a mismatch between the prosodic structure and the morphotactic structure in that a single morphotactic word is parsed into a prosodic word 'and a bit' or two or even more prosodic words. One would perhaps expect that the reverse is also possible, i.e. a polymorphic structure that corresponds to a single prosodic word. This, of course, is precisely what we find when we deal with affixes that are what are called 'cohering' or 'integrating'. These affixes (roughly the level I suffixes in English; cf. Allen 1978) 'integrate into the prosodic domain that is formed by their base' (Booij 1996):

(23) a.

$$A \quad N^{aff}$$
$$N$$
$$PrW$$
$$F \qquad F$$
compen   sat   ion

b.

$$N$$
constitution-al- iz-ation
F F F F
PrW   PrW
?PrW

Whether or not words that are formed with integrating affixes form one or two prosodic words depends on their length, if it is true that the PrW is not an endless domain. As suggested in Helsloot (1993), if there are more than two feet a single prosodic word unit cannot comprise the whole word, as in (23b), where we still leave the matter undecided as to whether the whole unit is a PrW.

However, when we start dealing with units that are bigger than single morphemes (or bigger than simplex words), another type of motivation for phonological structure comes into play, namely the drive for phonological structure to be isomorphic to the morphotactic-semantic structure.

In line with this, as it is frequently claimed (as in Kabak and Revithiadou 2009), every morphotactic word (belonging to a major lexical category; cf. below) wants to be a prosodic word. The drive for isomorphy would lead to another structure for the words in (23):

(24) a.

$$A \quad N^{aff}$$
$$N$$
$$PrW$$
$$PrW$$
$$F \qquad F$$
compensate   ion

b.

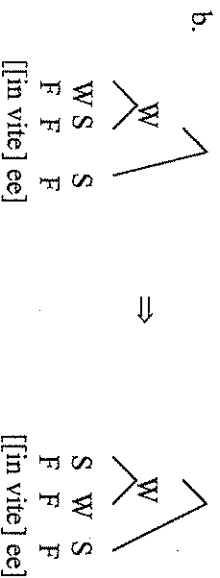$$N$$
constitution-al- iz-ation
F F F F
PrW
PrW
PrW

Technically, these structures emerge when metrical organization is assigned *cyclically* (Kiparsky 1979). A reflection of such cyclic application would be the fact that primary accents of embedded words are preserved as 'cyclic non-primary accents'. If this is how prosodic structure behaves, it would seem that prosodic structure mimics the recursion that is present in the morphotactic plane. Note, however, that the prosodic structure does *not* mimic the morphotactic structure in one important respect. Whereas in the latter structure newly added material (suffixes) are heads (because suffixes determine the category of the complex word), the idea that prosodic domains corresponding to more deeply embedded words are contained in prosodic domains of less deeply embedded words suggests that the more deeply embedded domains are heads to which the new material is adjoined as dependent material. This assumption (which may be misguided) leads to the fact that the recursion that we find in the prosodic hierarchy is *adjunctive recursion*, while the recursion in the morphotactic hierarchy is *subjunctive recursion*. I will return to this point in section 4.

The cyclic-isomorphic account can be enforced derivationally in terms of cyclic application or, non-derivationally, in terms of constraints that
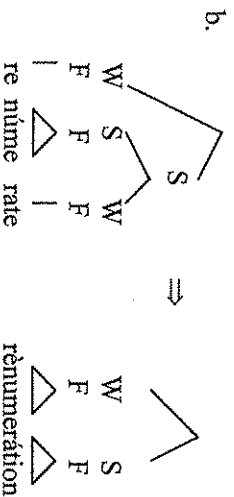
demand alignment of morphotactic edges with prosodic edges or, more straightforwardly, demand each morphotactic word (or phrase) to be a prosodic word (or phrase). The question arises, however, to what extent, phonology serves isomorphy? Kiparsky (1979) demonstrates that cyclic structure is changed into rhythmic structure in case the primary accent of the embedded word is adjacent to the primary accent of the suffix, thus avoiding a clash:

(25) a.   invite ~ invitée

b.

```
        W                        W
      / |                      / |
   W   S                    S   W   S
   F  F  F                  F   F   F
  [in vite] ee]     =>     [in vite] ee]
```

Likewise, restructuring is likely to happen if the primary accent of the embedded word is non-initial since, in English and other languages, initial syllables attract the secondary accent:

(26) a.   renumerate ~ rénumération

b.

```
       S                   S
     / | \               / | \
   W  S  W             W   S   F
   F  F  F             W   S
   |  /\  |            F   F
   re néme rate   =>   rénumeration
```

It would seem then that unbalanced recursive structure within the prosodic word tends to be replaced by balanced recursive structure.
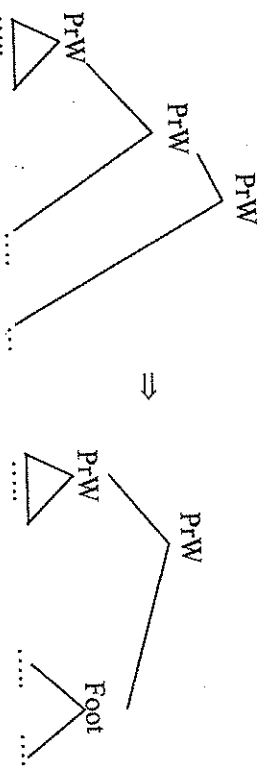
Another area where unbalanced recursive prosodic word structure arises above the level of the morphotactic word, i.e. 'in the syntax', occurs when lexical items belonging to closed categories 'cliticize' to a host to their right or left. The resulting structure, which some have termed the *clitic group*, has been identified as a *recursive prosodic word* (Peperkamp 1997):

(27)   PrWord (~ clitic group)

```
        Pr.Word
        /    \
     ....   ....
```
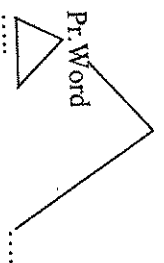
But when more than one clitic is added, as in (28), we need to ask whether the structure remains recursive (and thus isomorphic), or whether it will be 'flattened':
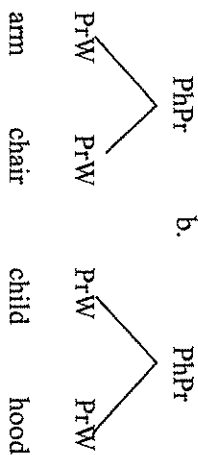
(28)

```
        PrW                      PrW
       /   \                    / | \
    PrW    ....     =>       PrW PrW Foot
   /  \                      ...  ...  ...
 PrW  ....
 / \
.... ....
```
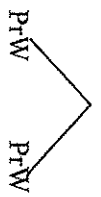
Peperkamp (1997) compares various Italian dialects in terms of the effect that clitics have on the rhythmic structure of words and it would seem that in some dialects the restructuring in (28) applies while other perhaps tolerate the unflatted structure. This seems to mean that the conflict between rhythmic grouping and isomorphy can be resolved by giving precedence to one over the other. If the multiple recursive structure in (28) is a possible structure this implies that phonology allows more recursion in case of morphotactically complex expressions than for simplex words, simply, we would have to assume, in order to maintain isomorphy and this again raises the question how recursive (and thus disrhythmic) phonology is willing to be in order to comply with the demands of isomorphy.

Turning to morphological compounds, it would seem that, at least in English, their prosodic structure is isomorphic to their morphotactic structure, each member of the compound forming its own prosodic word. However, how are these prosodic words organized into larger prosodic units? The original strict layer hypothesis would require that a compound is a phonological phrase. This kind of structure, then, would also be likely for words derived with 'heavy' suffixes like *–hood*, which have often been claimed to display the same kind of prosodic structure as compounds:

(29) a.

```
        PhPr
       /
     PrW
    /   \
   PrW
  arm  chair
```

b.

```
        PhPr
       /   \
     PrW   PrW
    child  hood
```

In fact, even non-compound words that apparently display the phonotactic structure of compounds would be represented in this way. Such words may be loan words or 'old (hidden) compounds'.

However, rather than taking this step, other researchers (Kabak and Revithiadou 2009, Itô and Mester 2008) have suggested that such complex words have *balanced* recursive structures:
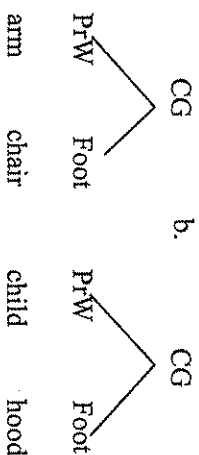
(30) a.

```
        PrW
       /   \
     PrW
    /   \
  arm  chair
```

b.

```
        PrW
       /   \
     PrW   PrW
    child  hood
```
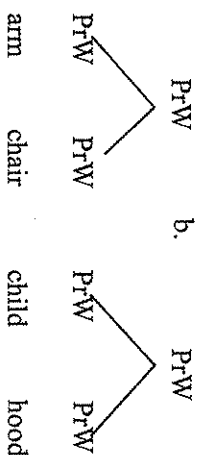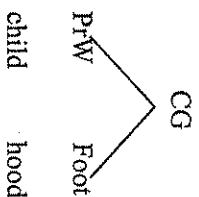
Vogel (2009), on the other hand, proposes that compounds are more like 'clitic groups' (which she calls 'composite groups' to express the idea that the unbalanced recursive prosodic word covers more than clitic structures):

(31) a.

```
        CG
       /
     Foot
    /   \
  arm  chair
```

b.

```
        CG
       /   \
     PrW   CG
    child  Foot
          hood
```
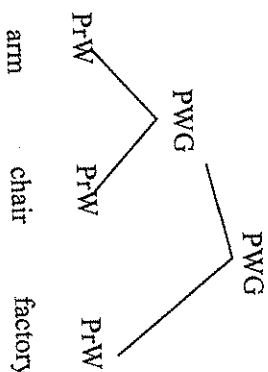
A third kind if proposal can be found in Vigário (to appear) who proposes that the prosodic unit formed by compounds (and compound-like structures) is a new category that she calls the *Prosodic Word Group*. One argument for recruiting a new category rather than a recursive structure is that the relevant unit has properties that can be quite distinct from the properties of prosodic words. A property that Vigário discusses is the fact that compounds often have a prominence pattern that differs from that of words and that of phrases, which suggests that this unit should not be identified with either.
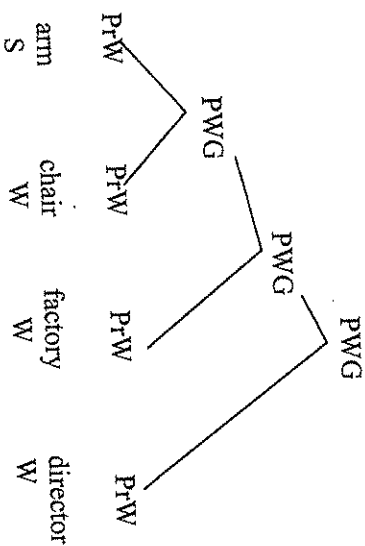
Here I will remain neutral on which proposal is more appropriate, although, perhaps, more than one should be allowed, albeit for different kinds of data. The structures in (31) would attribute less prosodic autonomy to the right-hand compound member which may apply to certain languages or be the result of diachronic 'weakening' from balanced structures.

Whatever the case may be, when compound structures get more complex morphotactically, the question arises again to what extent the phonological structure stays isomorphic or will be subjected to 'flattening'. The evidence suggests that flattening is very likely to occur (Giegerich 1985, Visch 1999). Thus, while the structure in (32a) is isomorphic and still rhythmic (being ternary), the even longer compound in (32b) is likely to be subject to flattening so that we get (32c) instead:[20]

(32) a.

```
        PWG
       /   \
     PrW   PWG
    arm   PrW  PrW
         chair factory
```

b.

```
          PWG
         /    \
       PrW    PWG
       arm   PWG  PrW
             S
        PrW  PrW  PrW
       chair factory director
         W     W     W
```
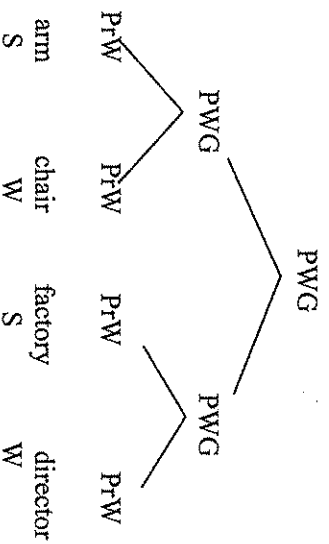
20. Here I adopt Vigário's Prosodic Word Group, assuming that this category tolerates unbalanced (as in 32a and b) and balanced (as in 32c) occurrences for compounds consisting of more than two terminal words.
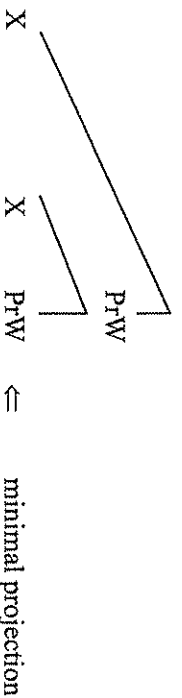
c.

```
            PWG
          /     \
        PrW      PWG
               /     \
             PrW      PrW

        arm   chair   factory   director
         S      W        S         W
```

(32c) results when rhythm (the phonology-inherent force) takes over from isomorphy.[21] Note, however, that in both cases we have recursive structure on the assumption that compounds, no matter how complex, form prosodic word groups rather than phonological phrases.

Recapitulating, we have seen two types of recursive prosodic word structures, *unbalanced* and *balanced*. Both structures are recursive and both can be subject to flattening. Structures of this sort have been put to use in recent studies by Kabak and Revithiadou (2009), Itô and Mester (2009) and Vigário (to appear). Itô and Mester (2009) suggest that recursive structures are limited in the following manner:

(33)

```
              PrW        ⇐    maximal projection
           /   |   \
          X    X    PrW
                   |
                  PrW

          X    X    PrW      ⇐    minimal projection
                   |
                  PrW
```

(As we will see below, they propose the same scheme for the phonological phrase.) By allowing adjunction (creating recursive structure), Itô and Mester claim that we can avoid unprincipled proliferation of prosodic categories. The suggestions made here concur with the ideas of these authors and it is interesting that they limit the adjunction scheme to precisely the point where further adjunction would create a quaternary and this disrhythmic structure.

---

21. This prosodic structure is ambiguous in that a different compound [[arm chair] [factory director]] 'an armchair kind of factory director' (i.e. he doesn't have much practical experience), has this same structure, albeit that in English the second 'S' would be the primary compound accent in that case.

3.2. *The phonological phrase (and beyond)*

Climbing up the prosodic hierarchy, the next unit is the *phonological phrase* and here too, as we expect, isomorphy (to morphotactic structure) plays an important role. Much has been written on the formation of prosodic phrases and their relationship to syntactic phrases (starting with Selkirk 1978, 1980, Nespor and Vogel 1986 followed by a lot of further work; cf. Truckenbrodt 2007 and Elordieta 2008 for overviews). Firstly, a distinction must be made between phrases with a lexical head and phrases with a functional head. The latter typically do *not* project prosodic phrases, but instead are adjoined to prosodic phrases that are projected from lexical heads; depending on the language, the host of adjunction is either the complement of the functional category, as in (34) (which preserves isomorphy), or not:
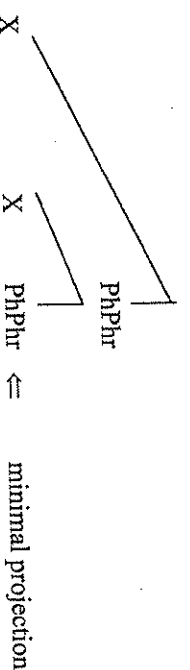
(34)

```
            PrPhr
          /      \
       PrPhr      △
        the     /    \
              the    man
```
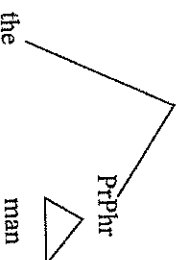
Returning to the notion of clitic group (interpreted as a recursive prosodic word), one might ask whether functional words can adjoin at the prosodic word level or at the prosodic phrase level. Different authors take different points of view, although adjunction at the level of the PrW seems to be the more popular approach (Booij 1996).

Turning now to lexical phrases that recursively contain lexical phrases, we might ask whether prosodic phrases (analogously to prosodic words) allow various levels of adjunction, thus forming recursive prosodic structure that is isomorphic to the morphotactic structure. Itô and Mester (2008, 2009) suggest that it does and they propose the following structure:

(35)

```
              PhPhr       ⇐    maximal projection
           /    |   \
          X    PhPhr

          X    X    PhPhr   ⇐    minimal projection
                   |
                  PhPhr
```

This still leaves open what the prosodic status of 'X' is in such cases:

(36)

```
          PrPhr
         /     \
      PrPhr     \
      /  \    [PrW ~ PrPhr]
  (The man)    upstairs
```
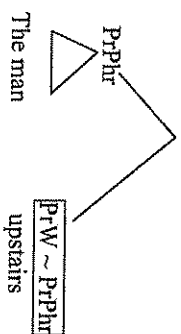
Selkirk (1986) and others have shown that whether or not complement phrases form their own prosodic phrases depends on the 'weight' of the phonological material of the syntactic complement. In addition, however, languages may simply be different in this respect.
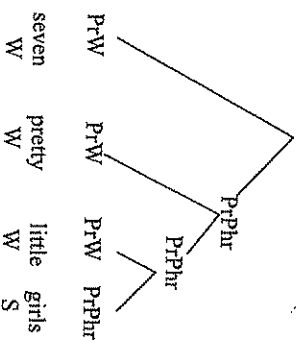
Different types of prosodic phrases (such as minor and major phrases; Beckman and Pierrehumbert 1986) have been distinguished. One would have to re-examine all these proposals, but it is possible, as Itô and Mester suggest, if not likely, that these distinctions are simply specific instances of recursion within the prosodic phrase, e.g.:

(37)

```
PrPhr (~ Major Phrase)
   PrPhr (~ Minor Phrase)
      PrPhr (~ PrPhr)
         .....
         .....
```
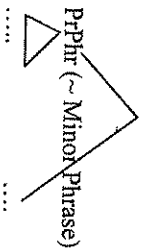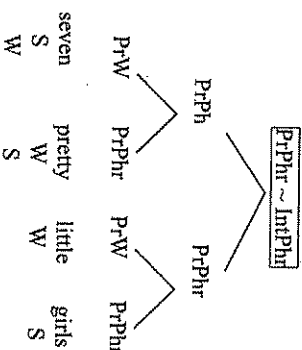
If we allow the recursive structure in (37) we might again ask how much recursion in prosodic structure is tolerated. If, let us say, two levels of embedding are added, do we get (38a) or (38b)?

(38) a.

```
                PrPhr
               /     \
            PrPhr     PrPhr
           /   \      /    \
        PrW   PrPhr  PrW   PrPhr
         |    /  \    |    /  \
      seven ... ...  pretty little girls
        W    W   S     W    W    S
```

b.

```
                PrPhr
               /     \
          [PrPhr ~ IntPhr]
            /        \
         PrPhr       PrPhr
         /  \        /   \
       PrW  PrPhr  PrW   PrPhr
        |   /  \    |    /   \
     seven ...     pretty little girls
        S   W  S     W    W    S
```
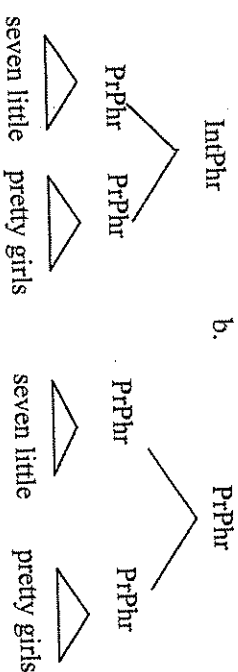
Giergerich (1985: 235 ff.) already proposed that with increasing phrasal embedding, isomorphic (recursive) prosodic structure gives way to a flatter
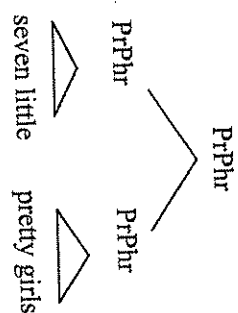
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rhythmic balanced grouping so that (38b) is preferred over (38a) as evidenced by the two possible rhythmic structures of the phrases here informally represented with Ws and Ss.[22]

With reference to (38b) one could furthermore ask whether a conjunction of two phonological phrases necessarily means that the combination is a higher prosodic category, such as the Intonational Phrase. Would instead of (39a), (39b) also be possible?

(39) a.

```
         IntPhr
        /     \
     PrPhr    PrPhr
     /  \     /   \
  seven little  pretty girls
```

b.

```
            PrPhr
           /     \
        PrPhr    PrPhr
        /  \     /   \
     seven little  pretty girls
```
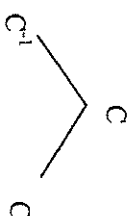
If the structures that group phonological phrases are analogous to those that group prosodic words, we would expect that a case can be made for either structure.

As in the previous section, it would seem that structures as in (40a), balanced structures, are needed in addition to the one in (40b), unbalanced structures:

(40) a.

```
      C
     / \
    C   C
```

b.
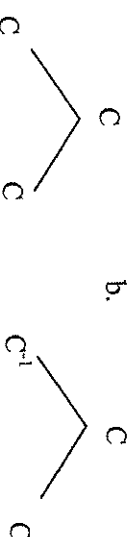
```
      C
     / \
    C¹  C
        |
        C
```

Ladd (1996: 244) indeed proposes balanced structures of this kind (with specific reference to the Intonation Group) which he calls *compound prosodic domains*. Besides providing empirical evidence for his proposal, he also motivates this type of structure by pointing out that repeated flattening of recursive structures would lead to an undesirable proliferation of prosodic categories unless balanced recursion of categories is invoked. Again the view concurs with what is suggested in this chapter. Let us conclude then that prosodic structure displays recursion which is either unbalanced (and isomorphic to morphotactic structure) or balanced (resulting from flattening when unbalanced embedding exceeds degree 2). In the 2nd edition of

22. See Schreuder, Maartje, Dicky Gilbers and Hugo Quené (2009) for a recent study showing that the accentual patterns in phrases can reflect the recursive morphotactic structure of these phrases which means that rhythmic adjustment is not always obligatory.
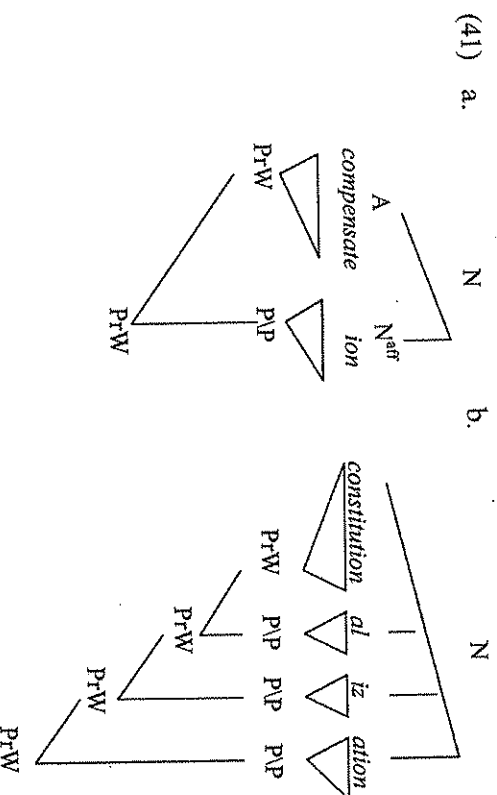
his book on intonation, Ladd (2008) writes: "... many researchers now accept that some form of recursion and/or indeterminate depth of structure must be incorporated into our understanding of prosodic structure ... Many details, though, remain to be worked out."

4. Concluding remarks

In this chapter, I have explored the (potential) use of recursive structures in phonology. My starting point was that recursion is not, as Hauser, Chomsky and Fitch (2002) believe, limited to the syntactic module. Following Anderson's notion of Structural Analogy, *my* working hypothesis has long been that the same kinds of structures are available in all modules of grammar. (In fact, I believe that recursion is a general faculty of the human mind, employed in language where needed.) In discussing the notion of recursion, we have first looked at levels of organization where isomorphy with morphotactic structure plays no role. Kabak and Revithiadou (2009) suggest that these lower levels of organization are fundamentally different from the higher levels of prosodic organization. They conclude from this that recursion at these levels is unexpected, but this is fueled by their belief that recursion is phonology must be morphotactically motivated. While I accept that this is true for higher levels of prosodic organization (surrounding the prosodic word and the prosodic phrase), I have suggested that 'feet' can be analyzed as resulting from recursion, either because syllable heads (nuclei) can take syllables as 'complements' which leads to subjunctive recursion, or as a result of adjunction. It may very well be that syllables (in the extended sense proposed here, i.e. including foot structure) display a kind of recursion that is different from what we find at higher levels, a finding that further illustrates the parallelism between these basic phonotactic units and the basic morphotactic units (i.e. syntactic phrases), a point to be developed below. Proceeding with a discussion of higher prosodic levels (the prosodic word and the prosodic phrase) we have seen that the idea of strict layering has been widely abandoned, being replaced by two types of recursive structures, unbalanced and balanced. Unbalanced recursion always appears to follow from adjunction, whereas balanced recursion results from conjunction. Thus neither type of prosodic recursion results from subjunction.

At this point I return to the question why this should be so. Let us look back at the examples in (24). Why do we think of prosodic words that occur inside extended prosodic words as heads and of the added material as dependent? If prosodic structure tries to be isomorphic to morphotactic

structure why aren't suffixes, for example, prosodically strong? After all, some suffixes literally are prosodically strong in that they will receive primary accent or at least attract the accent in their direction. It would seem that the headedness of the extended prosodic word is actually irrelevant, at the very best. What matters is the formation of domains within which certain rules, for example accent rules, may apply. However, in many cases, in particular, languages with so-called lexical accent systems, there is reason to believe that the accentual properties of affixes predominate over the accentual properties of their base such that the accent of the last added affix that has a lexical accent predominates. Systems of this sort require a default statement which assigns an accent if no morpheme in the word brings in a lexical accent. In languages where only suffixes may have accentual properties, the facts can be accounted for by saying that the primary accent lies on the *rightmost* accented morpheme or, if no lexical accent is present on the last or first syllable. A case in point is Russian which indeed has primary accent on the rightmost accented syllable and initial accent if there is no lexical accent. English works like this too, but here there is no default clause since, whereas suffixes may be accented or unaccented (or even pre-accented), there are no accentless stems. If we would choose to capture the rightmost effect in terms of headed prosodic structure we would then represent the suffixes (as prosodic entities) as heads that take the prosodic unit forms by their base as a 'complement'. This leads to an adaptation of the structure in (24) as in (41); in these structures headedness is indicated by vertical lines:

(41) a.

  A   N^af
compensate ion

      Pr-W   PrP
         PrW

   b.

  N
constitution al   iz   ation
      PrW   PrP   PrP   PrP
         PrW   PrW
            PrW

For the suffixes I have chosen a 'categorial' prosodic category 'P\P' which stands for 'takes a prosodic word to form a prosodic word'),[23] In other words, the relevant suffixes are subcategorized for taking a prosodic word as their base and forming a prosodic word when attached. With a representation of this sort, in which affixes are prosodic heads, we provide a basis for the fact that their accentual properties, if present, prevail. What this 'exercise' demonstrates is that the recursion in the prosodic hierarchy does not have to be of the adjunctive kind (as in 24). In fact, we can get mileage out of displaying it in terms of subjunctive recursion.

Finally, there is one other important issue that we need to address which specifically regards higher prosodic structure. We have seen that if prosodic structure wishes to be isomorphic to morphotactic structure, this structure will have to allow, especially unbalanced, recursion (as in 24 or 41). The evidence for this isomorphic prosodic structure comes from 'rules' (segmental rules and 'stress' or 'accent' rules). Then, there is other evidence, specifically involving rhythm which suggests that the prosodic structures appear to be 'flatter' and thus much less isomorphic. Now let us recall a point that was made in section 1 (following Wagner 2005), namely that evidence from rules which seem to respect recursive morphotactic structure do not automatically support the idea that there is a prosodic structure which is also recursive. Rules of this sort could simply make *direct reference* to the morphotactic structure which would make them irrelevant as evidence for any kind of prosodic structure, recursive or not. Here we need to bear in mind that the existence or need for prosodic structure that is isomorphic to morphotactic structure is hard to prove on principled grounds. Assuming that the morphotactic structure is independently needed, if phonological rules can simply be applied with reference to this structure, postulating additional isomorphic prosodic structure is uncalled for.[24] The crucial evidence would have to come from cases where the alleged prosodic structure differs (perhaps only minimally) from the morphotactic one. Indeed, much of the original motivation for
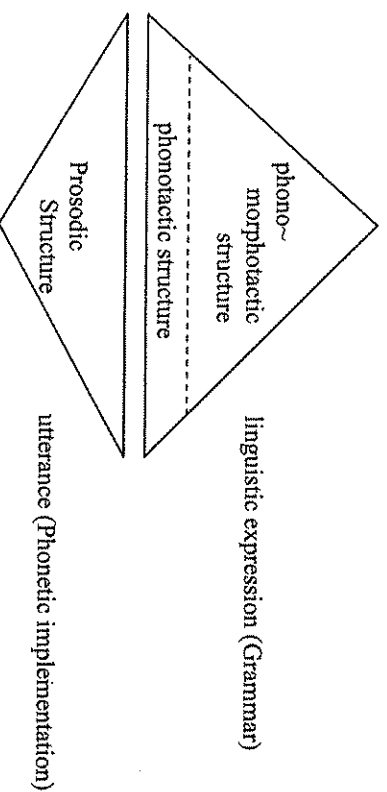
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23. I actually explored a proposal of this sort in van der Hulst (1982). I here also refer to Wheeler (1981) who develops a categorial approach to phonology which captures this kind of isomorphism between morphotactic and phonological structure.

24. By thus increasing the isomorphy between the morphotactic structure and the phonotactic structure, as in (41), we make this case for a separate prosodic structure even weaker. We can state the generalization that the accentual properties of suffixes prevail directly in terms of the morphotactic structure in which suffixes are heads.

prosodic structure took this form (cf. Nespor and Vogel 1986), although many of the case studies had or have been analyzed with rules that refer to syntactic structure (Kaisse 1985, 1990; Odden 1987). Now, we have also considered the fact that next to recursive prosodic structures which are isomorphic or perhaps near-isomorphic to morphotactics, there is evidence, specifically rhythmic evidence which suggest a different much flatter organization. Following earlier proposals (e.g. Giegerich 1985) I took it for granted that there are prosodic transformations which map unbalanced recursive structures that exceed degree 2 embedding by balanced recursive structures. In van der Hulst (2003, 2009) I suggest a perspective that allows a different view on the clash between recursive structures and rhythmic structures. The basic idea is that there are most likely *two* phonological hierarchies, one which is very close, if not identical to the morphotactic organization (and, as such, it *is* perhaps really the morphotactic hierarchy) and another one which is driven by the distribution of 'phonological' hierarchy) and purely rhythmic. I will use the term *phonotactic hierarchy* for the first level and reserve the term *prosodic hierarchy* for the second level. The exact nature of the rhythmic prosodic organization is not fully clear. However, being rhythmically driven we expect unbalanced (adjunctive) recursion to accommodate ternary rhythms and otherwise balanced recursion. In this dual view, I would consider the structure of syllables and feet (as discussed in section 2) to be part of the first phonotactic hierarchy. In other words, phonotactics (understood as the syntax of segments; the so-called 'second articulation') forms one plane with the morphotactic hierarchy (the 'first articulation') which explains that both systems are structurally so much analogous, displaying the same kinds of subjunctive recursion (syllable inside syllable; phrases inside phrases). Whether at higher levels we need a phonotactic plane that is near isomorphic, but not identical to the morphotactic plane remains an open question, as we have just seen. The proposals of Itô and Mester (2008) and Kabak and Revithiadou (2009) demand a very high degree of isomorphy and this suggests that, perhaps, we are really dealing with morphotactic structure here and that rules referring to higher levels *are* direct reference rules. With reference to the structures in (41), I further add that the phonotactic structure coinciding with the morphotactic structure may be even more isomorphic to is usually assumed. The prosodic structure, however, is fully independent from the morphotactic plane and belongs to 'utterances' rather than abstract linguistic expressions. It provides the context for fast-speech rules and the fine details of intonational con-

tours or, more generally, for *phonetic implementation* (cf. Pierrehumbert 1980). The prosodic hierarchy ranges from the lowest units (segments, or even gestures) to the highest (utterances) and thus has units which are somewhat like the phonotactic syllables discussed in section 2, which I will call prosodic or phonetic syllables. Perhaps *prosodic* syllables are less structured, flatter (as in Kahn 1976), forming iterative rather than recursive patterns (cf. van der Hulst 2003). By invoking *two* phonological levels (the (phono~morpho)tactic level and the prosodic level) we can dispense with restructuring rules that 'flatten' unbalanced recursive structures that exceed degree-2 embedding. In phonetic interpretation, rhythmic beats respect primary word and phrasal accents that have been assigned at the (phono~morpho)tactic level, but they can 'overwrite' the potential impact of the more deeply embedded 'cyclic' accents which are inherent to the phonotactic hierarchy (cf. van der Hulst, in prep.). The resulting model is much in the spirit of Kaisse (1990), which admits two kinds of phonological rules. Firstly, there are 'direct reference' rules which operate in terms of the abstract grammatical *tactic structure*. Then, there are the prosodic rules operating in terms of prosodic domains which belong to actual utterances. In fact, Nespor and Vogel (1986) also admitted both levels, while the idea that all phrasal phonology is prosodic ('indirect reference') was promoted in Hayes (1990).[25] The diagram in (42) captures the idea of there being two phonologies:

(42)

phono~morphotactic structure   linguistic expression (Grammar)

phonotactic structure

Prosodic Structure   utterance (Phonetic implementation)

25. Frota (to appear) provides an overview of 'prosodic' structure, making explicit reference to the fact that different hierarchies have been suggested, for different purposes. Whether, these different hierarchies can be reduced to one, as has usually been assumed, is, as she says, an empirical issue.

So, while it is true that Martinet's second articulation ('phonology') exists below the level of the first articulation ('morphology and syntax'), the two being sequential, it is, at the same time true that there is a phonological organization that is fully parallel with the entire morphotactic structure (although I would say 'with the entire tactic structure'). This view, as pointed out in van der Hulst (2003, 2009) resolves 'structure paradoxes, especially with reference to lower levels of organization and provides a home to 'phonological (i.e. phonotactic) syllables and feet and 'phonetic' (i.e. prosodic) syllables and feet.

The exact nature of the prosodic hierarchy remains to be determined. It could be arboreal (tree-based), displaying 'Abercrombian feet' (see van der Hulst 2009 for discussion) or it could be purely grid-based, or both (as in Nespor 1990 who proposes two different planes as in Liberman and Prince 1977, or Halle and Vergnaud 1987 who use 'bracketed grids'). If the prosodic hierarchy is not arboreal (as suggested in Prince 1984 and Neeleman and van der Koot 2006)[26] it is perhaps less appropriate to speak of recursion since there would be no containment relations defined over nodes. It seems to me that the authors cited here who argue in favor of recursion at higher levels, at least in part, study phenomena that fall within the tactic realm rather than the prosodic realm. We have seen that at this level, phonotactic structure displays considerable recursion, firstly at the syllable/foot level and, secondly, at the word and phrase level. In the case of word or phrase level recursion it remains to be seen whether the recursive structure isn't really the morphotactic structure. However, the syllable/foot level recursion, albeit limited, is inherent to the phonotactic structure. Whether the *prosodic phonology* also displays recursion should be seen as a separate issue, but if intonation domains belong to the prosodic hierarchy, as suggested in Rischel (1982) there are grounds for accepting that the prosodic hierarchy also displays (both unbalanced and balanced) recursion. This is also confirmed by the work of Ladd (1986, 1996), Hunyadi (this volume) and Fox (2000: 317–320) who all describe the inclusion of intonation domains within larger intonation domains.

26. Both proposals do not distinguish between the two phonologies (phonotactic and prosodic), however. Hence, I think that, Neeleman and van der Koot are not right in denying recursion to (phonotactic) syllable, but they may be right in their assessment of higher levels of organization provided that they are talking about the prosodic hierarchy.

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