Linearisation as repair*

Joost Kremers
University of Frankfurt, Germany
j.kremers@em.uni-frankfurt.de

April 16, 2011

1 Introduction

Since Chomsky (1995), the assumption that syntactic structures are purely hierarchical and do not encode linear order has become dominant in generative syntactic theory. On this assumption, some procedure is needed to derive linear order from hierarchical structure. In the literature, there are roughly two kinds of approaches to linearisation. On the one hand, there are approaches inspired by Kayne's (1994) LCA. These assume a strict correlation between asymmetric c-command and linear order, which means that elements higher in the tree precede elements lower in the tree. On the other hand, there are approaches that assume ordering parameters in some form or other.

Although fundamentally different in certain ways, both types of approaches also share two basic assumptions. These are the *Exclusivity Condition* and the *Nontangling Condition*, as formulated in Partee et al. (1993: 442):

(1) a. *The Exclusivity Condition*:
In any well-formed constituent structure tree, for any nodes x and y, x and y stand in the precendence relation P, i.e., either $\langle x,y\rangle \in P$ or $\langle y,x\rangle \in P$, if and only if x and y do not stand in the dominance relation D, i.e., neither $\langle x,y\rangle \in D$ nor $\langle y,x\rangle \in D$.

b. *The Nontangling Condition*:
In any well-formed constituent structure tree, for any nodes x and y, if x precedes y, then all nodes dominated by x precede all nodes dominated by y.

In the present paper, I shall refer to two alternative formulations of these conditions. Kayne (1994) assumes the principle of *Totality*, which has the same effect as the *Exclusivity Condition*:

*The research reported on in this paper was funded by the German Research Foundation (DFG), grant number GR 559/8-1.

(2) *Totality*:
Given a tree K and the set T of terminals in K:
$\forall x,y\ (x,y \in T \wedge x \neq y |\ x < y \vee y < x)$.

Here, $a < b$ means '*a precedes b*'. Kayne's Totality is basically just a reformulation of the Exclusivity Condition. Ackema & Neeleman (2004) formulate the principle of *Linear Correspondence* (LC), which is essentially a derivational equivalent to the *Nontangling Condition*:

(3) Linear Correspondence:
If a node X is structurally external to a node Y, then Φ(X) is linearly external to Φ(Y).

Here, Φ is the linearisation function that maps hierarchical structure onto linear structure.[1] What LC amounts to is that if two nodes are not in a dominance relation, the phonological material associated with one cannot be inside the phonological material associated with the other. That is, if we have two (sister) nodes *x* and *y*, and Φ(*x*)=/abc/, while Φ(*y*)=/d/, then the linear order will be either /abcd/ or /dabc/, but not */adbc/ or */abdc/.

In spite of the fact that these assumptions are so fundamental to any approach to linearisation, there are exceptions to them. The goal of the present paper is to take a closer look at these exceptions and discuss what their implications are for the standard views on linearisation. I will argue that the best way to handle these cases is to see linearisation itself as a kind of repair strategy. In the hierarchical syntactic structure, the sisterhood relation is not temporally ordered. The phonological system attempts to represent this non-orderedness directly, but fails to do so most of the time. The structure is then repaired by linearising it.

2 Violations of Totality and LC

Consider the following examples, taken from German Sign language:[2]

(4) a. **face:** *with effort* *DGS*
hands: STUDENT GEBÄRDENSPRACHE LERN
student sign language learn
'The student learns sign language with difficulty.'
(Leuninger 2005)

b. **face:** *anxiously*
hands: SCHRANK:3 KATZE HERUMGEH:$\text{Cl}_{\text{animal}}$:3
closet cat walk about
'A cat is walking about anxiously on the closet.'

[1] Cf. Kremers (2007).

[2] The following sign languages appear in this article: DGS (German Sign Language), NGT (Sign Language of the Netherlands), ASL (American Sign Language), BSL (British Sign Language). In the sign language examples, the articulators are bold; signs printed on top of each other on different articulator tiers are realised simultaneously. If a sign on one tier is spread over more than a single sign on another tier, this is indicated with a line stretching over the entire articulation domain.

In these examples, a manually signed verb (LERN 'learn' and HERUMGEH 'walk about', respectively) is accompanied by a so-called *non-manual adverbial*, an adverbial realised through facial expression, head/body position, or a combination of both. That is, the manual sign and the non-manual adverb are realised *simultaneously*.

Such non-manual adverbs are not merely gestural, they are true lexical items. They have a fixed, lexical meaning, they are not iconic,[3] they are subject to grammatical constraints, e.g., they can only occur as adverbials, not as adjectives or predicates, they must co-occur with V, they cannot co-occur with the subject, etc. Non-manual adverbials are found in (virtually) all sign languages.[4]

The examples in (4) are VP-adverbs, but non-manual adverbs are not restricted to these. As Happ & Vorköper (2006: 363ff) point out, sentential adverbs that express epistemic modality may also be expressed non-manually:

(5) **face/body:** *mod:certain*——————————— *DGS*
hands: (SICHER) SWEN ARBEIT:3 GEH:Perf:3
(certainly) Sven work go
'I'm sure Sven has gone to work.'
(Happ & Vorköper 2006: 363)

In this example, the sentential adverb SICHER 'certainly, I'm sure' expresses epistemic modality. The manual adverb is accompanied by a non-manual marker that expresses the same meaning. As the parentheses around SICHER indicate, the manual sign is optional. The intended modality can also be expressed with the non-manual adverb alone.

In fact, the non-manual adverb is not always identical in meaning to the manual adverb, it may also qualify the manual adverb in certain ways:

(6) a. **face/body:** *mod:presumably*——————————— *DGS*
hands: (MÖGLICH) SVEN ARBEIT:3 GEH:Perf:3
possible Sven work go
'I suspect Sven has already gone to work.'

b. **face/body:** *mod:possibly*———————————
hands: (MÖGLICH) SVEN ARBEIT:3 GEH:Perf:3
possible Sven work go
'Sven may already have gone to work.'
(Happ & Vorköper 2006: 363)

These examples show that the non-manual adverbials here are meaning-bearing elements of their own. The relevance of these non-manual adverbials to linearisation should be obvious. As adverbials, they are adjoined to some projection in the clausal projection line, say VP/*v*P in

[3] Although they may have an iconic origin, they are lexicalised in the same way that words such as *moo* or *meow* are.

[4] For more discussion, see Sandler & Lillo-Martin (2005: 60–63).

the case of lower adverbs such as 'with difficulty', and CP in the case of sentential adverbs.[5] Totality and LC then require that the adverbial is linearised with respect to the VP or CP, either «XP – adverb» or «adverb – XP». But obviously, no linear order is established. Instead, the two elements are realised simultaneously.

Sandler & Lillo-Martin (2005) tentatively suggest that non-manual VP adverbs might be dealt with in the word-building module of grammar, which would make their relevance to linearisation less obvious. However, non-manual VP adverbs combine freely with verbs, there are no morphological restrictions on their use, which suggests that the underlying structure is syntactic.[6] Furthermore, a morphological approach is clearly not possible in the case of sentential adverbs, which combine with more than a single manual sign.

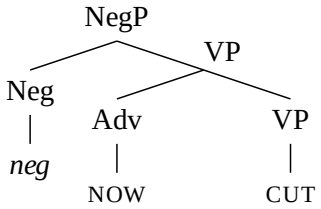
A morphological analysis also does not seem able to account for cases such as those in (7):

(7) **head:** *neg* *NGT*
right hand: CUT
left hand: NOW
'Don't interrupt me now!'
(Miller 1994: 105)

The example in (7) contains three simultaneously realised signs: the (imperative) verb CUT, the temporal adverbial NOW, and a non-manual negation, realised by a head shake. Note that both CUT and NOW are realised manually: the first on the right hand, the second on the left hand. Although sign languages do have bimanual signs, the combination of CUT and NOW in (7) violates the morpho-phonological restrictions that apply to bimanual signs (cf. Sandler & Lillo-Martin 2005: ch. 12), which suggests that the utterance in (7) is not the outcome of a morphological process.

A rough syntactic structure of (7) would look like (8):

(8)



Given Totality and LC, all three terminal elements in this tree, *neg*, NOW and CUT, should be linearised with respect to each other, which, however, is obviously not the case.

Other data that preclude a morphological analysis are those examples where a non-manual spreads over more than one manual sign. We have already seen sentential adverbs with this property, but there are other cases:

[5] Following e.g., Rizzi (1997), the adverbs could also be in specifier positions of designated functional heads, but that still raises the same questions about linearisation.

[6] In fact, in section 5 I argue that it is generally the case that a structure that looks superficially to be morphological may have an underlying syntactic structure.

(9) **head:** *neg*——⊣ *ASL*
hands: JOHN BUY HOUSE
'John is not buying a house.'
(Neidle et al. 2000: 44ff)

In this example, the non-manual negation, again realised by a head shake, is spread over the verb and the object. There is no sensible way in which this can be claimed to be a morphological structure.

It should be noted that the realisation of negation is not the same in every sign language. DGS, for example, may realise negation in a way similar to ASL, as in (10a),[7] but it also allows negation to be realised with just the verb, as in (10b):

(10) a. **head:** *neg*——⊣ *DGS*
hands: MOTHER FLOWER BUY

b. **head:** *neg*
hands: MOTHER FLOWER BUY
'Mother does not buy a flower'
(cf. Pfau 2001, 2002)

Consider also the *wh*-marking in (11):

(11) **face:** *wh*——⊣ *ASL*
face: *close*——⊣
hands: HAPPEN YESTERDAY NIGHT
'Did it happen just last night?'
(Liddell 1980: 49; cited in Sandler & Lillo-Martin 2005: 63)

The phrase in this example is an interrogative clause, which is marked through a facial expression that spreads over the entire utterance. If we assume that the clause is headed by a [+*wh*] C° head and that the facial interrogative marking is the overt expression of this C° head, we again see a case in which Totality and LC do not hold.

Note that the interrogative marking does not extend over a topic:

(12) **eyebrows:** *wh*——⊣ *BSL*
hands: K.I.L.B.Y BEFORE GOOD NOW GOOD
'Kilby, who was good before, was he good now?'
(Kyle & Woll 1985: 156)

The interrogative marking in (12) is very similar to the well-known interrogative intonational pattern observed in spoken languages:

[7] Pfau (2002) argues that the underlying structures are different, however.

(13) a. **int:** *wh*——————⊣ *English*
segm: Is he coming?

b. **int:** *wh*——————⊣
segm: Kilby, who was so good before, was he good now?

Intonational patterns are normally not thought of as direct realisations of syntactic heads. One reason for this, however, is presumably to be found in the assumption that Totality and LC hold without exception. Intonational patterns are not linked to particular words, they are linked to phrases. Under Totality and LC, it is therefore impossible to treat them as direct representations of (morpho)syntactic heads.

However, if there are exceptions to Totality and LC, things change. It does not follow, of course, that every intonational pattern is the reflex of a morphosyntactic head, but the possibility exists that certain specific patterns are, and the interrogative pattern seems to be a likely candidate. While this may seem far-fetched at first, note that in sign languages, interrogative marking and negation are very similar: they are both expressed non-manually.[8] That negation is the reflex of a syntactic head is not a controversial assumption. It follows, then, that the non-manual *wh*-marking in sign languages may be the reflex of a syntactic head as well. And if this is a possibility in sign languages, it could also be a possibility in spoken languages.

There are possibly more examples of simultaneity in spoken languages. Certain African languages, for example, express case marking through tone:

(14) a. ɛ́-dɔ́l ɛmbártá *Maasai*
3-sees horse.ACC
'he sees the horse'

b. ɛ́-dɔ́l ɛmbartá
3-sees horse.NOM
'the horse sees him'
(Tucker & Tompo Ole Mpaayei 1955)

Maasai has a high tone, marked with an acute, a low tone, marked with a grave, a midtone, which is not marked in writing and a contour tone high-low, marked with a circumflex. There are four major tone classes in the nominal system, all with subclasses, making about 20 different noun tone classes. The noun *ɛmbártá*[9] 'horse' belongs to a tone class that lowers the high tone on the penultimate vowel in the nominative, as indicated in (14).

Another possible example of simultaneity in spoken language is Semitic morphology:

(15) (ʔaqlaqa-nī) -ntiqād-u -l-rağul-i -l-mašrūʕ-a *Arabic*
(annoyed-me) criticising-NOM the-man-GEN the-project-ACC
'The man's criticising the project annoyed me.'

[8] Sign languages usually also have manual negation markers. They are accompanied by non-manual negation marking. Note, however, that overt interrogative particles are not uncommon in language in general, so that the parallel between negation and interrogative marking is in fact quite strong.

[9] As Tucker & Tompo Ole Mpaayei (1955) make clear, the accusative is the citation form of the noun in Maasai.

In (15), the deverbal noun *(i)ntiqāḍ* 'criticising' contains the verb stem morpheme *nt-q-ḍ*[10] and the deverbal noun morpheme *i-ā*. At the level of morphemes, these two elements are realised simultanously, so the deverbal noun may be seen as an instance of simultaneity.[11]

It may be argued that these two spoken language examples are morphological in nature, not syntactic. Note, however, that the deverbal noun in (15) has the ability to assign accusative case to its object *al-mašrūʕ* 'the project'. Since case assignment is a syntactic process, we must assume that a syntactic structure underlies the formation of the deverbal noun (cf. Abney 1987 and much literature since; cf. also Fassi Fehri 1993 and Kremers 2007 for Arabic). As for the case morpheme in (14), if we follow the standard analysis of tone and assume an autosegmental tonal tier (cf. Goldsmith 1976, McCarthy 1981), a syntactic analysis in which the case marker is associated with a separate Case° head that is realised simultaneously with the noun becomes at least feasible.

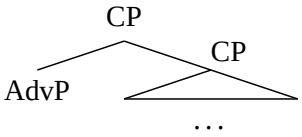
The examples in (14) and (15) are obviously not as clear-cut as the adverbials shown in (4)–(6) or even the *wh*- and negation markers in (9)–(13). But the adverbials and the *wh*- and negation markers clearly show that there is more going on than the simple lining up of elements in determining the linear order of syntactic terminals. Sometimes, elements can be superimposed, i.e., realised simultaneously. This observation obviously raises several questions. The two most pertinent ones are **(i)** what types of elements can be superimposed; and **(ii)** what is the relation between two superimposed elements? These questions are discussed in the next section.

3 Types of simultaneity

The data in the previous section (see also the discussion in Kremers submitted) show that there are essentially two types of elements that can be realised simultaneously with other material: functional elements (Neg°, [+*wh*] C° or Foc°, possibly Case°, etc.) and adverbials. If we look at the tree structures of these cases, there turns out to be a basic pattern to all of them.[12]

The adverbials illustrated in examples (4)–(6) are adjoined to either the VP or to CP:

(16) a.



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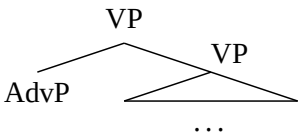


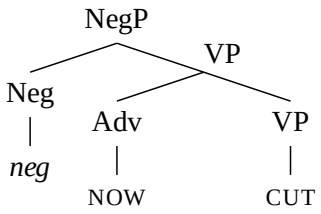
[10] Which itself is composed of the root *n-q-ḍ* and a stem infix *t*.

[11] At the phonological level, the segments are of course not realised simultaneously. But simultaneity involves the simultaneous realisation of two or more elements of the morphosyntactic tree, which means that the fact that the actual (meaningless) segments are realised sequentially is not relevant.

[12] The tree structures given here omit irrelevant details. Adverbs are assumed to be adjuncts rather than specifiers, but nothing hinges on this.

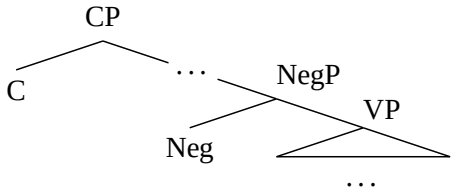
The example in (7) has the tree structure in (8), repeated here:

(8)



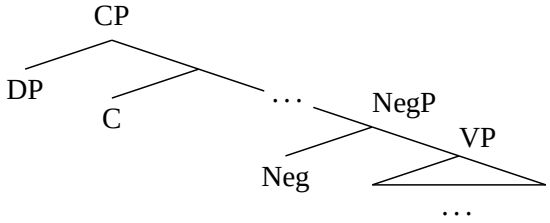
In general, negation is represented by a Neg° head, part of the clausal projection line:

(17)



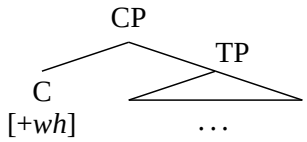
If the clause contains a topic, which is not under the non-manual negation marker, we may simply assume this DP resides in Spec,CP:[13]

(18)



The tree structure for the *wh*-examples are essentially similar to those of negation. Again, a topic may be assumed to be in Spec,CP:

(19) a.



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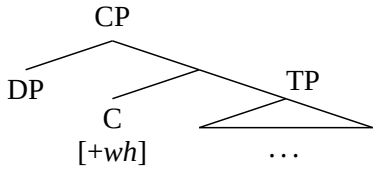
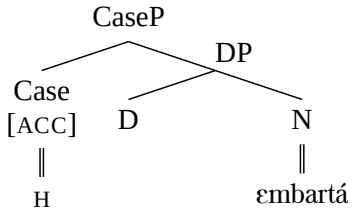


[13]We may also assume that the topic is adjoined to CP, or alternatively, that it sits in Spec,TopP. In the latter case, we must assume that the *wh*-marking is in a lower Foc° head, which is certainly feasible.

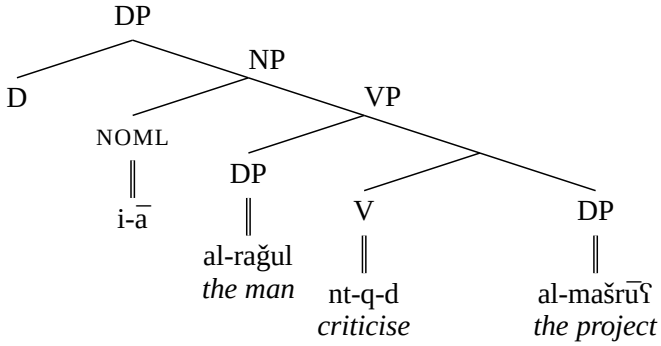
Assuming that case is represented syntactically by a Case° head that takes the DP as its complement (Abney 1987, Bittner & Hale 1996), the Maasai example has the following structure (H stands for high tone):[14]

(20)



The Arabic example is somewhat more complex (see Kremers 2007 for details). Because the deverbal noun assigns accusative case, I assume it starts out as a verb. The category change is brought about by a nominalising head that adjoins to VP (following Abney 1987):[15]

(21)



The various tree structures here are of course all different, but there is a common theme to all of them. In essence, there are two possibilities. First, two elements realised simultaneously may be sister nodes. Examples are the sentential adverbials in (5) and (6), which are sisters of CP, the *wh*-markers in (11)–(13), which are sisters of TP, and the negation marker in (9) and (10a), which are both sisters of *v*P.

The second option is demonstrated by the non-manual VP-adverbs in (4), the negation marker in (10b) and the case marker in (14). In these cases, the two elements realised simultaneously are not sisters. Rather, one element, the one realised non-segmentally, is a sister of a projection of the other, or more precisely, of an extended projection of the other element. This second element itself belongs to a lexical category.

The general picture that emerges, then, is that if an element A is realised simultaneously with an element B, B is (an extended projection of) a head beloning to a major lexical category, and A is a sister of B or of an extended projection of B.

[14] In fact, the phonological form of accusative marker must be a bit more complex than shown here, because it is linked to the penultimate syllable.

[15] In section 5, the structure is discussed in more detail.

4 Phonological composition

The requirement that A be a sister of (a projection of) B in order for simultaneous realisation to be possible is not the only condition, however. It is also necessary that the phonological form of A is appropriate for simultaneous realisation. That is, the phonological form of A has to be autosegmental (cf. Goldsmith 1976, McCarthy 1981).

This is in fact a crucial observation: whether two elements are to be realised simultaneously or not is something that can only be established when the phonological forms of both elements are known. By assumption, however, phonological information is not present in the syntactic structure (cf. Beard's 1988 *Separation Hypothesis*).[16]

This conclusion has certain consequences for the theory of linearisation. First and foremost, the process that derives a linear string from a hierarchical structure does more than just lining up terminal elements. For this reason, I propose to use the term "phonological composition" for the process that derives the phonological structure from the syntactic tree. Second, there is a clear consequence for the point in the derivation where linearisation of those elements that actually *need* to be linearised takes place. It is the phonological form of the elements in question that determines whether they need to be linearised or not, so linearisation can only take place when the phonological forms of the elements are known.

Phonological structure consists of a number of autonomous *tiers* (see Goldsmith 1976 and much subsequent literature). The way in which these tiers are combined to build a coherent phonological structure is determined by certain phonological principles, some of them universal (e.g. *Left-to-Right Association*), others language-specific.

Given the Separation Hypothesis, morpho-syntactic elements consist of bundles of features without phonological information. At the syntax-phonology interface, these feature bundles are associated with phonological material. For example, the lexical item *man* and the definite determiner *the* may be represented as follows:

(22) a. $\text{MAN}_{\langle e,t\rangle} \leftrightarrow \begin{bmatrix}\text{N, sg}\\ \text{count}\end{bmatrix} \leftrightarrow /\text{mæn}/$

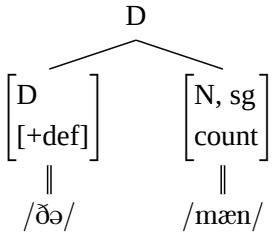
b. $\imath x[\dots] \leftrightarrow \begin{bmatrix}\text{D}\\ \text{[+def]}\end{bmatrix} \leftrightarrow /\text{ðə}/$

This representation also contains a specification for the semantics (which is kept overly simple here, as it is not relevant to the current discussion), following Jackendoff (1997, 2002). Suppose the syntactic component generates a structure by merging these two elements:[17]

[16] This assumption also underlies the principle of *Late Insertion* in Distributed Morphology. Note, however, that I do not adopt a DM approach.

[17] The double lines indicate the link to phonology, i.e., the material below the double line does not appear in the syntactic component.

(23)



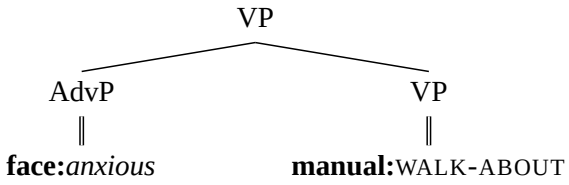
When this structure is sent to the phonological component, it must be converted into a valid phonological string. The two syntactic heads are mapped onto /ðə/ and /mæn/, respectively. Because these two chunks of phonological structure are both segmental, they must be realised on the same tier and therefore cannot be realised simultaneously. The structure must therefore be linearised and we end up with /ðəˈmæn/.[18]

Taking another example, the non-manual adverbial in (4b), repeated here:

(4) b. **face:** *anxiously*
hands: SCHRANK:3 KATZE HERUMGEH:Cl_{animal}:3
closet cat walk about
'A cat is walking about anxiously on the closet.'

A rough syntactic representation of the VP in this example is (24):

(24)



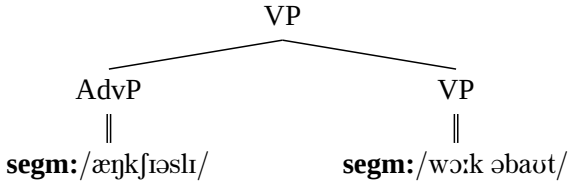
When this structure is sent to the phonology, the two elements are realised on different tiers:

(25) **face:** *anxious*
|
manual: WALK-ABOUT

Because they are realised on different tiers, the phonogical component can associate the two in the temporal sequence, so that they are realised simultaneously. If we look at the spoken-language (English) equivalent, however, it is obvious that simultaneous realisation is *not* possible:

[18] This of course requires that the phonological component can determine the correct order in which to linearise both elements, a point to which I return below.

(26)



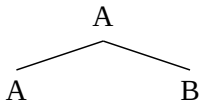
Because both phonological components in (26) are segmental, they must be realised on the same tier, so that simultaneous realisation is not possible and linearisation is required.

This is not the entire story, however. Note that although the sign-language example uses simultaneous realisation, it does not *have* to do so. There is a manual sign ANXIOUS in DGS that could be used instead. The question then is, why does the simultaneous option even exist? Why not use a manual sign to express the meaning ANXIOUS?

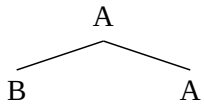
One answer to this question is of course "because it is possible and the speaker chooses to do so." However, this does not answer the more fundamental question *why* it is possible in the first place. An answer to this question, I believe, lies in the observation made in the previous section that an element A can be realised simultaneously with an element B if A is the sister of (an extended projection of) B.

Sisterhood in syntax is an unordered relation: the two trees in (27) are equivalent:

(27) a.



b.



The simultaneity data suggest that when the phonological system processes a node K(A,B), it first tries to express this unordered relation directly, i.e., by realising both elements A and B simultaneously. When the phonological forms of both elements are on different tiers, this is possible. Most of the time, however, the phonological forms are not on different tiers and a direct realisation of the unordered sisterhood relation becomes impossible. Therefore, a repair strategy has to be used, so that the structure can be realised. This repair strategy is linearisation.

Note that if linearisation were the default strategy of the phonological component, then we would not expect simultaneity to occur. Linearisation is always possible, all it requires is two elements whose phonological forms are segmental. Since the possible repertoire of segmental elements is by its very nature infinite, a UG that uses linearisation as its default strategy would yield languages in which all syntactic elements have a segmental phonological form.

On the contrary, a UG that uses simultaneous realisation as its default strategy will not have the effect that *all* phonological externalisation is simultaneous, for the simple reason that the possible repertoire of simultaneously realisable non-segmental elements is finite (and in actual fact relatively small), and because the number of autosegmental tiers is limited. Linearisation is therefore required as a second strategy in a UG that allows languages with the expressivity of human language.[19]

[19]This of course does not answer the more fundamental question why segments (i.e., phonemes in spoken languages and the components of manual signs in sign languages) have the status that they have in UG. It is theoretically feasible to have a combinatorial system with e.g. tone that has a similar infinity that phonemes have, but UG does

In other words, the sheer existence of simultaneity shows that simultaneous realisation, i.e., the direct expression of the unordered nature of the sisterhood relation, is the primary strategy of the phonological system, and that linearisation of phonological elements is a secondary strategy, one that is employed when simultaneous realisation is impossible. As pointed out above, this conclusion has a further consequence: linearisation is a process that takes place in the phonological component. It cannot be syntactic for the same reason that simultaneity cannot be syntactic: linearisation will only take place once the phonological forms of the elements to be linearised are known and it has been established that simultaneous realisation is impossible.

This does not mean, however, that the actual syntactic structure is not relevant to this proces. We can see this very clearly when we consider the sign-language example in (4b) again, together with its tree in (24). In this example the non-manual adverbial *anxious* is associated with the verb HERUMGEH 'walk about'. However, the entire utterance contains not just the manual sign HERUMGEH but also SCHRANK 'closet' and KATZE 'cat'. In fact, the principle of Left-to-Right Association says that the elements on two different tiers should be associated with each other from left to right, suggesting that the adverbial *anxious* should be associated with the first manual sign SCHRANK.

To be more precise, the principle of Left-to-Right Association recognises the fact that some autosegmental elements can only be associated with segments of a specific nature. Tones, for example, can only be associated with vowels, not with consonants. But the manual signs SCHRANK and HERUMGEH cannot be distinguished on phonological criteria, only on syntactic criteria. We do not, however, want to assume that the entire syntactic structure is still accessible in phonology. Such an assumption would render the Separation Hypothesis null and void.

Rather, we should look for a different way to limit the application of phonological composition to the relevant constituents. In a derivational theory such as I am assuming here, the obvious option is to say that phonological composition applies to chunks of structure, not to the syntactic structure as a whole. Possible candidates are nodes, the standard building blocks for trees, and phases (Chomsky 1999, 2008), chunks of structure sent to the interfaces.

In the previous section, the conclusion was reached that sisterhood plays a crucial role in phonological composition. It follows from this that phonological composition applies to nodes. That is, phonological composition takes a single node and derives a phonological structure from it. However, the data suggest that this phonological structure is not finalised immediately. Take the DGS negation example in (10), repeated here:

not utilise this option. Note, however, that such a system would also crucially rely on serialisation, so it would not yield an externalisation system that is more simultaneous in nature than the actual existing externalisation systems (the ones based primarily on voice and hands).

(10) a. **head:** *neg*——————⊣ *DGS*
hands: MUTTER BLUME KAUF
mother flower buy

b. **head:** *neg*
hands: MUTTER BLUME KAUF
mother flower buy
'Mother does not buy a flower'
(Cf. Pfau 2001, 2002)

There are several ways to express negation in DGS (see esp. Pfau 2001 for details), but the most common way is through a non-manual marker, specifically a headshake, that accompanies the verb, as indicated in (10b). This marker may spread over the entire VP, as in (10a), but it does not have to. These two options reflect the two possibilities arrived at in the previous section: Neg° is realised simultaneously either with its sister node or with the lexical head of its sister node.

Note that both variants in (10) have the same meaning. It is not the case that the negation scopes only over the verb in (10b) and over the entire VP in (10a). Therefore, we must assume that in both cases, Neg° is above VP. If each node is finalised immediately, we would expect that the only possible simultaneous realisation of the negation is (10a), in which negation spreads over the entire VP. Since (10b) is also a possibility, however, the merge order and projection line of the node {KAUF,BLUME} must still be available, otherwise it would not be possible to associate the negation with just the verb.

It seems, then, that when phonological composition of a node takes place, the syntactic information of that node is not immediately discarded. Rather, it is retained for at least a bit longer. How much longer is an open question, but in the framework assumed here, an obvious hypothesis would be to say that this information is retained until the syntactic phase containing the relevant node is completed. More specifically, assuming that Neg° is merged above *v*P, the information about the syntactic composition of the node {KAUF,BLUME} must be retained until the spell-out domain of the next higher phase head (here C°) is transferred to the phonological system.

This is of course a very sketchy account of the process of phonological composition. In the next section, I discuss the topic in some more detail, but many details will have to be left open for future research. The crucial point, however, is that the main strategy of phonological composition is simultaneity, and linearisation is merely a way to repair a structure that would otherwise not be externalisable.

When linearisation applies, the system of course needs a way to decide in which order the elements under consideration must be linearised. This question is largely orthogonal to the issue disscussed here, so we do not need to delve into it deeply. A few words should suffice.

As argued above, linearisation applies in the phonological module. This means that detailed syntactic information cannot be used to determine linearisation order. However, as just discussed, some syntactic information must be accessible and remains so for a short period of time. This information minimally (and ideally, maximally) includes the merge order and the headedness of the structure. Interestingly, it is exactly this information that is needed to implement a

PF-based LCA-like linearisation strategy. It is therefore feasible that when linearisation applies, it applies according to the principle that c-command translates to precedence. Because linearisation applies if simultaneous realisation cannot, phonological composition may be summarised as "C-command translates to simultaneity if possible, to precedence otherwise."[20]

5 Morphology

Some of the simultaneity examples in section 2 involve cases that could be considered morphological in nature, and some, such as the Arabic deverbal noun, that are generally considered to belong to the morphological component. Why then, would they be included here as examples of simultaneous realisation? If they are handled by the morphology, would we not expect that the "normal" syntactic regularities do not apply?

The point of this section is to argue that such examples do indeed need to be included, for the simple reason that there is no real distinction between syntax and morphology. There is only one structure-building component, which is responsible for building both types of structures: those that we consider to be 'syntactic' and those that we consider to be 'morphological'. There are several theoretical reasons in favour of such an analysis, which will be mentioned here only very briefly. Most of this section is devoted to the analysis of deverbal nouns in Arabic, which demonstrates the advantages of abandoning the syntax/morphology dichotomy.[21]

First, from a theoretical point of view, it seems odd that language should have two computational systems, one for morphology and one for syntax. Syntax connects form and meaning, but so does morphology. And even though in languages within the Indo-European language family, morphology is often limited to expressing agreement, tense, aspect and case, and does so with sometimes highly irregular forms, there are languages (e.g. Turkish, Nahuatl, Inuktitut, etc.) that use morphology in an extremely regular fashion. In such languages, a verb or noun stem is the basis for so many different forms that it is inconceivable that they are all "listed in the lexicon" (cf. Jackendoff 2002 for this argument).

Moreover, language change often involves morphologically complex forms being replaced by so-called "analytic", i.e., syntactic, forms. While Latin had a pluperfect *porta-v-erat* 'carry-PERF-3SG.PPF', the modern Romance languages use auxiliary constructions to express pluperfect (e.g., Spanish *había portado* '(s/he) had carried'). Obviously, syntax and morphology overlap in the meanings that they can express.

Another reason to doubt the syntax/morphology dichotomy is the fact that certain data seem to require a mixed analysis. Gerunds and gerund-like deverbal nouns are a typical case. As is well-known, English gerunds can assign (abstract) accusative case to their objects. This is a property that they share with gerund-like deverbal nouns in other languages. Arabic deverbal nouns are no exception, as demonstrated in (15), repeated here:

[20] It is of course not inconceivable that a different approach to linearisation, using linearisation parameters, is also possible. Discussing these options would go beyond the purpose of this paper, however.

[21] The idea that syntax and morphology should be reduced to a single computational system is not new. It has been argued for on various grounds by e.g., Abney (1987), Halle & Marantz (1993), Siebert (1999), Julien (2002), and others.

(15) (ʔaqlaqa-nī) -ntiqād-u -l-rağul-i -l-mašrūʕ-a *Arabic*
(annoyed-me) criticising-NOM the-man-GEN the-project-ACC
'The man's criticising the project annoyed me.'

The deverbal noun *(i)ntiqād* 'criticising' assigns accusative case to the object, *mašrūʕ* 'project'.[22] Nouns do not normally assign accusative case, nor is case-assignment a process that is normally considered to belong to morphology. One solution to this problem, proposed by Abney (1987), is to assume that in the syntactic derivation, the deverbal noun actually starts out as a verbal head and that the verbal projection is converted into a nominal one by a nominalising affix. The problem with such an analysis is of course that we must assume that the word form, *(i)ntiqād* in this case, is formed "in syntax".

An approach that takes the Separation Hypothesis seriously can solve this issue by assuming that the actual word formation process takes place in the phonological component. To illustrate this, I will examine the Arabic deverbal noun in some more detail. As argued for by McCarthy & Prince (1990) (see also Kremers 2007), an Arabic deverbal noun contains four separate morphemes, which are listed in (28), together with the forms they have in the case of *(i)ntiqād*:

(28)

root:	/nqd/
stem VIII:	$(\sigma)\sigma_{\mu}$
	|
	/t/
nominaliser:	/i.a/
non-finite marker:	$\text{-}\sigma_{\mu\mu}$

Roots in Arabic consist of usually three consonants. These consonants appear in a fixed order (i.e., /nqd/ is a different root from /qnd/), but they of course require a pattern of vowels to be pronounceable. From each root, a total of 15 different verb stems may be derived, which are usually numbered with Roman numerals, I–XV.[23] These stems are characterised by syllabic patterns, sometimes augmented with pre- or infixes. The pattern for stem VIII consists of an extrametrical syllable followed by a short syllable with an onset position filled by the segment /t/.[24]

The root and the stem morpheme together form the lexical stem of the verb in question. That is, although the different stems often contribute a specific meaning component (e.g., stem II is intensive, stem III applicative, stem IV causative, stem VIII reflexive, etc.) there are many verbs in which this meaning component is not (or no longer) visible. *(i)ntaqada*, for example, has no reflexive meaning, although it is a stem VIII verb.

The other two morphemes in (28), the nominaliser and the non-finiteness marker, together derive the deverbal noun. The nominaliser is the actual nominalising morpheme, but each verbal word form in Arabic needs a marker for finiteness, either finite ($\text{-}\sigma_{\mu}$) or non-finite ($\text{-}\sigma_{\mu\mu}$). These

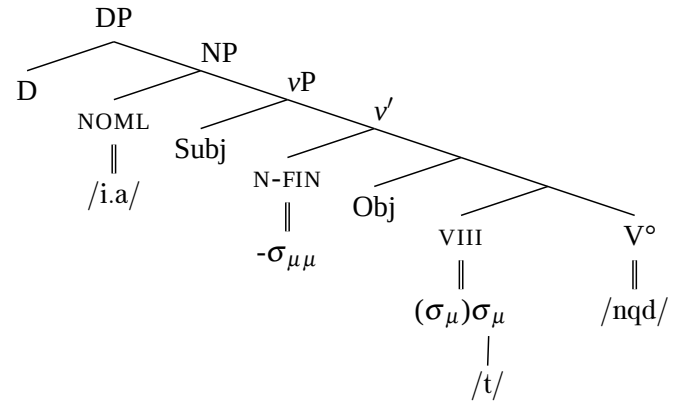
[22] Note that the subject has genitive case. Deverbal nouns in Arabic do not assign nominative case.
[23] There is no root for which all 15 verb stems exists, and in fact, stems XI–XV are extremely rare.
[24] Note that Arabic only allows a single consonant in the onset.

are suffixed to the stem morpheme, which I have indicated here with the hyphen.[25]

Two of the morphemes in (28) are syllabic, that is, they consist of syllable structure rather than of segmental material and are projected on an autosegmental (syllabic) tier (cf. Goldsmith 1976, McCarthy & Prince 1996). The syllabic and the segmental tier are of course associated with each other. In this sense, the word form is clearly an example of simultaneity.

As I argued above, the deverbal noun must be derived in syntax. Let us look at a possible tree:

(29)



I assume that the verb and the stem marker merge first since they contain the lexical meaning of the verb *(i)ntaqada* 'to criticise'.[26] The node thus created selects the object. I assume that the non-finite marker that McCarthy & Prince propose can be equated to the *v* head.[27] If this is a correct assumption, the subject is merged next, as it is selected by *v*. Lastly, the nominaliser is merged.

What happens next partly depends on the presence or absence of arguments. A deverbal noun can take a subject and object, as in the example here, which receive genitive and accusative case, respectively.[28] Depending on selectional criteria, it may also have the ability to take just one argument, either a subject or an object, which then receives genitive case. Lastly, a deverbal noun may take no argument at all. In that case, the deverbal noun has an overt determiner. When a genitive-marked argument, either object or subject, is present, the deverbal noun has no determiner, but instead takes the so-called *construct state*, the normal form for nouns with a genitive modifier.[29]

In Kremers (2003: 137), I argue that a construct state noun is headed by a special D head that lacks phonological content and therefore attracts the verbal head. This D head has a [+POSS] feature, which triggers the special construct state form. On its way up to D, V picks up the

[25] The fact that the non-finite marker and the nominaliser are separate heads makes sense given that verbs may also form participles, which have the same non-finite marker but obviously lack the nominaliser.

[26] In fact, in the approach advocated here, this is best seen as a "treelet" stored in the lexicon.

[27] Although nothing really hinges on this assumption. But note that when a verb has a finite marker instead of the non-finite marker, it still requires tense and agreement markers, which suggests that the finite marker cannot be identified with the T head.

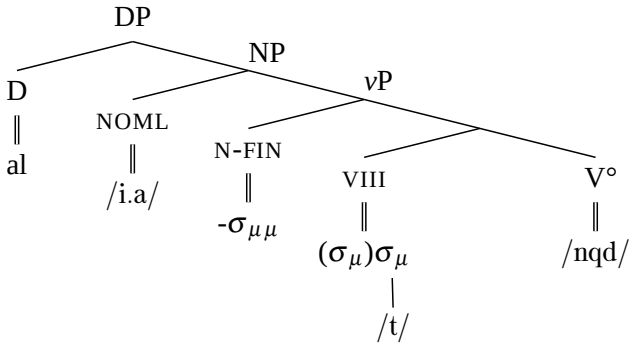
[28] Alternatively, the object is introduced with the preposition *li* 'to, for'. I take this, following Abney, to mean that the nominaliser and non-finite marker are merged before the object, so that no accusative case assignment is possible.

[29] See, e.g., Fassi Fehri (1993), Kremers (2003) for details.

intermediate heads VIII, N-FIN and NOML, yielding a complex head that includes all relevant morphemes.

When the verb does not project any arguments, D° lacks a [Poss] feature and V does not move. This raises the question how all morphemes end up together. Surprisingly, perhaps, this is not necessarily problematic:

(30)



If no arguments are present, the relevant heads already *are* together. There already is a subtree that incorporates the four morphemes, namely the NP in (30). Phonological composition of this subtree will yield the form *(i)ntiqād*.

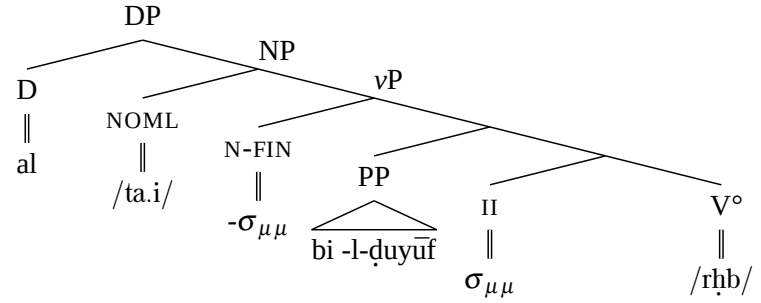
More problematic, however, is the case of a deverbal noun that takes a PP argument. In this case, the argument does not receive genitive case, so that the deverbal noun does not take the construct state form. Let us look at an example: the verb *raḥḥaba* 'to welcome, greet' selects a PP headed by *bi* 'with':

(31) a. raḥḥaba bi -l-ḍuyūf-i
welcome.PERF.3SG with the-guests-GEN
'He welcomed the guests.'

b. al-tarḥīb-u bi -l-ḍuyūf-i
the-welcoming-NOM with the-guests-GEN
'The welcoming of the guests'

The verb *raḥḥaba* is a stem II verb, which has a stem marker of the form $\sigma_{\mu\mu}$. As I argue in Kremers (2007), stem II verbs have a different nominaliser morpheme, consisting of the segments /ta.i/. The resulting deverbal noun is *tarḥīb* (as in the case of *(i)ntiqād*, the length of the second vowel, here /iː/, is the result of spreading due to the bimoraic syllable of the non-finite marker). Assuming again that the V head and the stem marker merge before selecting the PP object, the tree for the deverbal noun in (31b) is the following:

(32)



Again, if we adopt a syntactic movement approach, we must assume that movement from V to NOML takes place in order to obtain a subtree with all relevant morphemes in it. It is not clear, however, what triggers this movement. Above, I followed an earlier assumption and said that the movement of V to D is motivated by the fact that $D_{[+POSS]}$ is phonologically empty. In (32), the trigger for movement could be the fact that the nominaliser does not consist of an independently realisable form, either, so that it needs support as well.

However, given that I adopt the Separation Hypothesis, such a motivation for movement becomes suspicious. Head movement as assumed here takes place in syntax, while the trigger for movement is phonological in nature. If the syntactic component has no access to phonological material, it cannot determine whether the V head must move or not.

I believe that the intuition that V-movement takes places for phonological reasons, i.e., in order to combine the various morphemes, is essentially correct. Since this movement cannot be syntactic, we need a phonological mechanism to ensure that V° and its associated morphemes end up in the correct position. As a first step toward such a mechanism, I adopt another principle proposed by Ackema & Neeleman (2004), *Input Correspondence*:

(33) Input Correspondence:
If Y selects (a category headed by) X, then Φ(Y) takes Φ(X) as its host.

The rationale behind Input Correspondence is the common-place assumption that an affix must combine with a head. Ackema & Neeleman point out that this requirement actually breaks down into two components: a categorial (and therefore *syntactic*) requirement that an affix Y selects a category X, and a phonological requirement that an affix — or rather, its phonological form — must attach to a prosodic word. Ackema & Neeleman argue that in syntax, an affix may attach to any projection level. It is not restricted to attaching to an X°, it may equally well attach to an XP.[30] The requirement that the affix attach to a head is a *phonological* one. That is, the phonological form that the affix is mapped onto, denoted here as Φ(Y), must attach to Φ(X), i.e., to the phonological form of the *head* of the category it attaches to in syntax.

Input Correspondence guarantees that Φ(NOML), Φ(N-FIN) and Φ(VIII)/Φ(II) all take Φ(V) as their host,[31] but it does not guarantee that the resulting word form ends up in the right posi-

[30] In fact, in a bare phrase structure approach (which Ackema & Neeleman do not adopt), such an assumption seems inevitable. Note that this approach provides an easy way to distinguish affixes from (phonological) clitics. While the former are subject to Input Correspondence, the latter are not.

[31] In fact, in the analysis proposed here, Φ(NOML) only does so indirectly, as it selects *v* rather than V. But since Φ(*v*) is itself an affix that attaches to V, any element that attaches to it automatically attaches to V as well.

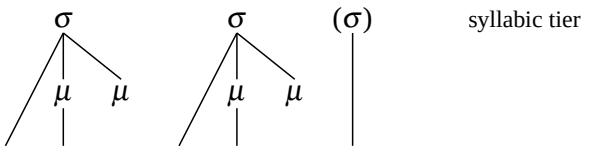
tion, i.e., in the position of NOML in (32). The bottom-up, step-by-step nature of phonological composition that I have assumed in the previous paragraph provides a tentative answer to this question, however. Phonological composition first applies to the lowest node, combining $\sigma_{\mu\mu}$, the stem II morpheme, and /rḥb/, the verb root. These two morphemes cannot be combined into a pronounceable form. Note, however, that I assumed above that phonological composition is not finalised until the next higher spell-out domain is transferred. It follows, then, that the form built so far is not necessarily the final form. It is still possible for additional morphemes to be added, which is exactly what happens.

When phonological composition applies to the *v*P node in (32), the phonological system finds a syllabic morpheme -$\sigma_{\mu\mu}$ that cannot stand alone and needs to combine with some other material. Input Correspondence entails that this material is Φ(V), which has already been combined with Φ(II). The combined material still does not yield a pronounceable form, but phonological composition has also not been finalised yet. At the next node, /ta.i/ is added into the mix. At this point, the phonological system has everything needed to compose a licit prosodic word.

Let us see how phonological composition yields the word form *tarḥīb*. The two syllabic morphemes are mapped onto the syllabic tier (which, as mentioned, has the status of an autosegmental tier in Arabic). The segments are of course mapped onto the segmental tier. The crucial part is the linking of the syllabic slots with the segments.

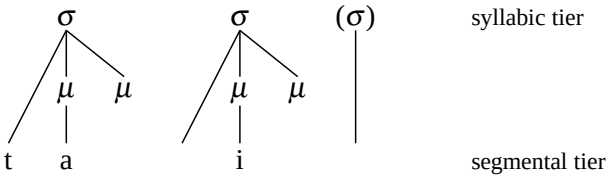
First, consider the syllabic tier. It contains Φ(II) followed by Φ(N-FIN). The latter morpheme is lexically specified as a suffix. Furthermore, each word in Arabic ends in an extrametrical syllable, so one is added. The resulting schema is (34):

(34)



Linking this syllabic skeleton with the nominaliser morpheme yields the following:

(35)

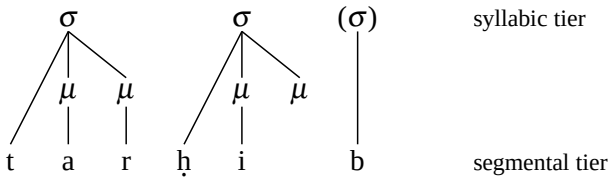


The segments of the morpheme are associated with appropriate slots from left to right. The /ta/ part is associated with the onset and nucleus of the first syllable, the /i/ part with the nucleus of the second syllable. Note that the vowel /i/ cannot be associated with the second mora of the first syllable, because Arabic phonology does not allow two vowels in a single syllable.[32]

If we then add the segments of the root, the following picture emerges:

[32] Arabic does have long vowels, but they result from spreading. It also has the diphthongs /ai/ and /aw/, but they result from combinations of vowel + glide.

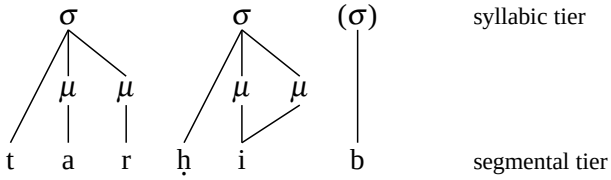
(36)



The first available position, which is the coda of the first syllable, is associated with the first root consonant /r/. The second available position is the onset of the second syllable, which is occupied by /ḥ/. The third root consonant, /b/ must be associated with the extrametrical syllable, because there is no other element that could otherwise fill this position. This actually conflicts with the principle of Left-to-Right Association, because Arabic does allow coda consonants, so that the /b/ could in principle occupy the coda position of the second syllable. The requirement of a stem-final extrametrical syllable overrides Left-to-Right Association, however.

This now leaves the second mora of the second syllable not associated with any segment. Therefore, the vowel /i/ spreads, filling both morae:

(37)



The important point to remember here is that there is no alternative way in which the four morphemes in the tree in (32) can be put together. If we were to place the first root consonant /r/ into the onset position of the first syllable, this syllable would remain without a vowel: Left-to-Right Association requires that the /a/ of the nominaliser follows the /t/, and the first available position for /t/ is the coda of the first syllable.

The method outlined here essentially implements a form of phonological head movement. The net effect is that V moves to NOML, taking along the intervening heads. Although it does not answer all relevant questions (such as, for instance, what happens in the case of head movement of an element that can, in principle, form a pronounceable prosodic word?) the current example demonstrates how a morphologically complex form can be derived from a syntactic tree without making reference to a separate morphology module in the grammar.

6 Conclusions

The data discussed in section 2 shows that the process of deriving a phonological structure from a syntactic one is not just a matter of lining up terminal elements. We need a more comprehensive picture of this process of phonological composition. The present paper looks at some of the issues involved and makes some suggestions toward solving the questions that are raised.

The system proposed here can be outlined as follows:

- Phase-based transfer of syntactic structures to the phonological component.

- If possible, two sister nodes are linearised simultaneously.
- If a syntactic node corresponds to an intonational pattern (in spoken languages) or a non-manual marker (in sign languages), simultaneous realisation may yield a structure in which this pattern or marker overlies a phrase, rather than a single prosodic word (head).
- If simultaneous realisation is not possible, linearisation is applied as a repair strategy.
- The only syntactic information available to the phonological system is the merge order and headedness. The phonological system does not have access to the morphosynactic features of the syntactic heads. (They are only accessible to the process that maps those heads onto phonology (i.e., the equivalent in the current model of Vocabulary Insertion), immediately before phonological composition takes place.
- The syntactic structure that is sent to the phonological system is not discarded immediately, but retained until the next phase is transferred.

The fact that phonological composition is not finalised (i.e., that the information about merge order and headedness is not discarded) until the next phase is transferred makes it possible for certain lowering effects (e.g., the DGS negation expressed on the verb) and for head movement to take place in phonology, rather than in syntax proper.

Without a doubt, the proposal made in this paper raises many questions. It is only an initial attempt at answering the questions that simultaneity effects raise for the theory of linearisation. The proposed analysis integrates syntax and phonology in order to answer questions that were formerly thought to be primarily syntactic, which is an approach that is still relatively new in generative syntax. Still, the potential gains for syntactic theory, the ability to integrate non-segmental structures in syntax together with a new perspective on head movement (which has sometimes been suggested to be phonological but without any concrete proposal), suggest the proposal is worth pursuing further.

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