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*Metrical constituency and rhythmic adjustment**

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1 Introduction

Over the past few years, research in metrical phonology has witnessed a shift in its main topic of investigation. Originally, attention was focused on the representation of prominence patterns of words (for example, Liberman & Prince 1977; Kiparsky 1979; Selkirk 1980; Hayes 1981), but more recently interest has arisen in several sorts of 'rhythmic' stress phenomena in larger domains (Prince 1983; Hayes 1984; Selkirk 1984; Hammond 1984; Giegerich 1985). One way of explaining this shift is by noting that the issue of the treatment of prominence patterns proper seems to have reached a stage where both grid-only (i.e. tree-*less*) theory and variants of tree-*full* theories, whether or not they employ grids as well, are capable of explaining the prominence patterns of words (see, for instance, Prince 1983; van der Hulst 1984). In this situation, investigation of rhythmic stress phenomena may offer the possibility of evaluating these theories because, as currently perceived, this area typically deals with the issue of whether metrical tree structure is needed at all, or whether grid structure by itself is capable of explaining rhythmic adjustments: on the one hand, grid-only theory claims that any constituency relevant to rhythmic adjustment is adequately encoded in the grid; on the other, tree theory holds that more detailed, or perhaps different, constituent information is required, as expressed in the metrical tree.

The main concern of this paper will be with this latter point. It will be our purpose to show that metrical constituent structure and its labelling are indispensable for the treatment of rhythmic adjustment. Thus, we prefer tree-full theories to tree-less theories as adequate accounts of metrical adjustment. To arrive at this conclusion, we will employ the framework provided by Hayes (1984), perhaps the most constrained version of tree-full metrical theory currently available. This variant uses both trees and grids, but we stress right from the start that the presence of the latter is not essential for the point that we intend to make.

Our line of argumentation will be the following. In §2 we will discuss both grid-only theory, represented by the work of Prince (1983) and Selkirk (1984), and tree theory as defended in Kiparsky (1979), Giegerich

(1985) (both grid-less variants) and Hayes (1984) (tree-*cum*-grid). We will also review some of Hayes' arguments against grid-only theory. In §3 we will show how Hayes (1984) runs into problems in cases of 'internal rhythm'. It is possible, however, to solve these problems by introducing a principle which makes exactly the right distinctions between acceptable and non-acceptable internal rhythmic adjustments. This principle, the Strong Domain Principle, is stated crucially in terms of arboreal properties, i.e. constituency and s/w labelling. We will show that grid-only theory must run into difficulties in deriving equivalent results in these cases, because of its inability to identify the relevant properties (this appears most clearly in cases with identical grids but different adjustment possibilities). §4 concentrates on Dutch, a language which resembles English with respect to leftward rhythmic phenomena, but which, because of its rightward rhythmic adjustments, also allows exploration of a new domain of observations. Specifically, the way adjustments in opposite directions interact will lead us to formulate a second principle, again stated in terms of arboreal properties, the Bottom-to-Top Principle. Our observations and conditions cover precisely those cases which are clearly problematic in a grid-only framework.

2 Overview

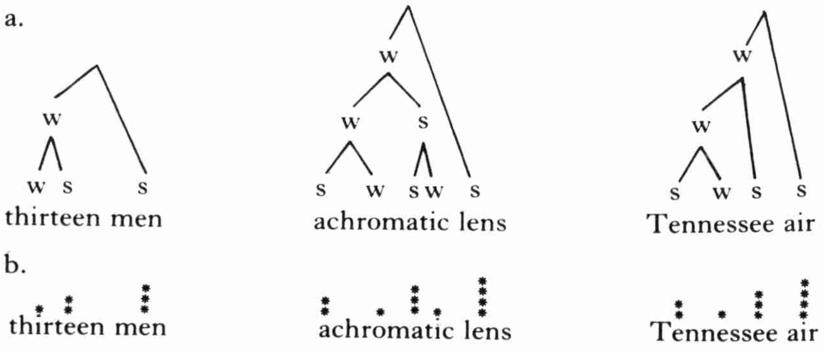
2.1 Introduction

The issue of trees (or trees-and-grids) *vs.* grids can be traced back to Liberman (1975) and Liberman & Prince (1977), who define relative prominence on trees. In order to account for rhythmic shift phenomena, Liberman & Prince introduce a separate representation of linguistic rhythm, the GRID, derived from trees by the Relative Prominence Projection Rule in (1):

(1) *Relative Prominence Projection Rule*
In any constituent on which the strong–weak relation is defined, the designated terminal element of its strong subconstituent is metrically stronger than the designated terminal element of its weak subconstituent. (Liberman & Prince 1977: 316)

Thus the grids in (2b) are derived by the RPPR from the trees in (2a):

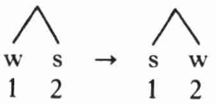
(2)



Clearly, grids do not preserve all information present in the tree; for instance, the direction of branching in the tree is lost. Further, s/w-labelling is encoded in the grid only to a certain extent; all bottom grid columns correspond to weak terminals, but detailed information on the labelling of nodes dominating non-terminals is not recoverable from the grid.

Part of the structural description of stress shift is constituted by a so-called 'clash' in the grid: two elements occurring on the same level without an intervening element one level down. The presence of a clash in the grid is an expression of the rhythmic pressure which causes a relabelling of nodes (a reversal of a strong–weak relation) in the tree within one of its constituents. This is the stress shift, formulated as (3):

(3) *Iambic Reversal* (Liberman & Prince 1977: 319)



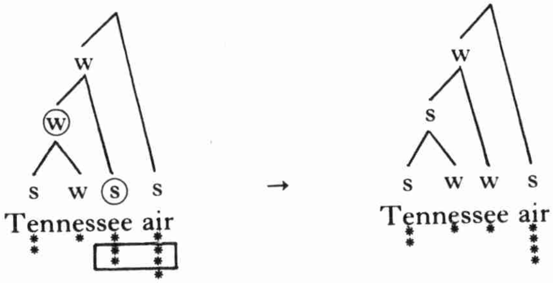
Conditions:

(i) Constituent 2 does not contain the designated terminal element of an intonational phrase

(ii) Constituent 1 is not an unstressed syllable

In (4) we give an example, in which the clash is boxed. The relevant nodes are circled. After reversal of the strong–weak relation, a new grid is constructed by the Relative Prominence Projection Rule in order to ascertain the absence of clashes:

(4)



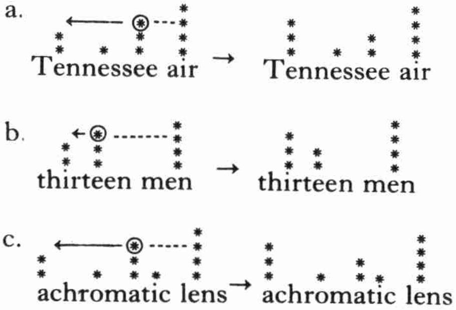
One of the most obvious objections to the Liberman & Prince theory of stress shift was that the functions and principles of grids, as opposed to those of trees, are not independently motivated, and that there is an overlap of information, because grids derived from trees partly contain information also present in trees. As a reaction to this, the development of theories which try to eliminate one of these representations was therefore not unexpected. The ensuing discussion focused on two points: first, the overlap between trees and grids, and second, the relevance of metrical constituency. As noted above, we will refrain here from taking up the first point. It will not be our aim to evaluate all theories against one another, and we will have little to say about the redundancy problem. From this it follows that for our purposes metrical theories fall into two categories:

grid-only ones on the one hand, and tree-only or tree-*cum*-grid ones on the other. We will discuss these variants in the following two subsections. In §2.2 we consider the treatment of rhythmic phenomena given by Prince (1983) and Selkirk (1984). In §2.3 we will take up tree theory, with the emphasis on Hayes (1984), which is partly intended as a reaction to Prince (1983).

2.2 Grid-only theory

Clearly, the essential feature of a grid-only theory is that both the pressure for rhythmic adjustment and the adjustment itself are expressed in one representation: the grid. The notion of clash is central, and rhythmic adjustment, which of course cannot be expressed in a tree, amounts to the movement of an element in the grid. Some examples are given in (5):

(5)



Not only is the notion clash important to shift phenomena but, in this theory, it is also crucial in the construction of grids below word level: word stress is also defined by grids, and clashes must be avoided in the course of the construction of grids over syllables. Throughout, we will consider these procedures as understood, although in one or two cases we will provide additional clarification.

Grid structure above word level is motivated by morphosyntactic structure. There is a one-to-one correspondence between morphosyntactic structure and grid structure: the grid is constructed by rules which add a level to the first or last strong element in a constituent. Prince calls these End Rules, whereas Selkirk calls them Domain-End Prominence Rules. Such rules operate obligatorily in all morphosyntactic domains.

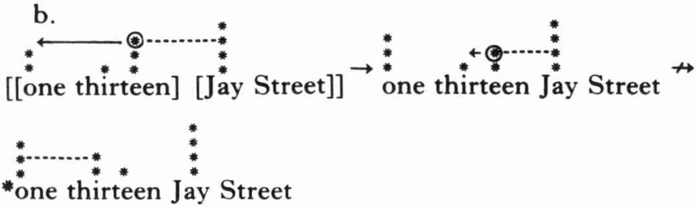
Although Prince's and Selkirk's proposals are to a considerable degree equivalent, there are also a number of differences, including the order of the adjustment rules with respect to the grid construction rules, the types of conditions on adjustments, and the types of adjustment rules. Let us briefly discuss these differences here.

2.2.1 *Prince (1983).* For Prince, rhythmic adjustment rules operate on exhaustively specified grids. Applying End Rules to different levels may result in a rhythmically ill-formed situation, i.e. a 'clash'. This clash triggers the rule Move x, and this rule in turn moves one clashing element at a time to the first available position to the left, obligatorily remaining in the same horizontal row. In (5b) we see that there is only a single landing site available; in (5a) and (5c), the clashing element is moved to the initial column, as the second column is not a possible landing site, being two levels down.

An important parameter is the direction of Move x: leftwards, rightwards, or in both directions. Clearly, English shows the first. Move x in combination with clash is restricted by two further conditions, defined on DOMAINS: first, Move x may not introduce a clash within its relevant domain (which derives from syntactic structure and not from the grid; see below), and second, the operation takes place within the *smallest* syntactic domain containing the clash. Prince combines these restrictions into a Bounding Condition. Crucial examples of course require embedded structures, or 'internal rhythm' contexts, as discussed first in Hayes (1982, 1984).

(6)[1] a.

b.

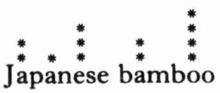


Shift is allowed in (6a). There is a clash in the domain *bambòo tábles*, and Move x removes this clash. The newly created clash is in a larger domain, *Jày's bàmboo tábles*, between the leftmost pair of syllables, but the Bounding Condition does not exclude this situation. In (6b) the first application of Move x removes a clash between *-teen* and *Jay*. However, a possible application within *thirteen* is blocked. The smallest domain which contains the clash is again *one thirteen Jay Street*. Move x would create a new clash in that same domain, a result excluded by the Bounding Condition.

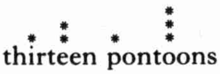
Note especially the crucial roles of both the notion clash and the syntactic organisation of the phrases involved.

Unfortunately, as Prince notes, the notion of clash is not always fully reliable in other cases, such as those in (7):

(7) a.



b.



In (7a), Move x derives the output *Jàpanese bambóo*, although the example lacks a formal clash. Prince notes: 'Move x applies in a wider range of environments than we predict. Perhaps "clash" ought to be characterized somewhat more broadly; or perhaps other conditions on eurhythmicity are having their effect – for example a distaste for upbeats' (Prince 1983: 35). In (7b), Move x operates in the same manner, and Prince concludes that (7a, b) are situations of 'quasi-clash', in which Move x must be allowed to apply.

Clearly, this move implies an extension of his theory on the one hand, and a weakening on the other: an extension because Move x is applicable in a wider range of cases, a weakening because, given the notion of 'quasi-clash', Move x now seems to be able to move virtually any vaguely relevant element in the grid. Furthermore, one may well wonder which interpretation should now be attached to the appeal to clash made in the Bounding Condition. All this implies that the notion of 'clash' can no longer be the firm cornerstone of grid-only theory, as Prince seems to suggest. In analysing word stress, Prince adheres to the strict interpretation of clash as the usual boxed quartet of x's. This notion is obviously too restricted for the theory of rhythm, but unfortunately Prince does not attempt to elaborate upon ways of remedying these defects.

A final remark of possible relevance to Prince's theory is that the author is somewhat unclear as to his views on the formulation of so-called 'rhythmic strengthening' or 'beat addition'. This phenomenon has figured in the metrical literature since Liberman & Prince (1977), who discuss examples like *pòlyvinylchlóride* and *thrèe red shírts*, where the leftmost lexical items each receive an initial beat. Although Prince considers a similar, though underived, example (*Apalachicola*), he does not present a formalised version of the rule in question. This is unfortunate in the sense that any account of rhythmic adjustment should, ideally, in some way address the remarkable similarities between rhythmic shift and rhythmic strengthening. This issue will be taken up in some detail in §2.3 below. A discussion of rhythmic strengthening in a grid-only framework is available in Selkirk (1984), a theory which we briefly review in the following subsection.

2.2.2 *Selkirk (1984).* In Prince (1983), as we have seen, rhythmic adjustment rules operate on completely specified grids; in Selkirk's view, on the other hand, such rules interact with the rules of grid construction. These rules build grids cyclically, and from bottom to top in morphosyntactic domains. A second class of rules, GRID EUPHONY rules, adapt the grid to the ideal of rhythmic alternation. These latter rules lack specific domains, but operate on each cycle after the application of the grid construction rules. The two grid euphony rules relevant for our purposes are those in (8):

(8) a. *Beat Movement*

$$\begin{array}{ccccccc} & *^{i} & * & & *^{i} & & * \\ * & * & * & \rightarrow & * & * & * \end{array}$$

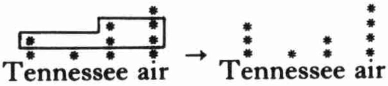
Condition: $*_{i}$ is a weak beat

b. *Beat Addition*

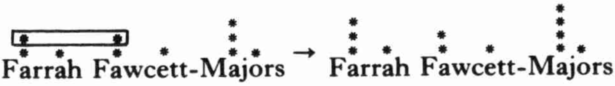
$$\begin{array}{ccccc} & & & * & \\ * & * & \rightarrow & * & * \end{array}$$

Both rules create rhythmic alternation by eliminating rhythmically ill-formed situations: clashes are eliminated by (8a), 'lapses' (sequences of weak stresses) by (8b). Beat Movement is restricted in the same way as Prince's Move x: 'A clashing beat is displaced to the left, landing on the next beat over of the next metrical level down' (Selkirk 1984: 169). The effects of Beat Movement and Beat Addition are illustrated in (9), where the environments of the rules are indicated.

(9) a.



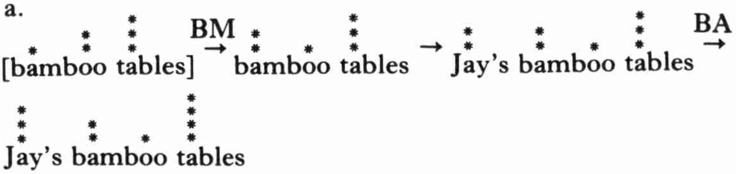
b.



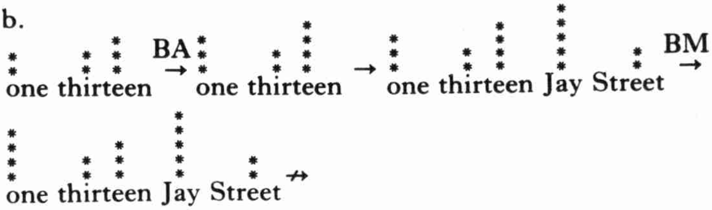
Furthermore, a 'Textual Prominence Preservation Condition' ensures that grid euphony rules cannot override the most prominent position within a cyclic domain: the cyclic peak will always be raised when Beat Addition raises another mark to equal prominence.

Presumably, Selkirk would account for contrasts like (6a, b) by the assumption that grid euphony rules operate on each cycle following the grid construction rules. The derivations then run as in (10):

(10) a.



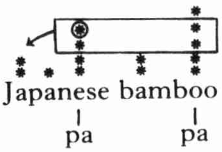
b.



Beat Movement on *bamboo* in (10a) cannot be inhibited by phonological material to its left, as only the domain *bamboo tables* is relevant. In (10b), however, internal rhythm on *thirteen* may be expected to be blocked due to the presence of *one* in the same domain.

It is important to note that Beat Movement expresses both the pressure ('clash') and the change, while Prince expresses these notions separately, allowing for 'quasi-clashes'. Selkirk accounts for examples similar to Prince's *Jàpanese bambóo* not by quasi-clash, but by 'grid strengthening' in the presence of a claimed 'pitch accent'. A syllable bearing pitch accent must have at least a beat at level four, which may result in a clash, as in (11):

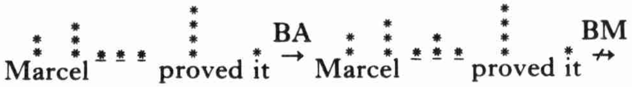
(11)



Note that (11) implies an extension of the environment of Beat Movement as formulated in (8): the first syllable of *Japanese* is, strictly speaking, not a landing site according to (8a), being two levels down.

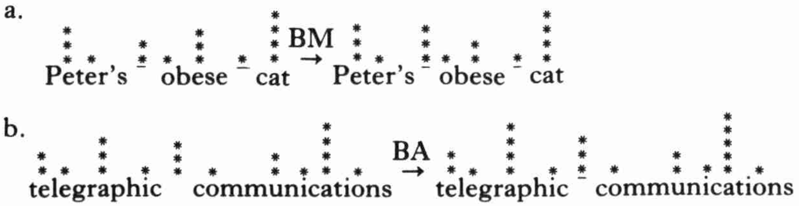
Selkirk's grid euphony rules are not subject to syntax-sensitive conditions of the Bounding Condition type. Indirectly, the operation of grid euphony rules is syntax-sensitive by the fact that they apply whenever a block of cyclic grid construction rules have applied. In addition, their operation across heavy syntactic boundaries is restricted by so-called 'silent beats', the number of which is proportional to the weight of the boundary. Silent beats are inserted at the lowest grid level and have several functions. They account for pauses in the case of heavy syntactic boundaries, i.e. they play a role in phonetic interpretation in the time domain. Because they are formally identical to grid positions that are aligned with syllables, they are subject to grid euphony rules, especially Beat Addition. This may have the effect of undoing clashes across boundaries, and of blocking Beat Movement. (12) is such a case, where Beat Movement is blocked by virtue of Beat Addition on silent beats:

(12)



These suggestions do not seem unproblematic, however. An effective use of silent beats in order to disrupt clashes across boundaries presupposes obligatory applications of Beat Addition to them, a situation which strikes us as unsatisfactory. Furthermore, silent beats interact with grid euphony rules, and many of the predicted interactions are at least suspect, as shown in (13):

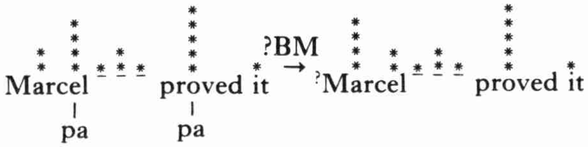
(13)



The application of grid euphony rules to silent beats may feed further grid euphony rules, which operate on beats associated to phonological material. In (13a), Beat Movement applies to a grid position created by an earlier application of Beat Addition to a silent beat. In (13b) a double application of Beat Addition to a silent beat results in Beat Addition to a column associated to phonological material (the syllable *-gra-*).

Although pitch accent in itself is a comparatively well-established notion, the assumption that it is rhythmically relevant may seriously undermine the explanatory force of silent beats as a clash-blocking mechanism. Pitch accents make it possible to satisfy the Structural Description of Beat Movement in positions where one will never find a stress shift, as shown in (14):

(14)

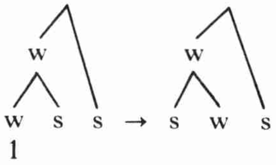


The explanatory force of both pitch accents and silent beats with respect to rhythmic adjustments is unclear for the time being. Both will be left out of consideration in the remainder of this paper.

2.3 Tree theory

The first reference to tree theory is Kiparsky's (1979) attempt at a tree-only variant of rhythmic adjustment. Kiparsky's aim is to raise the issue of the cycle in metrical theory, and against this background the phenomenon of stress shift can be seen as a source of superficial counter-examples to the idea that relative prominence is maintained under embedding. Curiously enough, his paper, although a reaction to Liberman & Prince, does not mention either grids or the redundancy problem, yet it presents a clear alternative to the clash-based views of Liberman & Prince. Kiparsky proposes the Rhythm Rule in (15), which the reader may check for himself against the examples in (2):

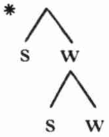
(15) *Rhythm Rule* (Kiparsky 1979: 425)



Conditions:

(i) Constituent 1 is not an unstressed syllable

(ii) It may not produce

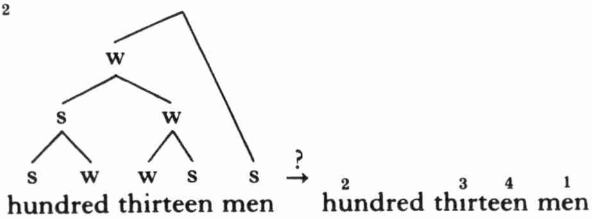


This is a purely arboreal account, in which the function of clash in the grid is replaced by a more detailed structural description of the rule in terms of tree structure. The basic principle seems to be that a pair of adjacent strong nodes in a tree represents a metrically ill-formed situation. The structural description in (15) expresses three important claims with respect to the structural relations between the nodes involved. First, as in Liberman & Prince, the relabelling occurs between *sister nodes*. Second, this pair of nodes is directly dominated by a *weak node*, and third, this weak node is a *sister* of a strong node (Designated Terminal Element) to its right.

Clearly, Kiparsky's Rhythm Rule was designed to cover cases of relabelling as in (2). This implies that, logically, two types of criticism may be levelled against it: cases of relabelling not covered by it, and cases outside relabelling that one would wish to be covered by an analysis of this type.

The first type may be illustrated by a case of internal rhythm such as (16):

(16)[2]

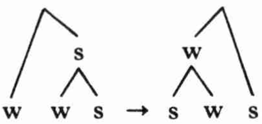


Note that the condition expressed in the Rhythm Rule demanding sisterhood of the Designated Terminal Element and the weak node dominating the pair to be relabelled is violated here. However, cases such as (16) are grammatical according to most descriptions (e.g. Hayes 1984; Selkirk 1984; Hammond 1984).

The second type of example left unaccounted for by the Rhythm Rule involves cases of 'rhythmic strengthening', mentioned in the previous subsection. If our interpretation of Kiparsky is correct, it seems to us that he may have intended to deal with these automatically by Liberman & Prince's counting algorithm, which correlates depth of embedding and level of prominence. As English is a right-branching language at the phrasal level, the highest non-primary stress is initial in a phrase. The idea that the counting algorithm cannot adequately handle this task, however, is already apparent in Liberman & Prince (1977: 324–330), and is developed most clearly in Giegerich (1981). Liberman & Prince give the Relative Prominence Projection Rule in (1) precisely to avoid the over-differentiation of cyclic stress levels implied by the counting algorithm, and to incorporate alternating rather than descending prominence to the left of the main stress.

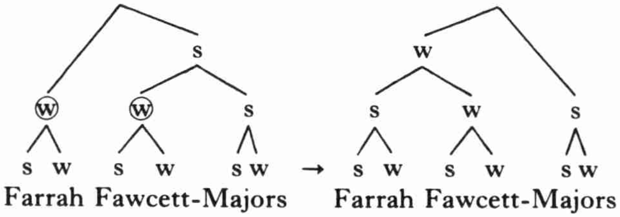
Giegerich (1985) presents a much more elaborate tree-only version; here, the drawback of Kiparsky's analysis mentioned above is avoided by the addition to the Rhythm Rule of a separate rule of 'W-Pairing':

(17) *W-Pairing* (Giegerich 1985: 238)



The structural description of W-Pairing mentions two adjacent weak nodes, the first of which is a *sister* of the node directly dominating both the second weak node and the Designated Terminal Element (which have to be *sisters* too, for this reason). The idea behind W-Pairing seems to be that not only adjacent strong nodes but also adjacent weak nodes are metrically ill-formed. The application of W-Pairing is shown in (18):

(18)



Although Giegerich (1985) represents the most elaborate tree-only variant currently available, it also fails in our opinion in various respects.

Because of the adoption of Kiparsky's Rhythm Rule, it cannot handle cases of 'internal' rhythm, represented by *h$\overset{2}{u}$ndred th$\overset{3}{i}$rt$\overset{4}{e}$en m$\overset{1}{e}$n*. Maybe this cannot function as an objection to Giegerich, as he explicitly denies the possibility of internal rhythm in (British) English in such cases. However, both Hayes' and Selkirk's work contain examples which demonstrate the acceptability of internal rhythm in at least some cases of this type (cf. Hayes 1984: 49–50, 54; Selkirk 1984: 177–182). Moreover, in Dutch (a language to which we will return later) internal rhythm appears to be possible under these circumstances.

More seriously, Giegerich fails to capture the similarities between shift and strengthening, a point that becomes most obvious when comparing the outputs of the Rhythm Rule in (15) and W-Pairing in (17). These two rules are just two of a longer list of rules with highly comparable effects, but as a whole these lack a common conditioning component dealing with both arboreal and rhythmic generalisations.

Among tree theories, more successful then either Kiparsky's or Giegerich's appears to be the tree-*cum*-grid variant of Hayes (1984), which incorporates some of their basic insights, but at the same time avoids some of the pitfalls. In order to demonstrate this, we will now turn to a discussion of Hayes' work.

2.3.1 *Hayes (1984).* Hayes (1984) may be viewed as a defence of the original Liberman & Prince (1977) position against grid-only theory. While incorporating many insights of tree-only theory with regard to metrical constituency, Hayes adds arguments in support of grids as well. To achieve this purpose, he defends a division between the functions and principles of trees as opposed to grids; hence, prominence and rhythm are different entities. Trees are constructed by independently motivated stress assignment rules forming the linguistic representation of prominence. Crucially, they are also the representations to which metrical adjustment rules apply. Grids, projected from trees by the Relative Prominence Projection Rule in (1), are the representation of rhythm. The grid contains the rhythmic targets of adjustment, which are formalised in a separate theory of eurhythmicity. The concept of separating the arboreal adjustment from its rhythmic conditioning offers the possibility of keeping each of the subtheories maximally simple and unaffected by the demands of other components.

The arguments supporting such a framework gravitate around two issues: first, the relative success of a subtheory of eurhythmy in comparison with the 'classical' clash-based theory; and second, the relevance of metrical constituent structure to adjustments.

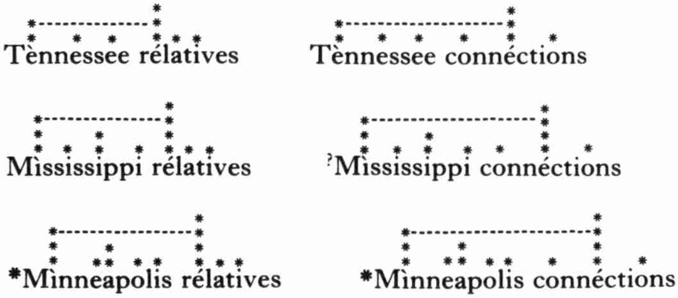
2.3.1.1 *Linear distance and eurhythmy.* Essentially, as we have seen above, the Liberman & Prince theory of stress shift is based on the elimination of a rhythmically ill-formed situation, the clash. The shift itself is executed in the tree. Hayes (1984) upholds this tree-*cum*-grid framework, but eliminates the notion of clash, replacing it with the notion of EURHYTHMY. Generally speaking, Hayes' theory of eurhythmy is based on the claim that linear distance, measured in grid positions over syllables, provides a more adequate rhythmic conditioning than does clash. After each application of a metrical adjustment rule in the tree, a new grid is constructed to check the rhythmic effects of the application.

In a eurhythmic grid, prominent elements at the same level are as much as possible equidistant, and alternate regularly with less prominent elements. This is expressed by the two rules in (19):

(19)[3] a. *Quadrisyllabic Rule*
A grid is eurhythmic when it contains a row whose marks are spaced close to four syllables apart.
b. *Disyllabic Rule*
The domain delimited on the level of scansion should be divided evenly by a mark on the next lower level.

The role of linear distance, defined on syllable spans in grids, can be illustrated by the examples in (20), which give the output grids after application of rhythmic adjustment in the tree. They are distinguished by gradual differences in acceptability, depending on the length of the interstress intervals before and after stress shift. These intervals constitute a span of four syllables in the ideal case, as expressed by the Quadrisyllabic Rule:

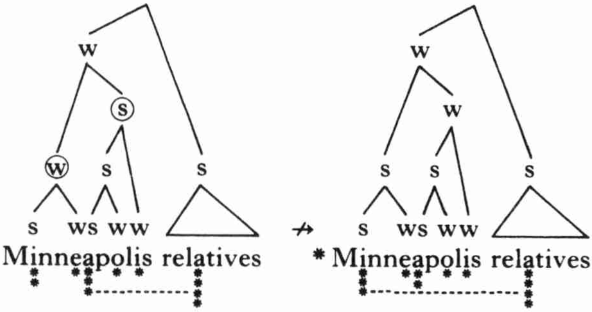
(20)



Since all of (20) contained clashes in their inputs, they clearly illustrate that Liberman & Prince's notions of alternation and adjacency of elements (i.e clashes) are insufficient. Hayes concludes that clash is neither a necessary nor a sufficient condition for stress shift.

In specific cases, the Quadrisyllabic Rule can also have a constraining effect on the operation of stress shift. (21) is an example of this type:

(21)

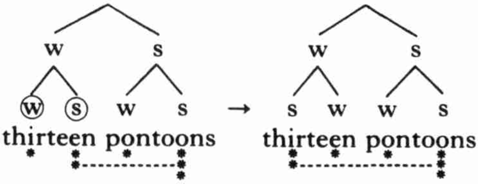


In (21), application of rhythmic adjustment in the tree results in an increase in distance from three to five syllables in the grid. This is not an improvement if the ideal distance is four syllables, and rhythmic adjustment will not apply (again, in spite of the fact that there is a Liberman & Prince-type clash).

Grid-only theory would face serious obstacles in incorporating eurhythmicity principles such as those just mentioned. Clash can hardly be eliminated, as grid-only theory has stressed the appropriateness of this notion with respect to word stress as well as adjustments, and, in particular, has emphasised the potential of the grid to bring out clashes clearly. Therefore, a certain amount of unwanted overlap would result between (linear) eurhythmicity and clash. (See also Kager & Visch 1987 for a more detailed discussion of this point.)

The eurhythmy model, on the other hand, appears to be supported in cases of 'quasi-clash', illustrated in (22):

(22)



In (22), Rhythmic Adjustment yields an improvement with respect to the Quadrisyllabic Rule.

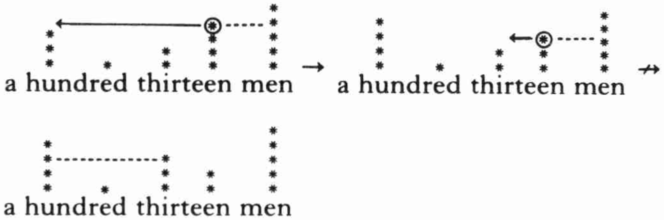
Of course, one of the most convincing ways of showing that a clash-based theory runs into trouble is to confront it with empirical material. In this vein, Hayes considers the (more complex) cases of internal rhythm in (23). The sole difference between (23a) and (23b) is the presence of an additional syllable in the initial item in (23b), resulting in a stretched interval, and a (relatively) well-formed output:

(23)[4] a. [[$\overset{2}{\text{one}}$[$\overset{4}{\text{thir}}\overset{3}{\text{teen}}$]]$\overset{1}{\text{Jay}}$ Street] ↛ *$\overset{2}{\text{one}}$ $\overset{3}{\text{thir}}\overset{4}{\text{teen}}$ $\overset{1}{\text{Jay}}$ Street (= (6b))

b. a[[$\overset{2}{\text{hun}}$dred[$\overset{4}{\text{thir}}\overset{3}{\text{teen}}$]]$\overset{1}{\text{men}}$] → a $\overset{2}{\text{hun}}$dred $\overset{3}{\text{thir}}\overset{4}{\text{teen}}$ $\overset{1}{\text{men}}$

Prince predicts that in both cases (of which he discusses only (23a)) the contour 2–3–4–1 must be excluded. But note that the Bounding Condition will incorrectly block Move x in (23b), just as it (correctly) blocks Move x in (23a). Compare the derivation in (24) with that in (6b):

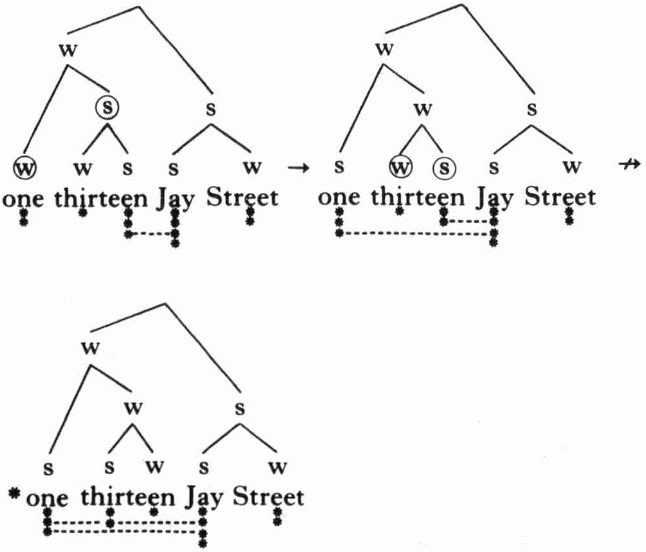
(24)



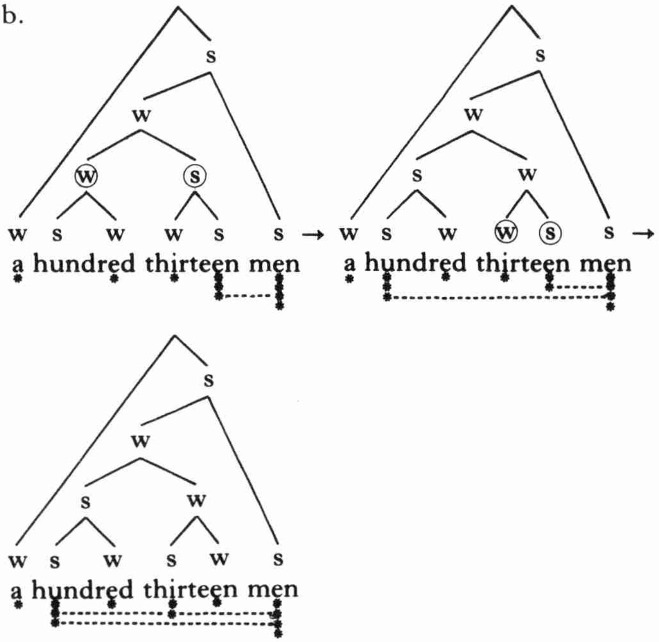
Move x is blocked as it would produce a clash within its own domain. Hence a clash-based theory cannot distinguish between (23a) and (23b), and a respectable class of internal rhythm cases will be incorrectly ruled out.[5]

The eurhythmy approach makes the right distinction here by virtue of the Disyllabic Rule:

(25) a.



b.



In (25a) internal rhythmic adjustment in the second stage of the derivation is blocked, as no progress is made with respect to the Disyllabic Rule: the resulting syllabic distance between *one* and *thir-* is no improvement over the original distance between *-teen* and *Jay*. In (25b), however, internal rhythm on *thirteen* will result in two disyllabic intervals: *hun-* – *thir-* and *thir-* – *men*. The difference in behaviour is thus reduced to a difference in linear distance.

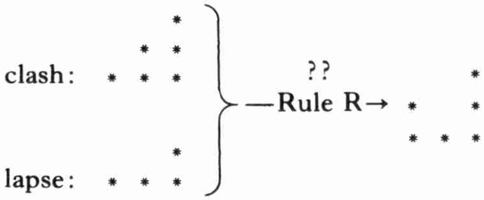
2.3.1.2 *Constituency*. Arboreal constituency and its effects on rhythmic adjustment constitute the second central topic in Hayes (1984). Replying to the grid-only proponents' claim that any constituency relevant to rhythmic adjustment rules is sufficiently encoded in the grid, Hayes shows that some cases with identical grids but different possibilities for rhythmic adjustments can only be handled in a theory which uses trees.

The theory of arboreal constituency that emerges contains two basic devices: an ADJUNCTION scheme which expresses the directional aspects of rhythmic adjustments, and a general principle which constrains the choice of adjoined nodes.

Before turning our attention to the crucial examples, we will discuss the configuration of the tree-based operation of rhythmic adjustment itself. As indicated earlier, two types of rhythmic adjustment must be distinguished: rhythmic shift ('Iambic Reversal' or 'Rhythm Rule') and rhythmic strengthening ('Beat Addition' or 'W-Pairing'). One of the most attractive consequences of separating constituency from rhythm is the possibility of formally unifying both types of adjustment into a one-step adjunction.

This seems quite difficult to establish in grid-only theory, where unification of Move x and Add x can result at best in a *two-step* process of the type 'Delete x – Add x'. In (26), the inputs and outputs of shift and strengthening are given as illustrations of this point:

(26)

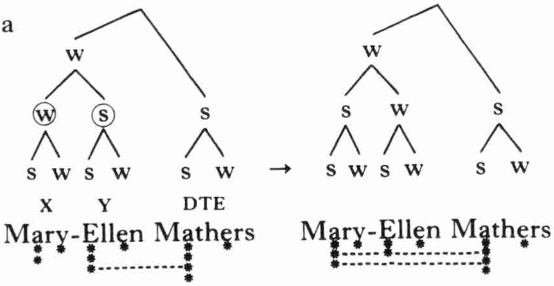


In unifying shift and strengthening, Hayes makes crucial use of metrical constituency. Adjustment is formalised as the arboreal adjunction of a node Y to a node X. The standard convention that an adjoined node Y is weak with respect to the node X to which it adjoins guarantees the required output labelling. The adjunction, RHYTHMIC ADJUSTMENT, is given in (27):

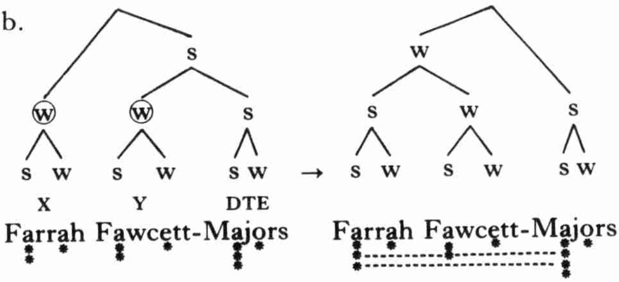
(27) *Rhythmic Adjustment*
In a configuration . . . X Y . . . DTE . . ., adjoin Y to X

(28) gives the basic examples of Rhythmic Adjustment: (28a) is a case of shift, (28b) one of strengthening:

(28) a



b.



In the shift case in (28a), adjunction is vacuous with respect to constituency, but effective with respect to labelling. The net effect is a relabelling. However, in (28b) adjunction destroys the original constituent structure, and the result is identical to the output of Giegerich's W-Pairing. The direction of Rhythmic Adjunction is claimed to be leftward, as expressed in (27). Notice that the output grids in both cases in (28) conform to the eurhythmy principles.

Clearly, Rhythmic Adjustment must be somehow constrained, especially with regard to the possible choices of X and Y. To this end, Hayes proposes the MAXIMALITY PRINCIPLE of (29):

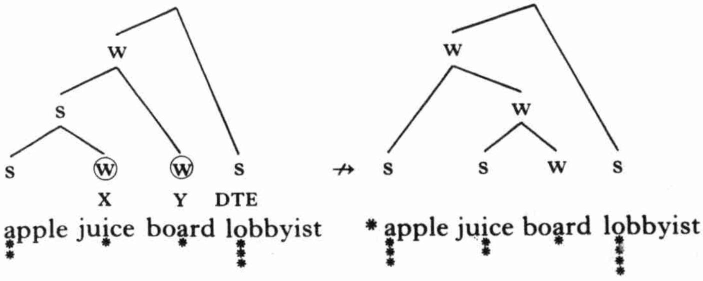
(29) *Maximality Principle*
Rules that manipulate tree structure must analyse maximal terms
Maximality:
Let R be a rule whose SD contains the terms $t_1, t_2, \ldots, t_n$.
Let T be a tree containing the constituents $c_1, c_2, \ldots, c_m$ $(m \leqslant n)$, matched up to the appropriate terms of R.
c_i of T is maximal iff there is no node c_i' that
a. satisfies R
b. dominates c_i
c. does not dominate any other member of the sequence $c_1, c_2, \ldots, c_m$.

That is, the node immediately dominating c_i must also dominate one of the other terms contained in the structural description of R. Therefore, X is maximal iff it c-commands Y and/or DTE, and Y is maximal iff it c-commands X and/or DTE. From this it follows that there are two cases in which all terms of Rhythmic Adjunction (X, Y, DTE) are maximal: (i) X and Y are sister nodes (i.e. c-command one another) and they are both c-commanded by DTE; (ii) Y and DTE are sister nodes (i.e. c-command one another) and they are both c-commanded by X.

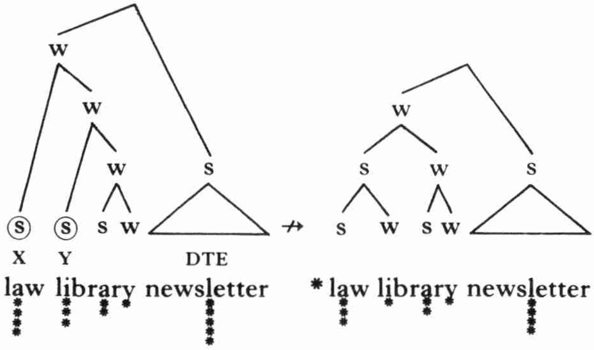
Notice that (i) restates Kiparsky's subcondition that the DTE c-command the pair subject to reversal, but still allows internal rhythm. The (ii) case is equivalent to Giegerich's conditions on strengthening.

The constraining effect of (29) can be illustrated with the following examples:

(30) a.



b.

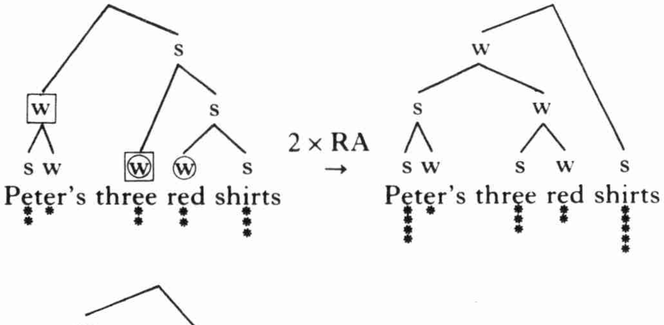


Maximality correctly blocks the adjustments that would result from the unconstrained version of Rhythmic Adjustment in both cases. In (30), X and Y are not sisters, nor is Y a sister of DTE and c-commanded by X.

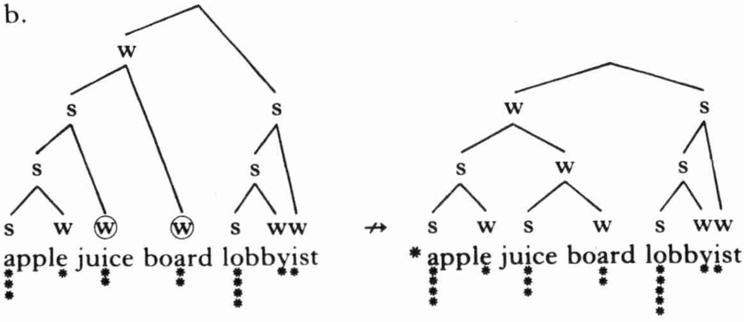
Both Rhythmic Adjustment and the Maximality Principle are formulated exclusively in terms of tree structure. The grid's sole task is to keep track of the input/output relation with respect to adjustment. Whether or not adjustment occurs in the first place is a matter of constituent structure.

If the central point is that constituency explains contrasting possibilities of rhythmic adjustments, this is illustrated most clearly by cases with identical grids but different constituency, and therefore different rhythmic behaviour. Compare the cases in (31):

(31) a.



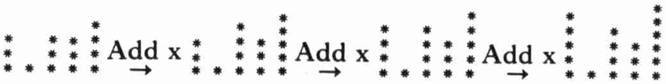
b.



In (31a) Rhythmic Adjustment may be applied twice, stimulated by the Quadrisyllabic Rule as well as the Disyllabic Rule, resulting in a 2–3–4–1 contour. If we compare (31b), we see that Rhythmic Adjustment cannot be applied here, despite the fact that this would be desirable according to the theory of eurhythmy (i.e. the Disyllabic Rule). The output grids arising by application of Rhythmic Adjustment in (31a) and (31b) are identical, and hence the reason for the contrast in acceptability cannot reside in grid structure: it must be found in the differences in the metrical structure of these examples. In (31b) the Maximality Principle is violated, which explains the blocking of Rhythmic Adjustment. (31a), however, obeys the demands of Maximality, and therefore Rhythmic Adjustment can apply.

In order to be entirely fair, let us now consider the fate of these examples in grid-only variants such as those of Prince (1983) and Selkirk (1984). Although they do not discuss these cases, an attempt may be constructed as follows. In (32), we give the full derivations as they would presumably appear in grid-only theory:

(32) a. [Peter's[three[red shirts]]]



b. [[[apple juice]board]lobbyist]

It seems reasonable to assume a rule such as Add x for these strengthening cases. If we wish to respect the left-dominant character of strengthening in English, this rule has to be conditioned by a peak at the righthand side of the focus. Notice that we deviate from Selkirk's formulation of Beat Addition in (8b) (which already overgenerates in comparatively simple structures such as *apple juice board* by adding a grid mark on *juice*).

Furthermore, without going into details, we assume that the rule of Add x operates in those cases where a general improvement in the alternation may be achieved. Beside this, Selkirk's Textual Prominence Preservation Condition is observed: the most prominent position will always be raised when Add x raises another mark to equal prominence.

Prince uses syntactic domains in constraining Move x by the Bounding Condition, so it seems reasonable to use the same method for applications of Add x. In (32a) we can apply Add x within the domain *three red shirts*. To arrive at the desired output, we have to apply it twice on the full domain, even though this means a violation of the Bounding Condition: a clash is created between the first syllable of *Peter's* and *three*. In (32b) left-directional Add x application is impossible on the domain *apple juice board*, as there is no conditioning peak to its right. But the full domain is a candidate, the peak being *lobbyist*. Note that, at this point, the derivation of (32b) results in a grid structure identical to an intermediate stage of (32a). Now, if there is anything which can prevent Add x on *juice* it would be the Bounding Condition, because of the resulting clash. But since the Bounding Condition was found to be unreliable in case (32a), the blocking in the comparable case (32b) can hardly be attributed to it.

Cyclic derivations of (32) in Selkirk's framework are identical to those in (32), thus failing in the same way. In short, it seems that no existing principle in grid-only theory can explain the contrast in (32).

Given the syntactic bracketing of material in the grid, it would perhaps be possible to formulate a substitute to Maximality in the framework of Prince (but not that of Selkirk, who does not allow direct reference to the syntax). For instance, it could be stipulated that adjustment rules can only insert grid marks in *left-peripheral* positions within a syntactic domain.[6] But then one would be hard put to maintain that the grid itself contains the relevant information. Moreover, as Hayes shows (1984: 62–63), the correct bracketing is in fact *metrical*, not syntactic. We will support the latter claim in the following section by showing that it is not just metrical bracketing that is relevant, but s/w-labelling as well.

Only a theory which uses trees can appeal to metrical constituency and typical constituent relations, such as 'c-command'. At best, grid-only theories can refer to syntactic structure, which in itself amounts to a weakening of their claims, and is probably insufficient as well. Therefore, differences in constituent structure and, as a result, different rhythmic behaviour, constitute one of the strongest arguments against grid-only views. Below we will continue to elaborate precisely this point: metrical constituent structure and labelling are necessary conditions for explaining differences in rhythmic behaviour, for which in grid-only theory an equivalent explanation is lacking.

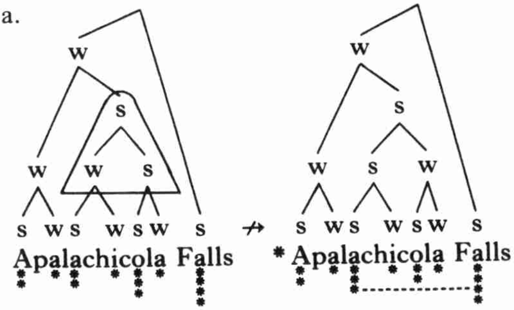
3 The Strong Domain Principle

Up to this stage of our exposition, we have formulated rather fundamental objections against grid-only theories, of both an empirical and a theoretical nature. We will demonstrate in this section that Hayes' view is not free of empirical problems either. These concern cases of internal rhythm. As will be recalled, Hayes and Prince differ in opinion with respect to cases such as (23b), where Hayes does, but Prince does not allow internal rhythm toward the contour *a hùndred thìrteen mén*. It will be demonstrated below, however, that Hayes overgenerates in this area. We will also show that most of these problems can be resolved by introducing the STRONG DOMAIN PRINCIPLE, which makes crucial use of metrical constituency and s/w-labelling, and therefore contributes to the central point of this paper. While Hayes (1984) underscores the necessity of metrical constituency, he does not discuss the potential (and predicted) sensitivity of Rhythmic Adjustment to s/w-labelling.

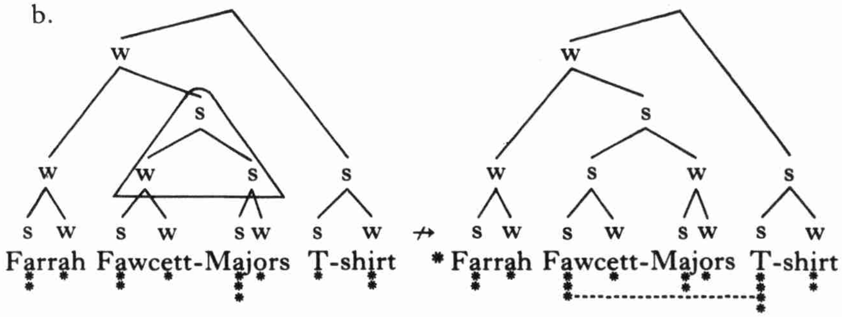
We will give independent evidence for the Strong Domain Principle by considering a type of example which can only be explained in a grid-only theory by ad hoc means. Besides this, this principle is able to force orders of application of Rhythmic Adjustment in cases where this is required. Finally, additional evidence for the Strong Domain Principle will be given in §4, where we will show that it is also applicable in Dutch, especially in cases of rightward rhythmic adjustment, a phenomenon which does not occur in English.

As an introduction to the Strong Domain Principle, consider the superficial counterexamples to Hayes in (33),[7] in which internal rhythm has to be blocked. ((33a) is taken from Prince 1983; (33b) is from Hayes 1982.) The relevant structures are indicated:

(33) a.



b.



Internal rhythm is disallowed in the absence of 'external rhythm' on the higher pair of nodes. Notice that other derivations by means of Rhythmic Adjustment are possible (as in (25b)). We will put these aside for the moment and return to them later.

In (33a, b) Rhythmic Adjustment is not allowed to apply, despite the fact that this would result in a gain in terms of eurhythmicity: the output grids conform more closely to the Quadrisyllabic Rule than do the input grids. Also, the Maximality Principle would allow the application of Rhythmic Adjustment in both examples.

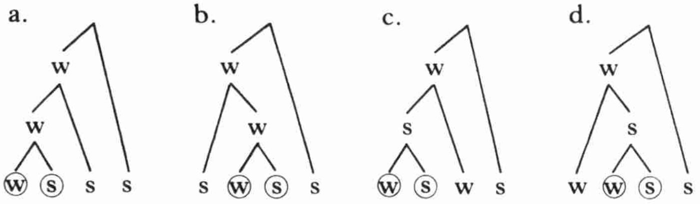
Let us assume therefore that the cause of the lack of Rhythmic Adjustment in (33) can be attributed to constituent structure and labelling: Rhythmic Adjustment is blocked in *constituents dominated by a strong node*. We will call this condition the Strong Domain Principle:

(34) *Strong Domain Principle*

No prosodic transformation may apply to the head of a strong domain. (The head of a constituent is the strong or only element of that constituent.)

This condition correctly blocks the application of Rhythmic Adjustment in (33).[8] Actually, (34) is very similar to Kiparsky's condition on weak constituency in his Rhythm Rule (15), but elevated to the status of universal principle. Viewed in terms of the four structures of internal rhythm in (35), we obtain the correct generalisation by excluding (c) and (d) through the Strong Domain Principle:

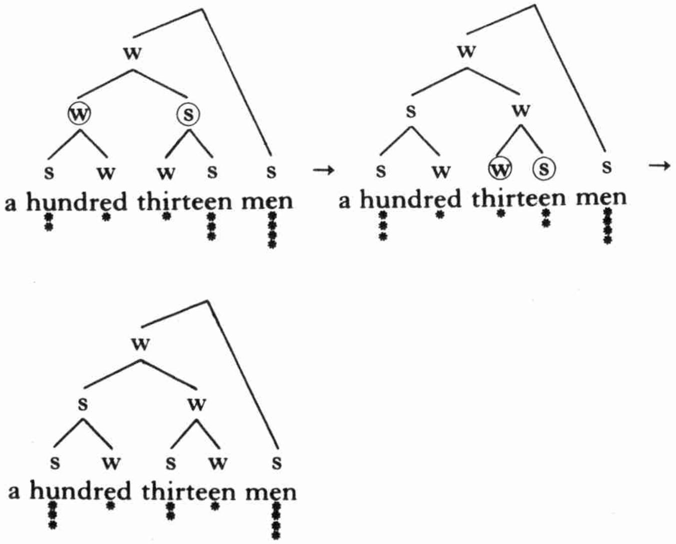
(35)



Moreover, it will be clear that precisely in its reference to strong constituents, the Strong Domain Principle embodies our claim that labelling is crucial to Rhythmic Adjustment.

An important additional effect is the principle's ability in relevant cases, such as (36), to determine the order of two applications of Rhythmic Adjustment. This explains the contour *a h$\overset{2}{u}$ndred th$\overset{3}{i}$rt$\overset{4}{e}$en m$\overset{1}{e}$n* vs. **a h$\overset{3}{u}$ndred th$\overset{2}{i}$rt$\overset{3}{e}$en m$\overset{1}{e}$n*:

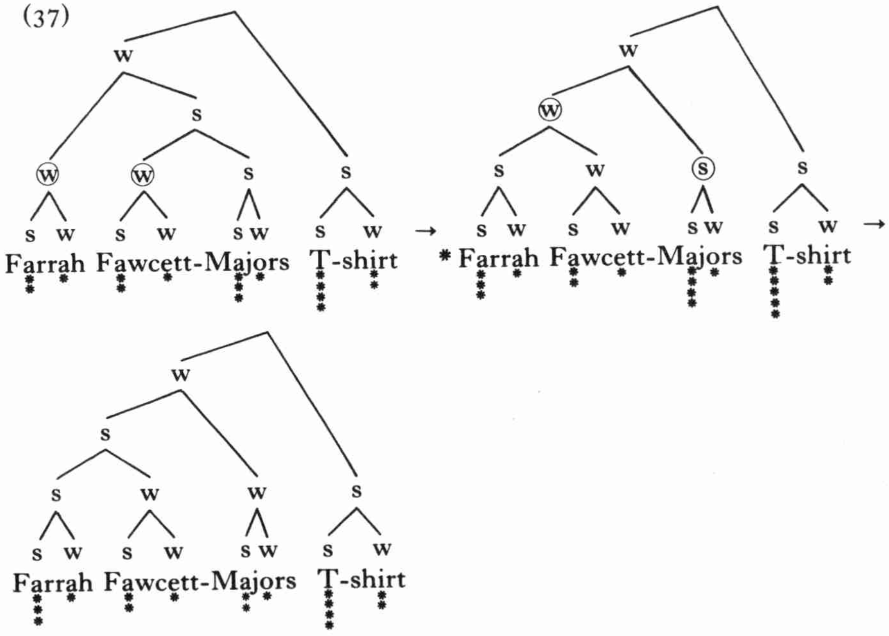
(36)



First, Rhythmic Adjustment applies to the higher pair of nodes and then, internally, to the lower pair. Internal adjustment as a first application would violate the Strong Domain Principle. Therefore, these derivations avoid the Strong Domain Principle by means of Rhythmic Adjustment to a higher pair. The same procedure accounts for the grammaticality of cases such as $\overset{2}{\textit{Farrah}}$ $\overset{3}{\textit{Fawcett}}$-$\overset{4}{\textit{Majors}}$ $\overset{1}{\textit{T}}$*-shirt*, in which the Strong Domain Principle is avoided *vs.* *$\overset{3}{\textit{Farrah}}$ $\overset{2}{\textit{Fawcett}}$-$\overset{3}{\textit{Majors}}$ $\overset{1}{\textit{T}}$*-shirt*; similarly, *$\overset{3}{\textit{A}}$*pal*$\overset{2}{\textit{a}}$*chic*$\overset{3}{\textit{o}}$*la* $\overset{1}{\textit{Falls}}$ is out, but not $\overset{2}{\textit{A}}$*pal*$\overset{4}{\textit{a}}$*chic*$\overset{3}{\textit{o}}$*la* $\overset{1}{\textit{Falls}}$ or $\overset{2}{\textit{A}}$*pal*$\overset{3}{\textit{a}}$*chic*$\overset{4}{\textit{o}}$*la* $\overset{1}{\textit{Falls}}$.

The only other way to remove a strong domain from the influence of the Strong Domain Principle is to extract a weak node from it, as in (37):

(37)



This produces a 2–3–3–1 contour. The derivation thus obtained also counters Selkirk's arguments (1984: 181) purportedly showing that a tree theory cannot derive 'equal stresses'.

As we see it, there are several further advantages to the Strong Domain Principle. The first advantage is that the principle allows linking the cases in (33) to a condition on metrical destressing rules that was proposed independently in Hayes (1981):

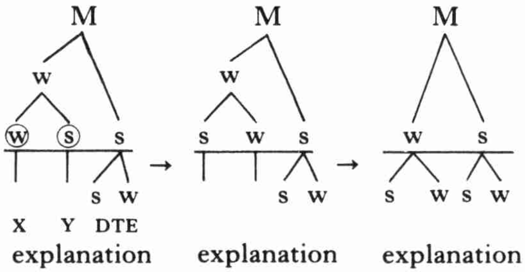
(38) No foot in strong metrical position may be deleted.

(Hayes 1981: 178)

The effect of (38) is to block extraction and subsequent reduction of a stressed syllable in a strong foot. The strong foot condition (38) falls out as a subcase of the Strong Domain Principle under the assumption that destressing rules are adjunctions of the head of a foot (i.e. a stressed syllable) to an adjacent foot, instead of foot deletion followed by Stray Syllable Adjunction, as in Hayes (1981) and Hammond (1984). The destruction of the original foot is a consequence of the extraction of its head. The Strong Domain Principle generalises over syllable adjunctions and Rhythmic Adjustment, as both can be viewed as belonging to the class of rules manipulating tree structure, referred to as 'prosodic transformations' (compare Giegerich 1985, Hammond 1984, and comments on the latter by Kager & Visch 1987).

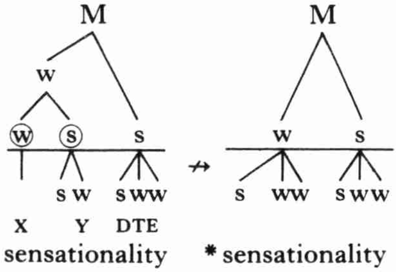
The Strong Domain Principle can be avoided word-internally only by applying Rhythmic Adjustment before destressing. The head of a strong domain, the syllable -*pla*-, cannot be extracted directly in an example such as (39):

(39)



The application of word-internal Rhythmic Adjustment is governed by conditions described in Kiparsky (1979). It does not apply, for instance, in cases where prominence would be shifted from a branching to a non-branching node, as in *sensàtionálity*. In such words, the Strong Domain Principle prohibits extraction of the second syllable, as this syllable remains the head of a strong foot:

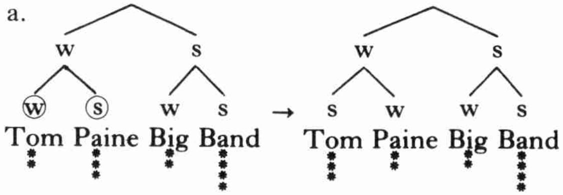
(40)



Additional evidence for the Strong Domain Principle appears when we consider the cases in (41), which again lack a straightforward explanation under the grid-only view. They are instances of shifts in embedded structures, and we have circled the relevant parts. ((41a) is from Hammond 1984; (41b) from Prince 1983.) In (41) the input and output structures of the grids are identical: the difference in behaviour with respect to

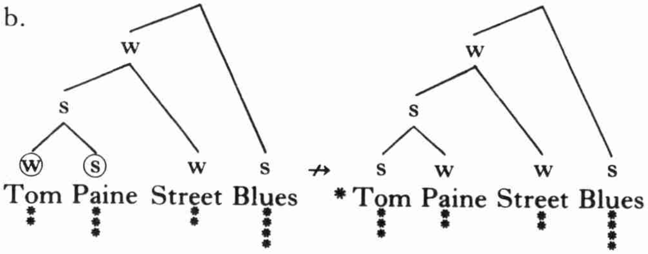
Rhythmic Adjustment can only be attributed to a difference in constituent structure:

(41) a.



idem: thirtèen big bánds → thìrteen big bánds

b.



idem: thirtèenth Street Bánd ↛ *thìrteenth Street Bánd

In both cases the theory of eurhythmicity (i.e. the Quadrisyllabic Rule) indicates a pressure for Rhythmic Adjustment. The Maximality Principle allows Rhythmic Adjustment in both cases. Yet in (41b) Rhythmic Adjustment would apply in a strong domain, and our proposed Strong Domain Principle prohibits this. Thus we account in a simple way for the difference between (41a) and (41b).

As far as we are aware, the types of examples discussed here (cases of internal strong rhythm as in (33), *Tom Paine*-cases like (41) and destressing cases like (40)) have been noted in the literature before, but have always been treated separately. The Strong Domain Principle relates these cases in a simple way. Especially important seems to us the derived status of the strong foot principle in (38), which is now the subcase of a more general principle (34). In §4, we will adduce additional evidence for the Strong Domain Principle from Dutch, while two issues remain to be dealt with in this section.

First, in keeping with one of the major goals of this section, we will show that cases (33) and (41) are problematic for grid-only theory. And secondly, we will discuss a residue of recalcitrant examples with respect to Hayes' theory of eurhythmicity, and suggest speculative ways out.

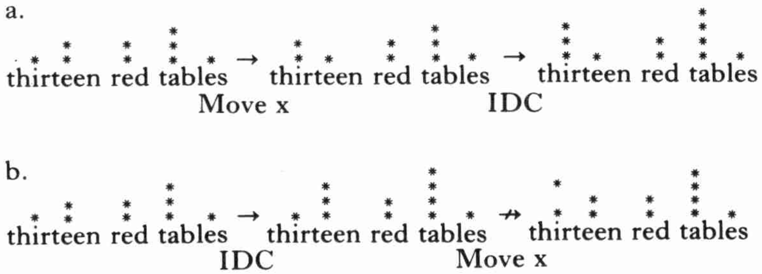
Let us first consider the fate of examples like (33) under grid-only theory. Prince suggests two explanations for the ill-formedness of (33a).[9] The first is to assume, as before, that Move x applies *minimally* (to the first position to the left) but that a process of 'Initial Downbeat Creation', similar to Selkirk's Beat Addition, bleeds it:

(42)

Initial Downbeat Creation strengthens the first syllable of *Apalachicola* (with the side-effect of raising the most prominent positions – i.e. the Textual Prominence Preservation Condition). At this point, the third syllable is no longer a possible landing site for Move x. This account is based crucially on the application of Initial Downbeat Creation and Move x in this order, which may either be derived from the phrasal cycle or from a brute-force statement. Our objections to the phrasal cycle with respect to rhythmic adjustments are the subject of §4.2; here we will show that the fixed order approach fails.

Consider *thirteen red tables* in (43). Both Move x and Initial Downbeat Creation operate on *thir-*. The correct output structure, however, can be derived only if Move x feeds Initial Downbeat Creation, as in (43a). The reverse order, as in (43b), fails, since Initial Downbeat Creation destroys Move x's only available landing site:

(43)



An additional problem seems to be that in Prince's solution Initial Downbeat Creation must apply obligatorily to (42), while adjustment rules are usually optional.

The second explanation suggested by Prince is to factor out Move x into a deletion and an insertion of grid marks, the insertion ('Add x') being limited to *peripheral* positions, much like End Rules. The effect is that stress shift applies *maximally*. This solution effectively blocks (33a), as will be clear, but has the major drawback of ruling out *all* types of internal rhythm, including those of (36), i.e. the ones that are characterised in terms of the Strong Domain Principle by a *weak* node dominating the pair X, Y. As 'weak internal rhythm' does occur in at least certain cases, we conclude that Prince's solution, much like Kiparsky's Rhythm Rule, fails by being overrestrictive.

The cases in (41) are equally awkward for grid-only theory. The grids of (41a, b) are identical, there are no formal clashes and there is no pressure for either Move x or Beat Movement to apply. Notice that grid-only theory and tree-*cum*-grid theory make different predictions here. Hayes' theory predicts application of Rhythmic Adjustment in both cases, and thus has to account for the blocking of Rhythmic Adjustment in (41b), whereas grid-only theory has to account for the application of Move x in (41a).

Somewhat surprisingly, Prince (1983) addresses the blocking case of (41b) rather than the well-formed one of (41a). He argues that the absence of a formal clash in (41b) cannot be held responsible for the blocking, since in similar examples involving quasi-clash, like *thirteen pontoons* and those in (41a), Move x applies in the absence of formal clash. Therefore, another explanation for (41b) is required.

Prince's solution lies in raising the grid on the basis of syntactic information. An extra grid mark is inserted on *Paine*, to represent its status as the strongest element in both the phrase *Tom Paine* and in the compound *Tom Paine Street*. Raising the grid blocks Move x, because there is no possible landing site for the element that is moved (*Tom* being two levels down), as shown in (44):

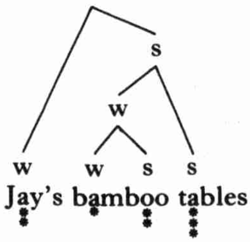
```
(44)[10]                        *    Phrase
                   *            *    Word (compound)
                   *            *    Phrase
             *     *      *     *    Word
       [[[[Tom Paine]]Street]Blues]
```

Putting aside the earlier objections to quasi-clashes, we note that this appeal to syntactic constituent information entails that Prince's theory essentially incorporates tree structure without s/w-labelling. But it is precisely s/w-labelling that is used to differentiate between the examples of (41), by means of the Strong Domain Principle. Thus grid-only theory necessarily uses different solutions to explain similar cases, whereas the tree-*cum*-grid framework offers a more generalising account by means of the Strong Domain Principle.

Finally, we notice some residual problems with respect to internal rhythm which cannot be resolved by the Strong Domain Principle. These problems are related to Hayes' theory of eurhythmicity. In cases like (45), Rhythmic Adjustment can apply without violation of any of the structural conditions on trees, but nevertheless yields no progress with respect to the Quadrisyllabic Rule and the Disyllabic Rule:

```
          2     4   3   1            2     3   4   1
(45) a. Jay's bamboo tables → Jay's bamboo tables
```

b.



As we have shown in §2.2, as well as $*\overset{2}{\textit{one}}\ \overset{3}{\textit{thir}}\overset{4}{\textit{teen}}\ \overset{1}{\textit{Jay}}\ \textit{Street}$, (45) led Prince to propose the Bounding Condition, which explained the differences in application of Move x. We showed above how the Bounding Condition fails as an explanatory principle of prominence theory.

To exclude examples such as $*\overset{2}{\textit{one}}\ \overset{3}{\textit{thir}}\overset{4}{\textit{teen}}\ \overset{1}{\textit{Jay}}\ \textit{Street}$, Hayes employs the Disyllabic Rule, but the Disyllabic Rule also blocks Rhythmic Adjustment in (45). A solution to this problem might be found in an alternative to the theory of eurhythmy and syllable counting, proposed by Hayes in the form of the 'Phonetic Spacing Hypothesis'. Hayes suggests that the spacing requirements of eurhythmy could be of a phonetic nature, based either on actual physical time, or perhaps on some more abstract phonological timing measure (Hayes 1984: 70). One of the most striking arguments for phonetic spacing is that additional length often appears in positions where eurhythmy would be increased. As Hayes says: 'the assumption that the spacing requirement is phonetic may also be sufficient to account for the observed interactions of rhythmic adjustment with syntactic boundaries. LP [Liberman & Prince] observe that resistance to relabeling increases with boundary strength in triplets like *Màrcel Próust* – $^{??}$*Màrcel's bóok* – $^{??}$*Màrcel léft*' (1984: 72).

This last remark could be related to the difference in rhythmic behaviour of $\overset{2}{\textit{Jay's}}\ \overset{3}{\textit{bam}}\overset{4}{\textit{boo}}\ \overset{1}{\textit{tables}}$ and $*\overset{2}{\textit{one}}\ \overset{3}{\textit{thir}}\overset{4}{\textit{teen}}\ \overset{1}{\textit{Jay}}\ \textit{Street}$. In the triplets starting with *Marcel* the distance between the syllable *-cel* and the second word increases as the syntactic boundary between them becomes stronger. Accordingly, there is less pressure toward shift. There is also a heavier syntactic boundary between *Jay's* and *bam-* than between *one* and *thir-*, after shift, thus the shift in *bamboo* must be better than that in *thirteen*.

Since the Phonetic Spacing Hypothesis is a relatively undeveloped notion, we will refrain from elaborating on these suggestions here.

Finally, note that in the original theory of eurhythmicity based on syllable counting, we predict that there will be a difference between the acceptability of $\overset{2}{\textit{Jay's}}\ \overset{3}{\textit{bam}}\overset{4}{\textit{boo}}\ \overset{1}{\textit{tables}}$ and $\overset{2}{\textit{Farrah's}}\ \overset{3}{\textit{bam}}\overset{4}{\textit{boo}}\ \overset{1}{\textit{tables}}$ (or, alternatively, $\overset{2}{\textit{Zack's}}\ \overset{3}{\textit{un}}\overset{4}{\textit{kind}}\ \overset{1}{\textit{letter}}$ and $\overset{2}{\textit{Oliver's}}\ \overset{3}{\textit{un}}\overset{4}{\textit{kind}}\ \overset{1}{\textit{letter}}$ (Hayes' examples, personal communication)). The latter example should be more acceptable than the former. If this is so, this is a subtlety whose consequences we leave undiscussed here.

4 Dutch

In many respects, Dutch is closely related to English with respect to rhythmic phenomena. For leftward rhythmic adjustments, we may even assume them to be twins. Dutch, however, diverges from English in one important respect: it is rhythmically ambidextrous.

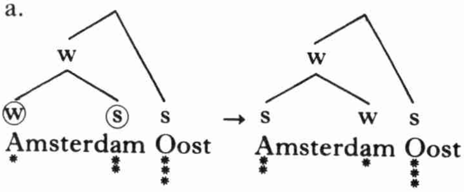
Rightward Rhythmic Adjustment, and especially the various interactions between rightward and leftward Rhythmic Adjustment, is a hitherto underexplored field of investigation.[11] We will start out with a survey of the correspondences between English and Dutch, and a validation of the Strong Domain Principle by means of Dutch examples. In §4.2, we will examine rightward Rhythmic Adjustment and the possibilities of interactions between rightward and leftward Rhythmic Adjustment. The existence of certain interactions, compared to the absence of others, lead us to introduce the BOTTOM-TO-TOP PRINCIPLE, which will account for the blocking of certain types of adjustment by forcing a fixed order of application. We will explore the possibility of reducing the Bottom-to-Top Principle to Strict Cyclicity for phrasal Rhythmic Adjustment, and conclude that this reduction fails.

Finally, we will show in §4.3 that the analysis developed so far will account straightforwardly for some apparent puzzling Maximality violations in Dutch that are, again, unknown in English.

4.1 Leftward Rhythmic Adjustment

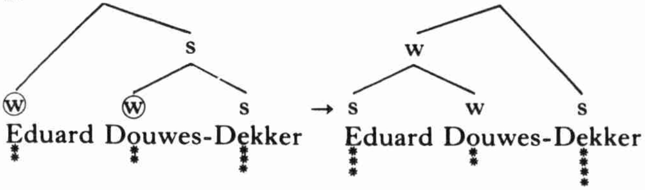
Dutch, like English, allows abundantly for leftward Rhythmic Adjustment in both its shift mode and its strengthening mode. Compare the examples in (46) with their English counterparts, for instance those in (28):

(46) a.



'East Amsterdam'

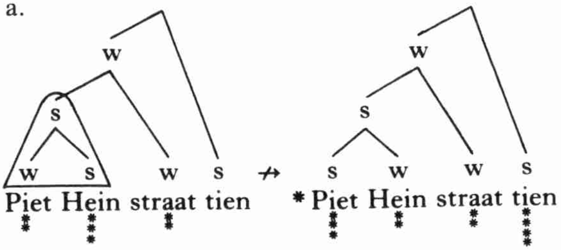
b.



(name)

The Strong Domain Principle, as formulated in §3, turns out to be supported by Dutch examples as well. It blocks Rhythmic Adjustment in cases which are exactly parallel to the English ones (compare (47a) to (41b), and (47b) to (33b)), and allows for (weak) internal rhythm, as shown in (47c). The ungrammatical examples in (47a, b) contrast sharply with the grammatical ones in (47c):

(47) a.

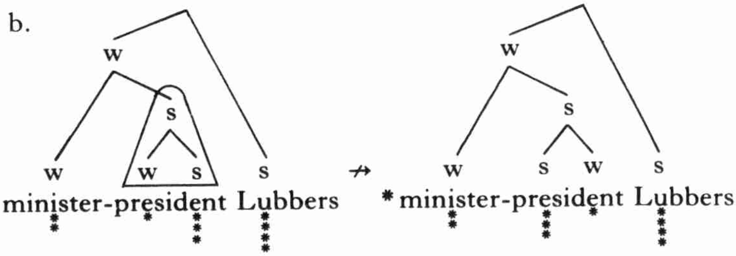


'10 Piet Hein Street'

idem:

[[[grof	vuil]	dienst]	Utrecht]	'heavy refuse service Utrecht'
heavy	refuse	service	Utrecht	
[[[onder	zee]	boot]	Nautilus]	'submarine Nautilus'
under	sea	boat	Nautilus	
[[[klaver	jas]	club]	Noord]	'card club North'
clubs	jack	club	North	

b.

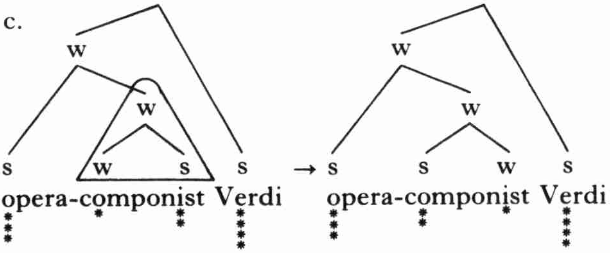


'Prime Minister Lubbers'

idem:

[[inter nationale]druk]	'international pressure'
[[sociaal economisch]beleid]	'social-economic policy'
[[Midden europese]hoofdstad]	'Mid-European capital'

c.



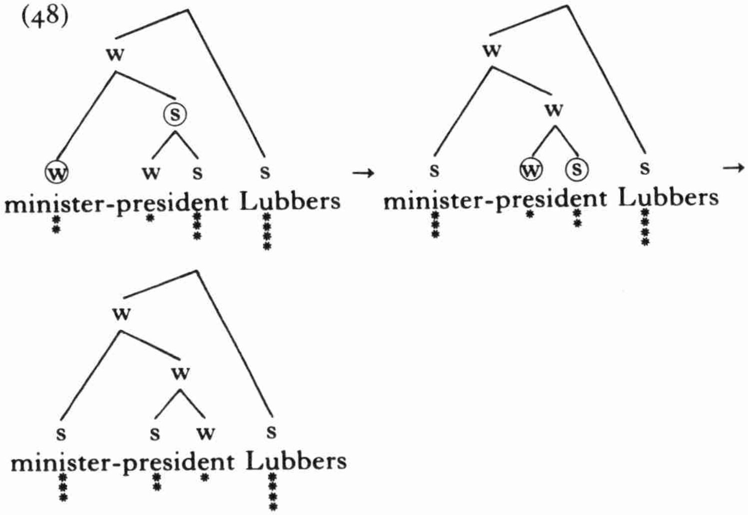
'opera composer Verdi'

idem:

[[vice president]Bush]	'Vice President Bush'
[[Edison winnares]Spee]	'Edison Award winner Spee'
[[interim directeur]Eduard]	'interim director Eduard'

Just as in English, the Strong Domain Principle forces Rhythmic Adjustment to apply in a fixed order in (48):

(48)



idem:

[[luitenant-kolonel]Bouterse]	'Lieutenant-Colonel Bouterse'
[[hetero seksueel]type]	'heterosexual character'
[[Nederlands–Portugees]woordenboek]	'Dutch–Portuguese dictionary'

Rhythmic Adjustment applies to the higher pair of nodes before the lower pair, as Rhythmic Adjustment on the strong internal pair would produce a violation of the Strong Domain Principle: this accounts for the ungrammatical contour **min*$\overset{3}{\text{i}}$*ster* $\overset{2}{\text{p}}$*resid*$\overset{3}{\text{e}}$*nt L*$\overset{1}{\text{u}}$*bbers*. By first applying Rhythmic Adjustment to the (weak) external pair in (48), the Strong Domain Principle can be circumvented (compare the English examples in (36)).

Cases of identical grids showing different rhythmic behaviour are easy to come by in Dutch, as in English: cf. (49). If we consider the metrical structures of these examples, we immediately see the Strong Domain Principle at work in an account of their rhythmic behaviour:

(49)

a.

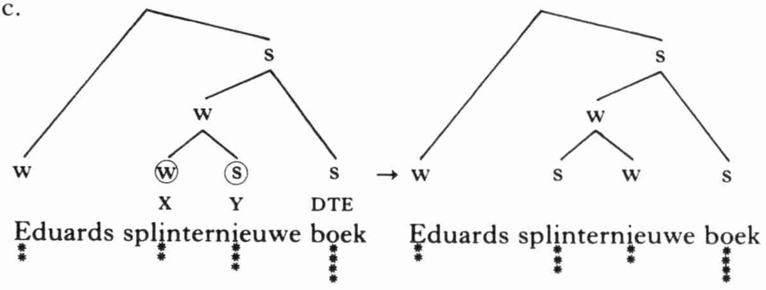
[[$\overset{3}{\text{E}}$duards[spl$\overset{3}{\text{i}}$ntern$\overset{2}{\text{i}}$euwe b$\overset{1}{\text{o}}$ek]] → $\overset{3}{\text{E}}$duards spl$\overset{2}{\text{i}}$ntern$\overset{3}{\text{i}}$euwe b$\overset{1}{\text{o}}$ek
'Edward's brand-new book'

idem:

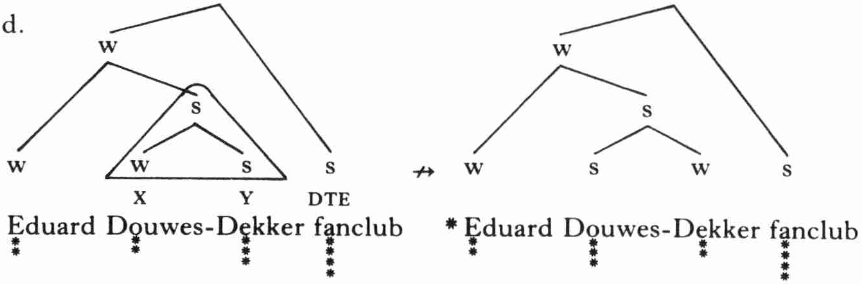
[oude[Zuid chinese[kunst]]]	'ancient South Chinese art'
[beker[ongekookte[melk]]]	'cup of unboiled milk'

b.

[[$\overset{3}{\text{E}}$duard D$\overset{3}{\text{o}}$uwes-D$\overset{2}{\text{e}}$kker]f$\overset{1}{\text{a}}$nclub → * $\overset{3}{\text{E}}$duard D$\overset{2}{\text{o}}$uwes D$\overset{3}{\text{e}}$kker f$\overset{1}{\text{a}}$nclub c.



d.



In (49c) Rhythmic Adjustment is triggered by the Quadrisyllabic Rule, and permitted by the Strong Domain Principle, whereas in (49d) Rhythmic Adjustment is blocked by the Strong Domain Principle, in spite of eurhythmicity.

As we have demonstrated repeatedly, grid-only theory cannot discriminate between these cases, their grids being identical:

(50)

a.

b.

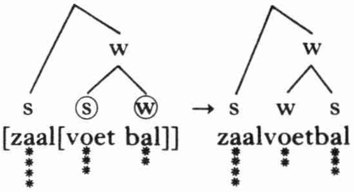
Neither case involves an introduction of clash by Move x, which renders the Bounding Condition irrelevant. The crucial factor proves to be s/w-labelling combined with constituency, as expressed by the Strong Domain Principle.

4.2 Rightward Rhythmic Adjustment and interactions: the Bottom-to-Top Principle

So far, Dutch data confirm the picture sketched in the first half of this paper in a rather trivial way. The interest of Dutch as a test case for theories of rhythmic adjustments, however, derives from the fact that it allows for rightward as well as leftward rhythmic adjustment. It will be clear that for these cases the rule of Rhythmic Adjustment has to be provided with its mirror image: '...DTE...YX..., where Y adjoins to X'.

In (51a) we illustrate rightward shift and in (51b) rightward strengthening by means of some simple examples:[12]

(51) a.

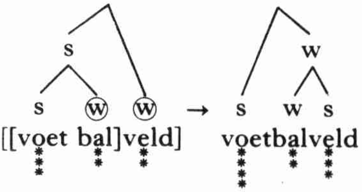


[gym[foot ball]] 'indoor soccer'

idem:

[hoofd[klem toon]]	[main[force tone]]	'main stress'
[kunst[ijs baan]]	[artificial[ice rink]]	'ice rink'
[hulp[werk woord]]	[help[action word]]	'auxiliary verb'
[bloed[armoede]]	[blood[poorness]]	'anaemia'
[tand[pasta]]	[tooth[paste]]	'toothpaste'
[nood[toe stand]]	[emergency[in state]]	'state of emergency'
[band[op name]]	[tape[in take]]	'tape recording'

b.



[[foot ball]field] 'soccer field'

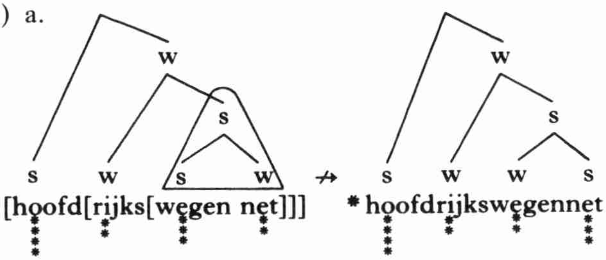
idem:

[[vlieg dek]schip]	[[flight deck]ship]	'aircraft carrier'
[[beeld houw]werk]	[[sculpture hew]work]	'sculpture'
[[kern ploeg]lid]	[[core team]member]	'member of the squad'
[[Water schaps]heuvel]	[[Water ship]hill]	'Watership Down'
[[voor hoofds]holte]	[[fore head]cavity]	'frontal sinus'
[[vak bonds]leider]	[[trade union]leader]	'union leader'
[[onder zoeks]methode]	[[re search]method]	'research method'

It is important to note that the cases in (51) conform to the formulation of the Maximality Principle. In (51a), X and Y are sisters and in (51b) Y is the sister of DTE and c-commanded by X.

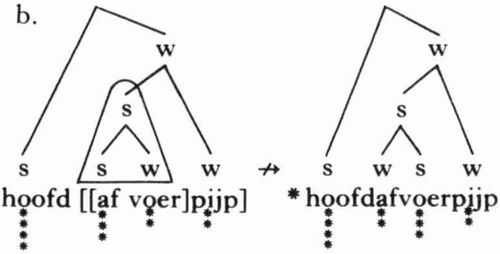
Our next examples show that the Strong Domain Principle is also relevant to rightward shifts. (52a, b) are the mirror images of (47a, b). Again, Rhythmic Adjustment is not allowed to apply and this is explained by the Strong Domain Principle:

(52) a.



main state road network				'national motorway system'
idem:				
[rijks	[kinder	[bij	slag]]]	'national children's allowance'
state	children	to	stroke	
[stads	[school	[advies	dienst]]]	'city school advisory board'
city	school	advice	service	

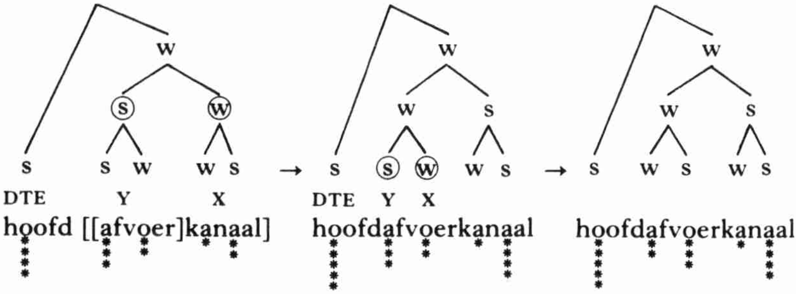
b.



main from carry pipe				'main drain'
idem:				
[top	[[voet	bal]	club]]	'top soccer club'
top	foot	ball	club	
[rijks	[[in	voer]	stop]]	'national import stop'
state	in	carry	stop	

The Strong Domain Principle may be circumvented by multiple applications of rightward Rhythmic Adjustment in (53), as may also occur in its leftward mirror image case (48):

(53)



main from carry channel 'main sewer'

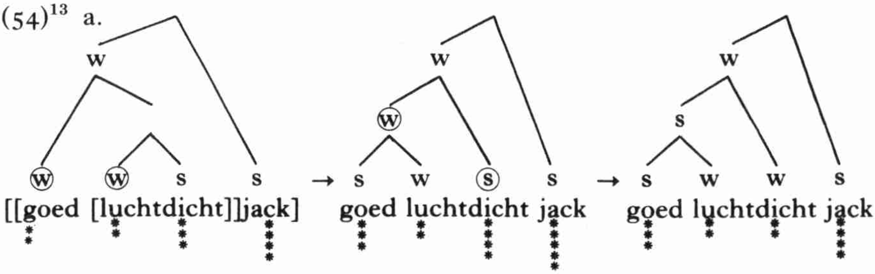
idem:

[groeps [[toe gangs] bewijs]] ‘group admission ticket’
group to pass ticket

[vaat [[af was] machine]] ‘automatic dish-washer’
dish off wash machine

The theoretical relevance of structures found in a language like Dutch becomes clearer in cases where interactions may be expected between the leftward and rightward rules. We first give some examples of interactions between strengthening and shift in the same direction:

(54)[13] a.

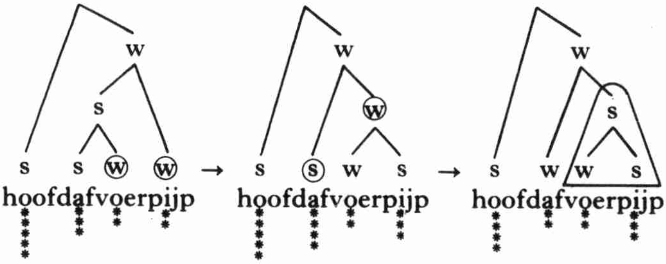


‘completely air-tight anorak’

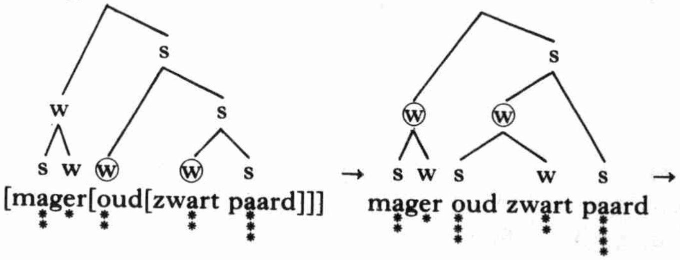
idem:

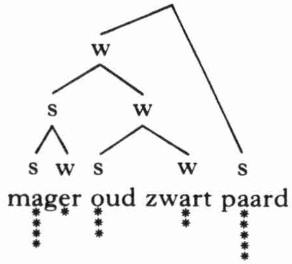
[[compleet [lood vrij]] potlood] ‘completely lead-free pencil’

b.



c.



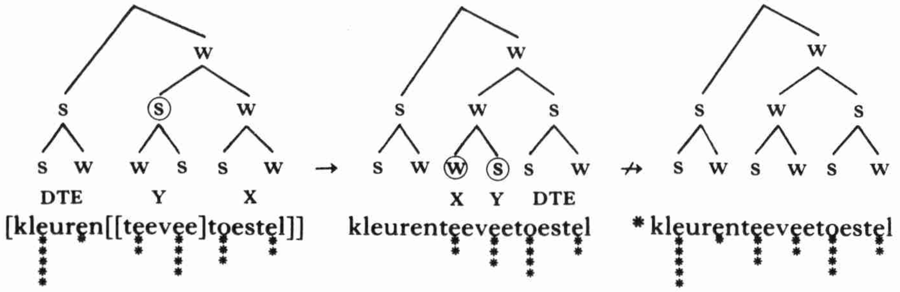


'lean old black horse'

In (54a), leftward strengthening feeds leftward shift. In its mirror image case (54b), rightward strengthening feeds rightward shift. Double application of leftward strengthening is shown in (54c), the Dutch counterpart of *Peter's three red shirts* (cf. (31a)). Recall our discussion of the problems posed by such constructions for grid-only theory.

We are confronted with an interesting problem when we consider interactions of Rhythmic Adjustment in opposite directions. So far we have seen that the Strong Domain Principle forces an order of Rhythmic Adjustment application from higher nodes to lower nodes, for instance in (48) and (53). These are clearly grammatical. However, this order of application appears to yield doubtful if not ungrammatical cases if rightward Rhythmic Adjustment on higher nodes is applied prior to leftward Rhythmic Adjustment on lower nodes, and vice versa, as in (55):

(55) a.



'colour TV set'

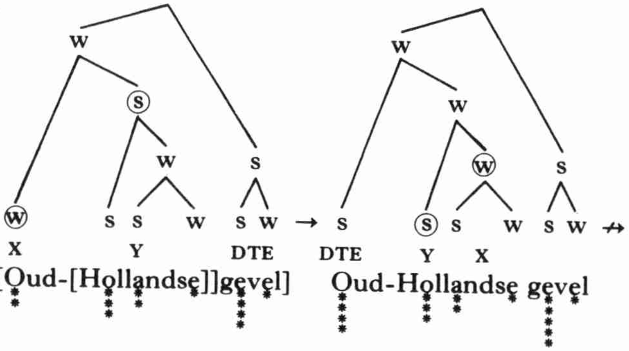
idem:

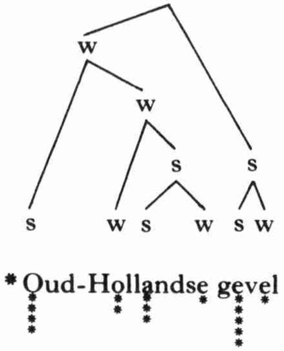
[import[[UV]filter]] 'imported ultra-violet filter'

[reclame [[zwart wit] film]] 'black and white commercial'

commercial black white film

b.





'old Dutch-like gable'

idem:

[[Nieuw-[Zeelandse]]tijd]	'New Zealand time'
[[na-[oorlogse]]woning]	'post-war house'

Notice that the internal constituents, such as *teevee*, may undergo stress shift in 'external' contexts (*tèevee éen* 'TV-one').

The derivations in (55) must be blocked after the first adjunction of the higher pair of nodes. If this is correct, the question immediately arises as to why this should be so. There is, however, an important difference between the derivations in (48)/(53) and those in (55): in (55), the DTE required for the second adjunction is *derived* by a previous adjunction. This means that the domain of the second application which contains the nodes X, Y and DTE is a derived prosodic subdomain (*teeveetoestel*) of the domain which contains the nodes, X, Y and DTE of the previous adjunction (i.e. the full domain *kleurenteeveetoestel*). Those cases in which a second adjunction is possible (cf. (48) and (53)) use the same DTE for both adjunctions, and hence are applied within the same domain. Apparently, adjunctions apply from bottom to top through the tree, each time to a larger domain. Within one domain, however, we may apply several adjunctions, also from top to bottom. Let us state this in the following principle of rule application:

(56) *Bottom-to-Top Principle*[14]

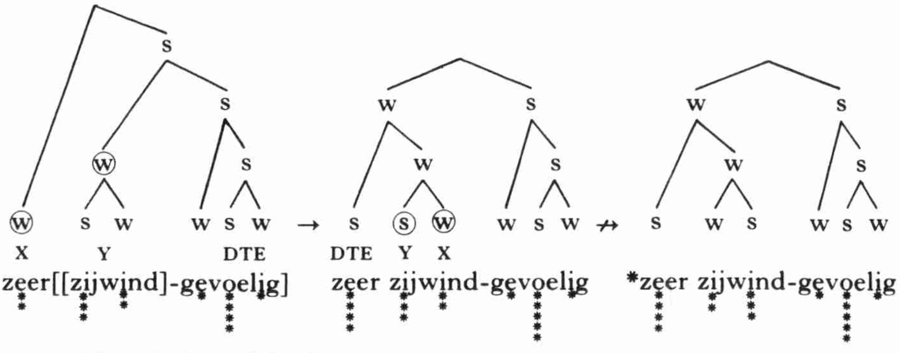
> A metrical adjunction rule may not be applied to a subdomain of a domain to which any metrical adjunction rule has applied.

The domain is the minimal configuration in which X, Y, DTE or DTE, Y, X are found.

We can now explain the difference between (48)/(53) and (55). In (48) and (53) we have two applications of Rhythmic Adjustment within a single domain. The Bottom-to-Top Principle is irrelevant to the order of application in this case. This order is determined by the Strong Domain Principle. In (55), however, after the application of Rhythmic Adjustment in a larger domain, a return to a subdomain is excluded by the Bottom-to-Top Principle.[15]

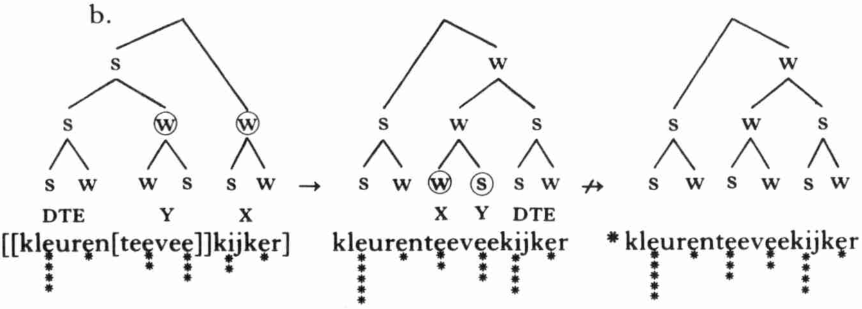
Additional evidence for the Bottom-to-Top Principle is found in (57), where strengthening on larger domains cannot be followed by opposite shifts on smaller domains:

(57) a.



'very side-wind sensitive'
idem:
[Wims[[zee zieke]katten]] 'Wim's seasick cats'
[drie [[roem rijke] helden]] 'three glorious heroes'
three glory rich heroes

b.



'colour TV watcher'

idem:

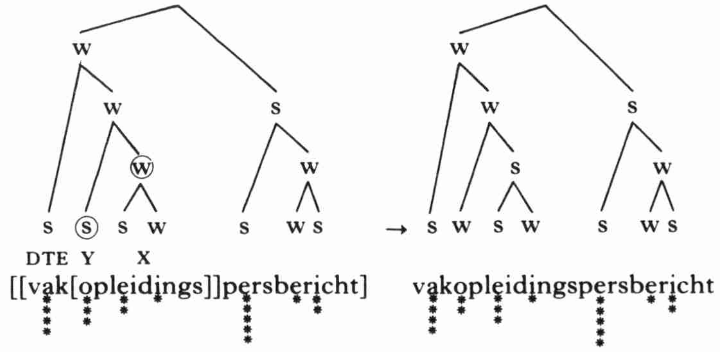
[[service[loket]] balie]	'service window counter'
[[water [niveau]] meter]	' water-gauge'
water level gauge	

After Rhythmic Adjustment applications to the larger domains in (57a, b), in conformity with the Quadrisyllabic Rule, Rhythmic Adjustment applications to smaller domains are blocked, even though they conform to the Disyllabic Rule. The latter application would take place in subdomains of the (maximal) domains of the former applications and would depend on derived DTEs, a situation which is ruled out by the Bottom-to-Top Principle.

We can think of three reasonable alternatives that might replace the Bottom-to-Top Principle, in order to derive its effects in a different manner. Each of these alternatives turns out to be untenable, however.

The first is to say by universal constraint that stress shift must always go in the direction away from main stress. In order to show the inappropriateness of this suggestion, we must construct an example where right-branching structure to the left of the DTE enforces left-to-right descending prominence which requires rightward rhythmic adjustment.[16] (58) is such an example:

(58)



'professional training press report'

A second alternative would be to rule out multiple applications of Rhythmic Adjustment in opposite directions. This hypothesis is falsified by one of the examples discussed below (cf. (66)), where a rightward application feeds a leftward one.

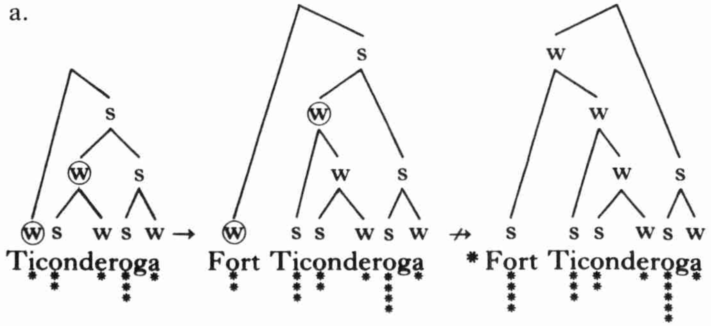
The third, and most obvious alternative to bottom-to-top application lies in the cyclic application of Rhythmic Adjustment. Although intuitively the idea of the Bottom-to-Top Principle comes close to cyclic rule application, the consequences are rather different. To begin with, Strict Cyclicity will only block a rule that operates fully on a previous morphosyntactic subdomain of the relevant domain, but cannot rule out applications taking place entirely on a *newly created metrical subdomain*, as in (55) and (57). And even if we leave Strict Cyclicity for what it is, arguments remain against cyclic phrasal Rhythmic Adjustment application. That is, bottom-to-top application has to be distinguished from cyclic application for independent reasons. These reasons are the following.

First, by definition, truly cyclic rule application on a given cycle cannot be inhibited by phonological material outside its cyclic domain. Thus we would expect eurhythmy conditions checking the application of Rhythmic Adjustment to a given domain to be limited to grid material associated to the domain in question. This prediction of cyclicity cannot be maintained, however. The examples in (59), partly from Hayes (1984), show that the application of Rhythmic Adjustment on inner domains may be rhythmically inhibited by prominences on outer domains, in accordance with the requirements of the Disyllabic Rule:

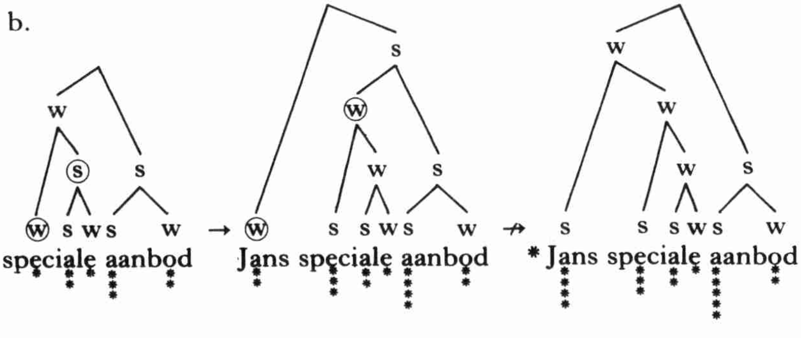
(59)	a.	Tìconderóga	[Fòrt[Ticònderóga]]
	b.	tòok out the bóok	[Jòhn[took òut the bóok]]
	c.	twèe zieke kátten	[Wìms[twee zieke kátten]]
		'two sick cats'	'Wim's two sick cats'
	d.	spèciale áanbod	[Jàns[specìale áanbod]]
		'special offer'	'Jan's special offer'

Only if there is sufficient (temporal) space between the outer and inner material may inner adjustment occur. In (60) and (61) we give some sample derivations to illustrate the difference between cyclic and non-cyclic application, respectively:

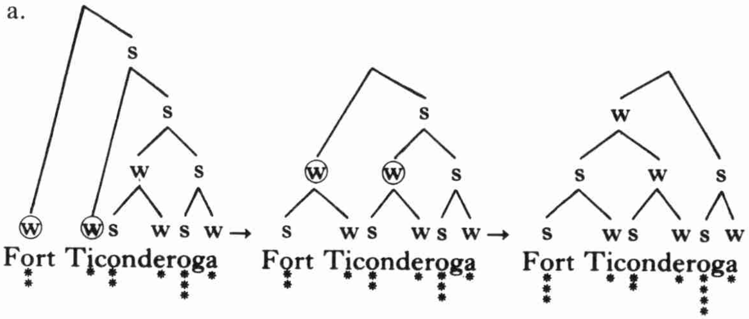
(60) a.



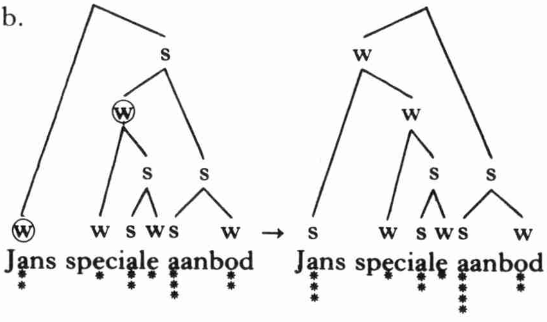
b.



(61) a.



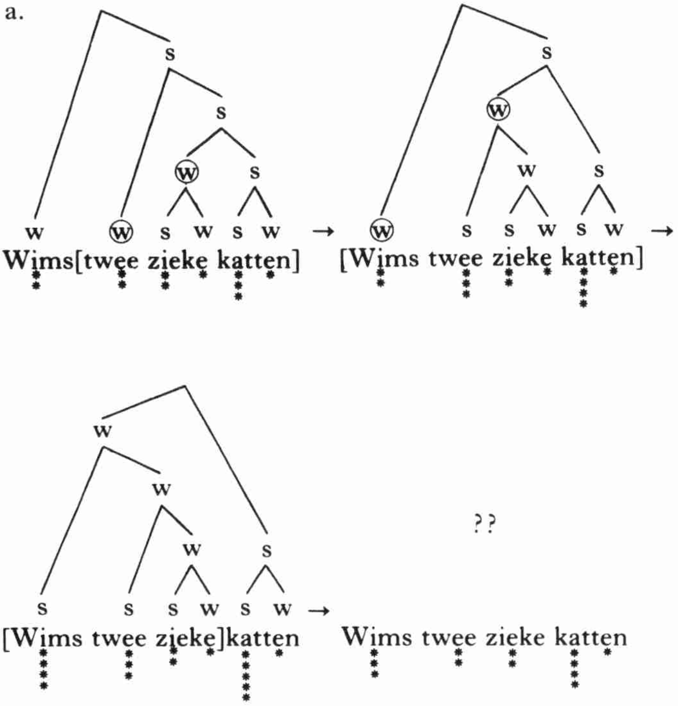
b.



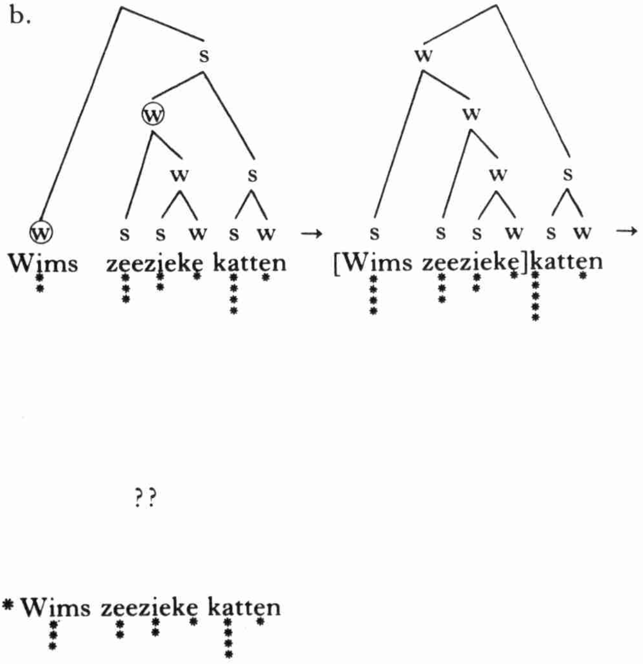
In (60), Rhythmic Adjustment on both cycles is stimulated by the Quadrisyllabic Rule, and both applications seems to give an improvement of the grid. Application on the inner cycles *Ticonderoga* and *speciale aanbod* conforms to the Quadrisyllabic Rule, increasing the relevant interval from two to three syllables. Application on the outer domain is fully in accordance with the Quadrisyllabic Rule too, giving a distance of four syllables between the two highest peaks. However, the output grids are not the ones we want, as the demands of the Disyllabic Rule are not satisfied.

The correct contours can only be derived in the non-cyclic derivations in (61), in which the full grids are always accessible. After the derivation of the contours *F$\overset{2}{o}$rt T$\overset{4}{i}$c$\overset{3}{o}$nder$\overset{1}{o}$ga* and *J$\overset{2}{a}$ns sp$\overset{4}{e}$ci$\overset{3}{a}$le $\overset{1}{a}$anbod* the procedure is cut off, as further Rhythmic Adjustment applications are unable to increase eurhythmy with respect to the Disyllabic Rule. Note that a cyclic treatment cannot be saved by assuming that the output of (60) can be changed into the output of (61). This would also incorrectly affect cases in which the prominence relations are already lexically identical to those in the output of (60), making them similar to the output of (61). We can show this by contrasting (59d), for example, with a minimal counterpart *Wims zeezieke katten*, in which *zeeziek* is one of the few Dutch adjectival compounds with underlying sw-prominence:

(62) a.


s
s
w s
w w s w s w →
Wims[twee zieke katten]
s
w
w s
w s s w s w →
[Wims twee zieke katten]
w
w
w s
s s s w s w →
[Wims twee zieke]katten
??
Wims twee zieke katten

b.

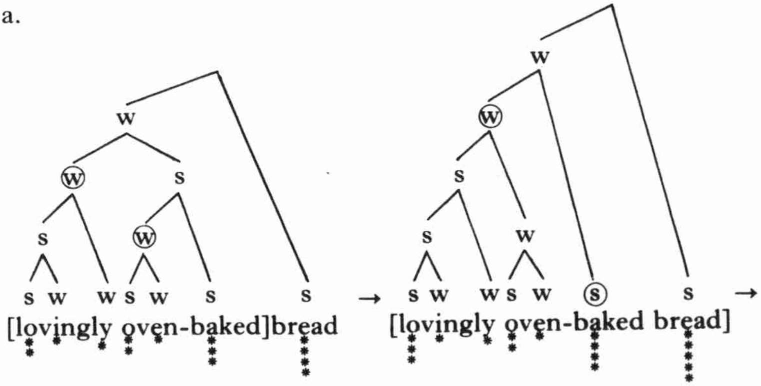

s
w
w s
w s s w s w →
Wims zeezieke katten
w
w
w s
s s s w s w →
[Wims zeezieke]katten
??
* Wims zeezieke katten

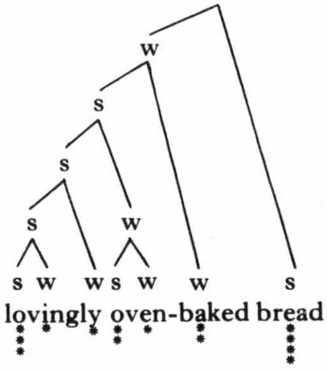
The outputs of (62a) and (62b) are identical. The impossibility of further operations on (62b), resulting in equal prominences on *zee* and *zieke*, illustrates that the preferred contour of (62a), i.e. equal prominences on *twee* and *zieke*, cannot be derived by a modification of the output of (62a) on the last cycle. Thus, we see that non-cyclic application, constrained by the Bottom-to-Top Principle, must be favoured over cyclic application.

A second argument which points in the direction of denying the relevance of the phrasal cycle for Rhythmic Adjustment comes from Lexical Phonology. Work in this area (for instance Kiparsky 1982) shows that the cycle may be seen either as derived from Word Formation Rules or as an artefact of them. In contrast, there are no arguments to the effect that the cycle is derivable from morphosyntactic principles at phrasal levels. This implies that the phrasal cycle should have to be stipulated as such by those who support it.

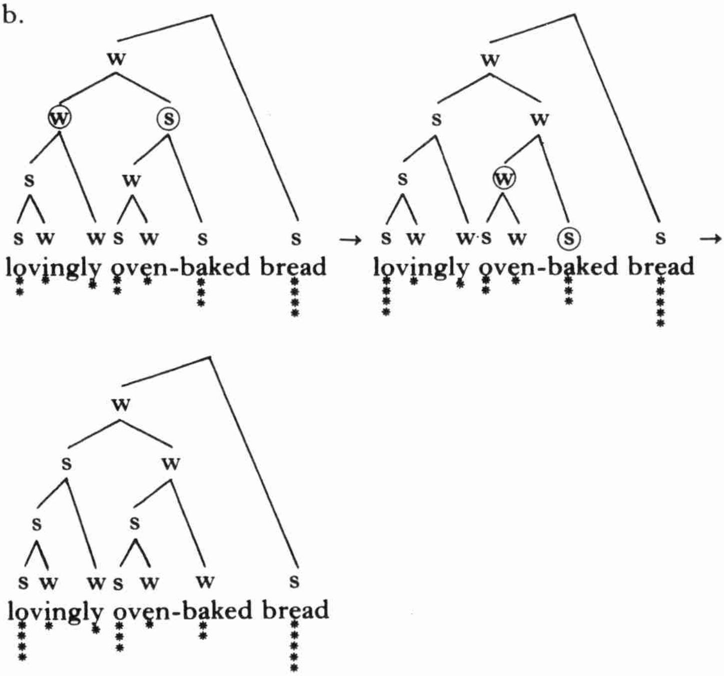
A third argument against cyclic application, provided by Hayes (1982), comes from cases of internal rhythm where Rhythmic Adjustment on an inner cycle would incorrectly bleed Rhythmic Adjustment on an outer cycle by destroying its environment. In (63) we give an example from Hayes (1982). Both outputs of (63) are grammatical:

(63) a.





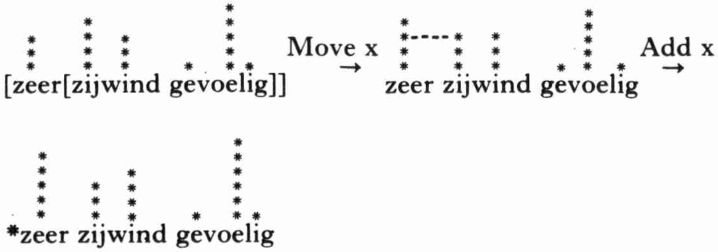
b.



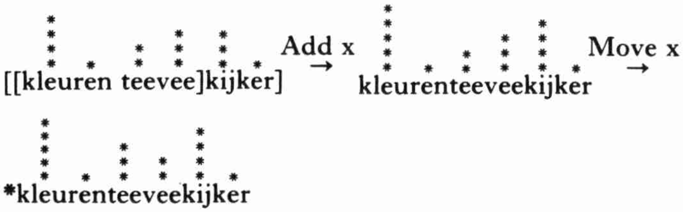
In a cyclic framework, the derivation runs exclusively as in (63a), so that it is impossible to derive the preferred contour *l$\overset{2}{o}$vingly $\overset{3}{o}$ven-b$\overset{4}{a}$ked br$\overset{1}{e}$ad*. In the non-cyclic framework, both derivations are allowed and conform to the Bottom-to-Top Principle.

Finally, the examples in (57) are problematic to grid-only theory in their own right, in a way which may be worth demonstrating once more. Their derivations would run as follows:

(64) a.



b.



In (64a), Move x must first operate so as to eliminate a quasi-clash. In the next step, Add x should, but cannot, be blocked since its conditions are met, and we are left with an ungrammatical result. In (64b), we have a comparable situation. Here Move x should, but cannot, be blocked.

In this subsection, we have discussed interactions of leftward and rightward Rhythmic Adjustment applications. It appeared that the theory was in need of a principle of rule application to rule out applications within subdomains of earlier applications. We have shown that this Bottom-to-Top Principle resembles Strict Cyclicity, but is not reducible to it. The Bottom-to-Top Principle makes crucial references to metrical constituents and thus supports the central point made in this article.

4.3 The Maximality Principle: Dutch compared to English

The Bottom-to-Top Principle allows us to explain a puzzling difference between Dutch and English, left unmentioned so far. At first sight, the Maximality Principle seems to be violated right away in Dutch in cases (analogous to English ones), like (65):

(65)

a. $\overset{2}{\text{a}}$pple j$\overset{3}{\text{u}}$ice b$\overset{3}{\text{o}}$ard l$\overset{1}{\text{o}}$bbyist $\nrightarrow$ *$\overset{2}{\text{a}}$pple j$\overset{3}{\text{u}}$ice b$\overset{4}{\text{o}}$ard l$\overset{1}{\text{o}}$bbyist

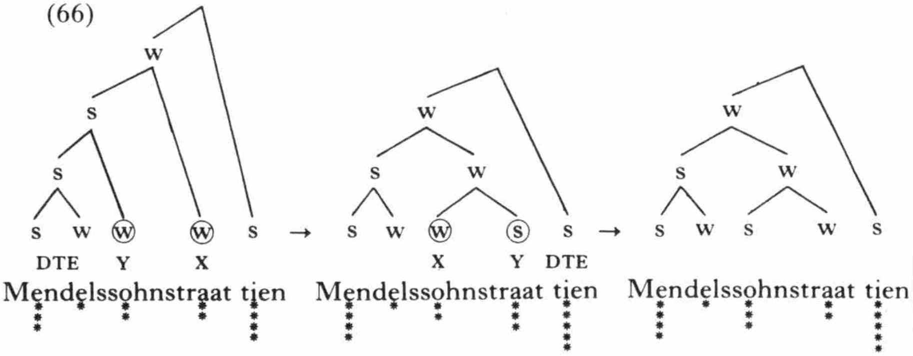
M$\overset{2}{\text{e}}$ndelss$\overset{3}{\text{o}}$hn str$\overset{3}{\text{a}}$at t$\overset{1}{\text{i}}$en → M$\overset{2}{\text{e}}$ndelss$\overset{3}{\text{o}}$hnstr$\overset{4}{\text{a}}$at t$\overset{1}{\text{i}}$en
'10 Mendelssohn Street'

b. l$\overset{2}{\text{a}}$w l$\overset{3}{\text{i}}$br$\overset{4}{\text{a}}$ry n$\overset{1}{\text{e}}$wsletter $\nrightarrow$ *l$\overset{2}{\text{a}}$w l$\overset{4}{\text{i}}$br$\overset{3}{\text{a}}$ry n$\overset{1}{\text{e}}$wsletter

v$\overset{2}{\text{a}}$k$\overset{3}{\text{o}}$pl$\overset{4}{\text{ei}}$dingsp$\overset{1}{\text{e}}$rsbericht → v$\overset{2}{\text{a}}$k$\overset{4}{\text{o}}$pl$\overset{3}{\text{ei}}$dingsp$\overset{1}{\text{e}}$rsbericht

In precisely those cases which led Hayes to formulate his Maximality Principle, Dutch appears to allow Rhythmic Adjustment. However, these violations of Maximality are only apparent, as the possibility of rightward Rhythmic Adjustment, constrained by the Bottom-to-Top Principle, provides an immediate explanation. The pattern *M$\overset{2}{\text{e}}$ndelss$\overset{3}{\text{o}}$hnstr$\overset{4}{\text{a}}$at t$\overset{1}{\text{i}}$en* is derived not by one, but by two bottom-to-top applications of Rhythmic Adjustment. Rightward Rhythmic Adjustment is followed by leftward Rhythmic Adjustment on a larger domain, in conformity with the Bottom-to-Top Principle:

(66)



idem:

[[[auto	bus]	dienst]	Haarlem]	'coach service Haarlem'
auto	bus	service	Haarlem	
[[[zieken	huis]	zaal]	tien]	'hospital ward 10'
sick	house	ward	ten	

The Maximality Principle permits both applications. In the first step of the derivation, X c-commands Y, and in the next step the nodes X and Y are sisters. English lacks the possibility of right-directional Rhythmic Adjustment, and the output of (66) could only result from a direct application of strengthening to the left as in (30a), which would involve a true violation of Maximality.

A similar explanation can be given for (65b) (compare the derivation in (58)), where rightward Rhythmic Adjustment can be applied in conformity with Maximality. In contrast, English would violate it, as it lacks rightward Rhythmic Adjustment.

Finally, although Dutch differs from English with respect to the facts in (65), it resembles English with respect to another class of examples given by Hayes as an illustration of Maximality. As before, the difference resides in branching *vs.* labelling, and both areas support the Bottom-to-Top Principle (cf. (67)):

(67) $\overset{4}{\text{o}}\text{verd}\overset{3}{\text{o}}\text{ne}$ $\overset{2}{\text{steak}}$ $\overset{1}{\text{blues}}$ $\nrightarrow$ *$\overset{2}{\text{o}}\text{verd}\overset{3}{\text{o}}\text{ne}$ $\overset{4}{\text{steak}}$ $\overset{1}{\text{blues}}$

[[$\overset{3}{\text{Wa}}\text{ter}\overset{4}{\text{loo}}$]$\overset{2}{\text{plein}}$] $\overset{1}{\text{een}}$ $\nrightarrow$ *$\overset{2}{\text{Wa}}\text{ter}\overset{3}{\text{loo}}\overset{4}{\text{plein}}$ $\overset{1}{\text{een}}$

'1 Waterloo Square'

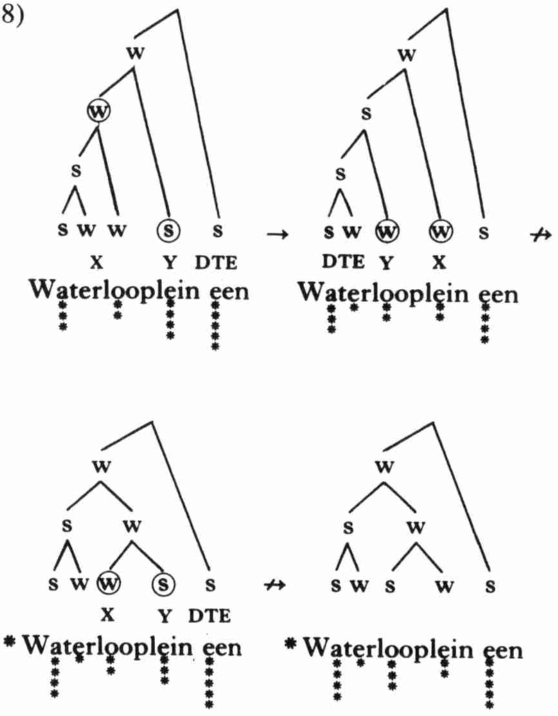
[[$\overset{4}{\text{A}}\text{mster}\overset{3}{\text{dam}}$]$\overset{2}{\text{O}}\text{ost}$] $\overset{1}{\text{Bij}}\text{lmerlijn}$ $\nrightarrow$ *$\overset{2}{\text{A}}\text{mster}\overset{3}{\text{dam}}$ $\overset{4}{\text{O}}\text{ost}$ $\overset{1}{\text{Bij}}\text{lmerlijn}$

'Amsterdam East Bijlmer railway'

(67) is identical to (65) with respect to branching, but crucially different with respect to s/w-labelling. Again, the Bottom-to-Top Principle gives an immediate explanation.

The derivation of (67) runs correctly up to the input structure of (66), the second step in the derivation:

(68)



idem:

[[[Watergraafs]meer]polderschap] 'Watergraafsmeer polder board'

However, if we want to proceed as in (66), we have to return to a metrical subdomain in (68) and this is blocked by the Bottom-to-Top Principle. The only remaining possibility for Rhythmic Adjustment would be strengthening to the left (a direct conversion of the second step into the fourth), but this would mean a true violation of Maximality. Therefore, we cannot proceed beyond the second step in the derivation, just as in English. In this way, the formulation of the Bottom-to-Top Principle allows us to draw exactly the right distinctions between structures identical with respect to constituency but differenct with respect to labelling.

Our proposal has the virtue of reducing the 'odd' behaviour of Dutch as compared to English with respect to Maximality to an obvious parametric difference between these languages: the direction of Rhythmic Adjustment.

5 Summary and conclusions

In this paper we have argued that metrical constituency and s/w-labelling, as encoded in trees, are essential to an adequate account of rhythmic adjustment. We have compared two competing theories of rhythmic adjustment, grid-only theory (Prince 1983; Selkirk 1984), and tree-*cum*-grid theory (Hayes 1984), by putting them to the test in a variety of empirical cases obtained from English and Dutch, especially cases with identical grids, but different tree structures. Grid-only theory was shown to be inadequate, due to shortage of information in the grid, whereas tree-*cum*-grid theory proved to be capable of handling these cases successfully.

Recently, grid-only theorists have put the burden on tree-*cum*-grid theory (as first developed in Liberman 1975; Liberman & Prince 1977) to prove that both representations, trees and grids, are in fact independently required. Hayes accepted this challenge, showing that rhythmic adjustment is conditioned by separate rhythmic and arboreal components, eurhythmy theory and adjunction theory. On the one hand, the notion of clash, essential to grid-only theory, was replaced by a set of eurhythmy conditions. On the other, arboreal constituency, built into trees by independently needed stress assignment rules, proved to contain exactly the kind of information adjustment turns out to be sensitive to. Hayes' framework, however, suffers from two shortcomings, one empirical, the other theoretical. The former resides in the fact that this framework overgenerates by allowing for too many types of adjustment, especially in 'internal rhythm' contexts. A theoretical shortcoming exists in that it predicts that adjustment, in addition to being sensitive to constituency, is potentially conditioned by strong–weak labelling by virtue of just that sensitivity; this however, was not illustrated by Hayes (1984).

Although (syntactic) constituency may still be obtained from a somewhat enriched representation, s/w-labelling cannot, as it has no direct correlate in the grid. Therefore, if adjustment can be shown to be sensitive to s/w-labelling, a strong argument for trees follows. We believe that the Strong Domain Principle (34) proposed here both effectively eliminates the overgeneration and fills the theoretical gap. The Strong Domain Principle blocks internal adjustment in the relevant contexts, and crucially refers to s/w-labelling.

In the remainder of this paper we examined leftward, rightward and bidirectional adjustment contexts in Dutch. Whereas unidirectional adjustment was sufficiently constrained by Hayesian adjunction theory, bidirectionally interacting adjustments turned out to be in need of a supplementary constraint, the Bottom-to-Top Principle (56). This principle determines the order in which adjustments apply through the tree bottom-up. This resembles Strict Cyclicity but, as far as we are aware, is not reducible to it. The Bottom-to-Top Principle is also firmly supported by its ability to explain some seeming counterexamples to Maximality in Dutch, and to reduce a seemingly problematic difference with English to a setting of just one parameter: the direction of Rhythmic Adjustment.

We conclude that, for instance, Selkirk's recent statement (1984: 169) to the effect that 'the fate of metrical trees would seem to be sealed: banishment to the archives of the history of ideas' is clearly premature and in fact, we believe, false.

NOTES

* Our special thanks go to Wim Zonneveld, Carlos Gussenhoven, Bruce Hayes and an anonymous reader for *Phonology*, who all contributed considerably to this article in its present form. Furthermore, to Marcel van den Broecke, Jan Don and Det Paulissen and the editors of *Phonology* for valuable comments and discussion. It goes without saying that we alone should be held responsible for possible errors.

[1] In most examples Prince does not indicate the syllable level, since it is irrelevant to higher level rhythmic structure.

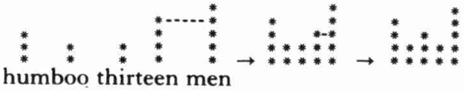
[2] No theoretical status should be attributed to the numbers in the examples; they are shorthand notations for prominence rank.

[3] It is important to note that the Quadrisyllabic Rule has priority over the Disyllabic Rule. Hayes also has a Phrasal Rule for even larger domains. This rule will play no role in our discussion.

[4] Gussenhoven (1986) questions the representativeness of examples such as *a hundred thirteen men*, where the lefthand member is a common numeral. Although it may be true that specific constructions bring about idiosyncratic rhythmic behaviour, there are other types of examples that do not contain specific items such as numerals or adverbial modifiers, and still allow internal rhythm. Here, we mention Hayes' example $\overset{2}{\textit{Mi}}\textit{ssiss}\overset{4}{\textit{i}}\textit{ppi–}\overset{3}{\textit{A}}\textit{lab}\overset{4}{\textit{a}}\textit{ma}$ $\overset{1}{\textit{ri}}\textit{valries}$ and refer to §4.1 below for examples from Dutch.

[5] It is possible to construct cases comparable to (22b) which are permitted by the Bounding Condition. Compare (23b) with (i):

(i)

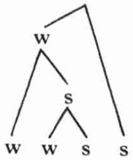


The Bounding Condition does not excluded Move x in (i) because there is an additional level on the second syllable of *humboo*, which is absent in *hundred*. This level accounts for English being a Quantity Sensitive language. The Bounding Condition's relevance for this kind of example is therefore accidental rather than principled: syntactic structure is identical in (23) and (i), and therefore we would expect the same behaviour with respect to the Bounding Condition.

[6] Actually, Prince suggests a similar solution to another set of examples, to which we will come back later, cf. (42).

[7] Selkirk (1984: 177–179) claims that internal rhythm in (i) is possible:

(i)



She gives as examples: $\textit{r}\overset{3}{\textit{a}}\textit{ther}$ $\textit{l}\overset{2}{\textit{i}}\textit{ly-wh}\overset{3}{\textit{i}}\textit{te}$ $\textit{h}\overset{1}{\textit{a}}\textit{nds}$, *a* $\textit{r}\overset{3}{\textit{e}}\textit{ally}$ $\textit{r}\overset{2}{\textit{i}}\textit{ght}$ $\overset{3}{\textit{o}}\textit{n}$ $\textit{r}\overset{1}{\textit{a}}\textit{dio}$ *show*, $\textit{sl}\overset{3}{\textit{i}}\textit{ghtly}$ $\overset{2}{\textit{u}}\textit{nderr}\overset{3}{\textit{i}}\textit{pe}$ $\textit{p}\overset{1}{\textit{e}}\textit{ars}$. Many cases of this type have an adverbial specifier in the initial w-position: *rather*, *really*, *slightly*. The position of the adverbial specifier is also often occupied by articles and prepositions, while other adverbs in this position block rhythmic adjustment. We will assume that function words such as articles are attached peripherally in the phonological phrase (cf. Nespor & Vogel 1982). Phonologically speaking, these do not count as separate phrasal constituents.

[8] Bruce Hayes pointed out to us that if the proposed account of **Apalàchicola Fálls* is correct, then it constitues evidence for binary-branching structure within the word; i.e. *-lachicola* must be a constituent.

[9] Selkirk gives cases of strong internal rhythm as well, but only when the first constituent is a modifier. They are grammatical if shift applies, but see note 7.

[10] Selkirk excludes both examples of (41), because the structural description of Beat Movement is simply not met.

[11] German cases, for example, were noted by Kiparsky (1966) and Giegerich (1985). See for Polish cases Hayes & Puppel (1985) and for Dutch Gussenhoven (1983) and van Zonneveld (1985).

[12] Even though rightward adjustment is a quite general process in Dutch, some counterexamples exist. However, this does not differ from what is known about leftward rhythm. Throughout our exposition, we will adhere to the following two guiding principles. First, we do not pretend that the possible contours that we give are always the *only* possible ones (degrees of acceptability are often under rhythmic control). Secondly, we intend to capture the *systematic* absence of certain contours in the whole array of facts.

[13] Notice that other derivations are allowed as well. For instance, a different output may result from applying leftward shift twice. This relative freedom of application is under rhythmic control.

[14] A more formalised definition would be as follows: let A and B be two nodes in a tree; if A dominates B, B is analysed as a possible rule domain *before* A. Rhythmic Adjustment within a domain can only apply if the analysed domain coincides with the minimal domain associated with the application *in casu*.

[15] The effects of the Bottom-to-Top Principle cannot be attested in English since that language allows for leftward adjunction only; the principle crucially constrains cases of bidirectional Rhythmic Adjustment.

[16] Bruce Hayes pointed this out to us.

REFERENCES

Giegerich, H. J. (1981). *On the nature and scope of metrical structure.* Indiana University Linguistics Club.

Giegerich, H. J. (1985). *Metrical phonology and phonological structure.* Cambridge: Cambridge University Press.

Gussenhoven, C. (1983). Stress shift and the nucleus. *Linguistics* **21**. 303–339.

Gussenhoven, C. (1986). Review article of Selkirk (1984). *JL* **22**. 455–474.

Hammond, M. (1984). *Constraining metrical theory: a modular theory of rhythm and destressing.* Indian University Linguistics Club.

Hayes, B. (1981). *A metrical theory of stress rules.* Indiana University Linguistics Club. 1980 PhD dissertation, MIT.

Hayes, B. (1982). The phonology of rhythm in English. Ms, UCLA.

Hayes, B. (1984). The phonology of rhythm in English. *LI* **15**. 33–74.

Hayes, B. & S. Puppel (1985). On the rhythm rule in Polish. In van der Hulst & Smith (1985). 59–81.

Hulst, H. van der (1984). *Syllable structure and stress in Dutch.* Dordrecht: Foris.

Hulst, H. van der & N. Smith (eds.) (1982). *The structure of phonological representations.* Vol. 1. Dordrecht: Foris.

Hulst, H. van der & N. Smith (eds.) (1985). *Advances in nonlinear phonology*. Dordrecht: Foris.

Kager, R. & E. Visch (1987). *Clash and/or eurhythmy*. Ms, University of Utrecht.

Kiparsky, P. (1966). Über den deutschen Akzent. *Studia Grammatica* **7**. 69–98.

Kiparsky, P. (1979). Metrical structure assignment is cyclic. *LI* **10**. 421–441.

Kiparsky, P. (1982). From cyclic phonology to lexical phonology. In van der Hulst & Smith (1982). 131–175.

Liberman, M. (1975). *The intonational system of English*. PhD dissertation, MIT. Distributed by Indiana University Linguistics Club.

Liberman, M. & A. Prince (1977). *On stress and linguistic rhythm*. *LI* **8**. 249–336.

Nespor, M. & I. Vogel (1982). Prosodic domains of external sandhi rules. In van der Hulst & Smith (1982). 225–255.

Prince, A. (1983). Relating to the grid. *LI* **14**. 19–100.

Selkirk, E. (1980). The role of prosodic categories in English word stress. *LI* **11**. 563–605.

Selkirk, E. (1984). *Phonology and syntax: the relation between sound and structure*. Cambridge, Mass.: MIT Press.

Zonneveld, R. van (1985). Word rhythm and the Janus syllable. In van der Hulst & Smith (1985). 133–140.

```
(201)a.                           /\          b.
             /\                  /  \
            / s                 w    s
           / /\                / \   /\                        /\
         /   s \              /  s   s \                      / s
        /   / \ \            / / \ / \  \        /\          / / \
        w  s  w w           w  s w s   w w      s w         w s  w
      [sensational]ity => [sensational]ity     [atom]ic => [atom]ic
        +  +  - +  - -      +  +  - +  - -      + +  -      + +  -
```

In contrast, existing structure cannot be reorganized at the supra-foot level (202a):

```
(202)        /\                      /\
            /  \                    /  s
           /    \                  / / \
          w      s                / /   s
         / \    / \              / /   /\
        /   s   s  \            / w     s \
       /   / \ / \  \          / / \   / \ \
       w  s  w s  w w         w  s  w s  w w
     [sensational]ity =/=>  [sensational]ity
       +  +  - +  - -         +  +  - +  - -
```

Accordingly, Kiparsky proposes to restrict metrical structure assignment so that it cannot destroy supra-foot structure.

Second, the uniqueness of the 4-3-1 contour in the *sensationality* class can be explained by the Rhythm Rule (125), reversing the word-internal prominence relations in all other classes, and producing 3-4-1 contours:

```
(203)                         /\                 /\
                             /  \               /  \
                            w    s             w    s
        /\                 /\    /\           /\    /\
       w  s               w  s  s  w         s  w  s  w
     [condens]ation  => [condensation]  =>  condensation
       +  +               +  +  +  -         +  +  +  -
```

The Rhythm Rule extends to words with different stress sequences such as *ìnstrumèntality* and *àrtificiálity*. Since these derivations run precisely as those of underived words, we refer to (126) by way of illustration. Crucially its rhythmic condition singles out *sensàtionálity* as the only type which preserves its embedded prominence relations.

Third, destressing in *explanation* is fed by the Rhythm Rule essentially as in (203). And as required, it also bleeds destressing of the initial prefixes in *condensation* (203), as this becomes strong.

However, phrasal applications of the Rhythm Rule are in their turn bled by prefix destressing: **èxact chánge*, **bènign túmor*, cf. section 3.1, by the removal of [+stress] from non-prominent vowels. This classical ordering paradox is resolved by assuming the Rhythm Rule to be *cyclic*: word-level prefix destressing is sandwiched in between its word-internal and phrasal applications. In the framework of those days this implied cyclicity of metrical structure assignment as well, since no non-cyclic (word-level) rules were ordered before the block of cyclic rules.

6.6 Hayes (1981)

Hayes (1981) attacks the problems which are posed to Kiparskyan analysis when the feature [+stress] is eliminated in favor of foot structure. A purely metrical foot-based